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Plurality of Social Currencies:
solidarity economy, municipal and community currencies for inclusive and sustainable futures

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INCLUSIVE PAYMENT AND SOCIAL COIN SOLUTION

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Abstract

This paper proposes the Inclusive Payment and Social Coin Solution, designed to leverage blockchain technology to enhance financial inclusion and promote community welfare. The solution aims to create a centralized global platform that aggregates contributions from value-based investors and everyday consumers. Serving as a communal repository for social coins, this platform facilitates community development, supports local businesses, and provides individual financial assistance. By utilizing economic theories such as cooperative economics and social capital theory, the solution seeks to incentivize positive social behaviors and empower beneficiaries to utilize social coins for both consumption and investment purposes. This paper outlines the technological framework, regulatory considerations, and potential impact of the proposed model, highlighting its significance in addressing global financial disparities.

Keywords: Inclusive Payment, Blockchain, Social Coin

1. Introduction

Financial inclusion is a pressing global challenge that affects billions of individuals, particularly those in underserved communities. According to the World Bank's Global Findex Database (2021) [1], approximately 1.7 billion adults worldwide remain

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unbanked, lacking access to basic financial services such as savings accounts, credit, and insurance. This financial exclusion perpetuates cycles of poverty and hinders economic development, as individuals are unable to save, invest, or access capital necessary for starting businesses or improving their livelihoods.

The barriers to financial inclusion are multifaceted, encompassing high transaction costs, geographical constraints, and significant information asymmetries. Traditional banking systems often impose fees that disproportionately affect low-income individuals and families, discouraging them from utilizing formal financial services. Additionally, in rural areas, the absence of physical bank branches can limit access, leaving populations reliant on informal financial networks that may charge exorbitant rates and lack regulatory oversight.

In response to these challenges, a variety of alternative solutions have emerged over the years, including microfinance, community currencies, and digital wallets. Microfinance institutions (MFIs) [2] have gained traction in providing small loans to low-income individuals, enabling them to engage in income-generating activities. While MFIs have successfully lifted millions out of poverty—evidenced by a reduction in poverty levels in regions like South Asia—critics point out that the model can lead to over-indebtedness and high-interest rates, trapping borrowers in a cycle of debt.

Community currencies, such as the Bristol Pound in the UK and the Chiemgauer in Germany[3], have aimed to strengthen local economies by encouraging spending within communities. These initiatives promote social cohesion and support local businesses but often remain limited to small geographic areas and lack the scalability needed to drive widespread economic impact.

Digital wallets and mobile banking platforms, exemplified by M-Pesa in Kenya[4], have revolutionized access to financial services by enabling users to send money and pay bills via mobile phones. M-Pesa's success illustrates the potential for technology to bridge the gap in financial services, having processed over $1 billion in transactions monthly as of 2020. However, challenges remain in ensuring security, education, and infrastructure support for underserved populations, which are critical components of the financial ecosystem. The Pix payment[5] system in Brazil also has transformed financial access, enabling instant, free transactions for all, including those traditionally excluded from banking.



Against this backdrop, the Inclusive Payment and Social Coin Solution emerges as a promising approach that leverages the advantages of blockchain technology to create a more inclusive financial ecosystem. This solution aims to harness the power of social coins— digital tokens designed specifically for community engagement and social welfare— to provide a platform where individuals can contribute to and benefit from local initiatives. Pix has boosted local economies and promoted financial inclusion. This innovation is a powerful step toward an inclusive, digitally connected economy in Brazil but lacks powerful characteristics of a Blockchain solution like security, transparency and fine-grained traceability of the transactions.

The proposed solution is built on the premise that by creating a centralized global platform for social coins, users can engage in peer-to-peer transactions that promote local economic development and foster community resilience. The platform will allow individuals to utilize social coins for various purposes, including purchasing goods and services, investing in community projects, and supporting local businesses. By emphasizing transparency and traceability in transactions, the solution aims to build trust among users and enhance the overall effectiveness of social coins.

In summary, this paper outlines the Inclusive Payment and Social Coin Solution, detailing its conceptual framework, technological underpinnings, and the economic theories that will guide its implementation. By promoting financial inclusion and community development, the proposed model seeks to address the critical barriers that many individuals face in accessing financial services, ultimately empowering communities and fostering sustainable economic growth.

2. Conceptual Framework

2.1 Social Coins Defined

Social coins are innovative digital currencies designed to facilitate community engagement and incentivize positive social behaviors within a defined ecosystem. Unlike traditional currencies that primarily focus on investment and speculative gains, social coins are purposefully created to enhance social welfare and strengthen community ties. The rise of digital currencies has opened new avenues for economic interaction, allowing for the development of currencies that serve specific social purposes.

Social coins operate within a blockchain framework, which provides security, transparency, and traceability in all transactions. The utilization of blockchain technology ensures that each transaction is recorded in an immutable ledger, making it easier for users to verify the flow of funds and understand the impact of their contributions. This feature is critical in fostering trust and accountability, which are essential for user participation in community driven initiatives.

Key characteristics of social coins include:

- Decentralization: Social coins facilitate direct peer-to-peer transactions, removing the need for intermediaries such as banks or payment processors. This decentralization not only reduces transaction costs but also empowers individuals to take control of their financial interactions, encouraging active participation in the local economy.

- Transparency and Traceability: Each transaction conducted using social coins is recorded on the blockchain, allowing users to see how their contributions are being utilized. This level of transparency promotes accountability among project leaders and community organizations, ensuring that funds are directed toward initiatives that genuinely benefit the community.

- Incentive of Positive Behaviors: Social coins can be structured to reward users for engaging in activities that foster community development, such as volunteering, supporting local businesses, or participating in community events. By linking the use of social coins to tangible social outcomes, the platform encourages users to align their spending with their community's goals.

- Accessibility: Social coins are designed to be user-friendly and accessible, particularly for individuals with limited digital literacy. Features such as mobile applications, physical tokens, and educational resources will be developed to help users navigate the system and understand how to leverage social coins effectively.

2.2 Centralized Platform Design

The Inclusive Payment and Social Coin Solution proposes a centralized global platform that aggregates contributions from users and provides a comprehensive framework for the use of social coins. This platform will serve as a communal repository for social coins,

facilitating transactions, investments, and community engagement. Key aspects of the platform design include:

• User Experience: The platform will prioritize user experience, ensuring that the interface is intuitive and accessible to all users, regardless of their technological proficiency. This may involve creating straightforward onboarding processes, employing clear and simple language, and ensuring that essential features are easy to navigate.

• Transaction Efficiency: To encourage widespread use of social coins, the platform will implement fast and low-cost transactions. By optimizing the transaction process and minimizing fees, the platform can facilitate regular interactions among users and promote the frequent use of social coins in everyday transactions.

• Community Engagement Features: The platform will incorporate various community engagement tools, such as forums and event calendars, to foster interaction among users. These features will enable users to share their experiences, provide feedback, and collaborate on community projects, strengthening social ties and enhancing the overall impact of social coins.

• Data Analytics and Reporting: The platform will utilize data analytics tools to track user engagement, spending patterns, and the impact of community projects funded by social coins. By providing insights into how social coins are being used and their effects on the community, the platform can continually refine its approach and demonstrate the value of user contributions.

• Integration with Existing Financial Systems: To enhance adoption, the platform will explore partnerships with local businesses, financial institutions, and government agencies. By integrating social coins into existing financial systems, the platform can facilitate the transition from traditional currencies to social coins, making it easier for users to participate in the ecosystem.

2.3 Expected Outcomes

The implementation of the Inclusive Payment and Social Coin Solution is expected to yield several positive outcomes, including:



• Increased Financial Inclusion: By providing a platform for unbanked individuals to engage in financial transactions, the solution can empower underserved populations and enable them to access essential services.

• Strengthened Community Ties: The emphasis on community engagement and shared responsibility will foster stronger social bonds, encouraging collaboration and mutual support among participants.

• Economic Empowerment: By enabling individuals to invest in local businesses and initiatives, social coins can drive economic growth at the community level, creating job opportunities and enhancing overall prosperity.

• Enhanced Transparency and Accountability: The use of blockchain technology will promote transparency in transactions, ensuring that funds are used effectively and in alignment with community goals.

• Sustainable Community Development: By focusing on community-driven initiatives and projects, the solution can contribute to sustainable development efforts that prioritize social welfare and environmental stewardship.

3. Technical Framework

We are revolutionizing the payment of benefits and social coins through the innovative application of blockchain technology. By transforming traditional benefit payments into social coins, we are pioneering a new approach that offers enhanced security, transparency, and efficiency allowing the access to the blockchain solution using the common physical cards and not just mobile phone applications.

Our system represents one of the first tokenized benefit payment ecosystem in Brazil, setting a new standard for how benefits are distributed and utilized. This groundbreaking initiative leverages blockchain's decentralized nature to ensure immutability and traceability of transactions, eliminating intermediaries and reducing the risk of fraud. Implementing a tokenized benefit payment system offers significant advantages for the state, population, and businesses. For the state, eliminating intermediaries and using a single card for multiple benefits enhances control and allows real-time monitoring of expenses.

This system also provides high traceability, transparency, and ease of auditing expenses, while facilitating the financial and technological inclusion of the needy population. The population benefits from easy access using physical cards and immediate consultation of their tokenized benefits through a multi-benefit card, which consolidates several benefits into one digital wallet. Establishments and businesses enjoy lower costs associated with receiving fees, can immediately use the currency in other establishments due to its circular nature, and experience faster transfer of resources.

3.1 The Use Case in the State of São Paulo

A prime example of this technology in action is the Santo Antônio da Alegria in the State of São Paulo with the Alegria Coin initiative [6]. It was initially implemented by the city hall for the payment of food vouchers to its employees. Figure 1.0 shows the migration from the traditional solution to a web3 solution.



Fig. 1. Traditional Model versus Web3 Model

The C9 Tech Platform for Social Coin stands as a groundbreaking solution poised to revolutionize benefit payment systems through web3 physical cards. By addressing the shortcomings of traditional methods, it enhances security, transparency, and

efficiency while promoting financial inclusion and sustainability. The platform's successful implementation, as seen in the Santo Antônio da Alegria for Alegria Coin initiative, highlights its potential to transform the distribution of social benefits, ensuring that resources reach those in need more effectively. As we move towards 2026 and beyond, embracing this technology will be crucial for building a more inclusive, equitable, and sustainable society.

4. Fueling Community Growth

The Inclusive Payment and Social Coin Solution will harness a variety of economic principles to enhance user participation and ensure the effective use of social coins within the community. By focusing on cooperative dynamics, building community connections, and fostering motivation through values, the platform aims to create an environment where users feel a sense of ownership and responsibility towards their community. This section outlines the mechanisms and strategies through which the platform will achieve these objectives.

4.1 Collective Prosperity

The foundation of the platform rests on the principles of collective prosperity, emphasizing collaboration and mutual benefit among participants. This approach acknowledges that collective efforts can yield greater returns for individuals and communities than isolated actions. Key features of this model may include:

- Collective Contribution Mechanism: The platform will allow users to pool their social coins to fund community initiatives, including local businesses, social services, or infrastructure projects. This mechanism not only democratizes funding but also encourages a sense of shared responsibility among users. Research has shown that community-driven funding models can significantly improve local economic outcomes, as they foster investment in projects that directly address the needs and preferences of the community [7].

- Decision-Making Participation: To enhance the sense of ownership, the platform will incorporate mechanisms for users to vote on projects or initiatives that receive funding from social coins. This participatory approach ensures that community members have a say in how resources are allocated, fostering democratic

engagement and increasing the legitimacy of funded projects. By empowering users to influence decisions, the platform can create a more responsive and adaptive ecosystem.

• Shared Goals and Outcomes: The platform will facilitate discussions and workshops to establish shared goals among community members. By identifying common objectives, users can collectively work towards initiatives that reflect their values and priorities, enhancing the sense of community ownership.

4.2 Building Community Connections

Incorporating the idea of building community connections is essential for enhancing engagement and trust among users. This concept refers to the networks of relationships and shared values that enable individuals to cooperate within a community. The platform will facilitate the development of these connections through:

• Network Building: The platform will create opportunities for users to connect and collaborate, fostering relationships that enhance community cohesion. Features such as user forums, discussion groups, and social events will be integral in facilitating interactions. These networks can serve as vital resources for sharing information, skills, and support among participants, ultimately strengthening the community fabric.

• Community Recognition Programs: To reinforce community connections, the platform will implement recognition programs that celebrate individuals and groups contributing positively to the community. By highlighting their contributions through social media shout-outs, awards, or community events, the platform promotes role models and encourages others to engage. Recognizing contributions can increase motivation and inspire collective action, as individuals see tangible examples of the impact they can make.

• Mentorship and Support Systems: The platform can also foster mentorship opportunities, where experienced community members guide newcomers in using social coins effectively or starting local initiatives. By nurturing these relationships, the platform can facilitate knowledge transfer and build a more resilient community network.

4.3 Motivation through Values

The platform will utilize incentive structures rooted in motivation through values, focusing on intrinsic motivations that drive user engagement. This approach recognizes that individuals are influenced by their values, beliefs, and social norms. The platform may include:

- Value-Aligned Incentives: Users will be encouraged to use social coins for purchases that align with their values, such as eco-friendly products, ethical businesses, or community projects. By creating a strong connection between personal values and the use of social coins, users may feel more motivated to engage with the platform. Research indicates that consumers are more likely to support brands and initiatives that resonate with their personal beliefs, enhancing loyalty and long-term participation [8].

- Impact-Oriented Feedback: The platform can provide users with narratives showcasing the direct impact of their contributions on community projects and initiatives. For instance, sharing success stories about how social coins have been used to support local charities or fund community events can deepen emotional connections and reinforce user engagement. Emotional storytelling can be a powerful tool for building community solidarity and encouraging ongoing participation.

Gamification Elements: Incorporating gamification strategies—such as badges, leaderboards, and challenges—can further enhance motivation. By framing participation as a game with rewards and recognition for engagement, users may be encouraged to interact more frequently with the platform. Gamification has been shown to increase user engagement significantly, making the process of contributing to community initiatives enjoyable and rewarding.

4.4 Measuring Success and Impact

To ensure that the strategies employed in the Inclusive Payment and Social Coin Solution are effective, it is essential to measure the success and impact of the initiatives. The platform will implement:



• Data Analytics: Advanced analytics tools will be used to monitor user engagement, track spending patterns, and assess the effectiveness of community projects funded by social coins. These insights can inform future initiatives and enhance the overall impact of the platform.

• Feedback Mechanisms: Regular surveys and feedback tools will be incorporated to gather user input on their experiences with the platform. Understanding user satisfaction and areas for improvement will be critical for ensuring the platform meets community needs.

• Impact Reports: The platform will produce regular impact reports that highlight the achievements of funded initiatives, including quantitative and qualitative data on how social coins have benefited the community. Sharing these reports with users will reinforce the value of their contributions and encourage continued engagement.

5. Empowering Community and Beneficiaries

The Inclusive Payment and Social Coin Solution is fundamentally aimed at empowering users and enhancing the capabilities of communities through targeted educational resources and investment opportunities. This empowerment not only contributes to individual financial stability but also fosters a resilient and interconnected community. This section outlines how the platform will achieve these goals through educational initiatives and investment mechanisms.

5.1 Educational Resources

Recognizing that financial literacy is a crucial barrier to effective participation in any economic system, the platform will prioritize the development and dissemination of educational resources tailored to the needs of its users. These resources will cover a variety of topics essential for users to understand and effectively use social coins. Key components of the educational strategy include:

• Workshops and Webinars: The platform will host regular workshops and webinars aimed at enhancing users' financial literacy. Topics may include personal finance management, savings strategies, budgeting, understanding digital currencies, and the benefits of supporting local economies. Expert facilitators can lead these sessions, offering participants valuable insights and practical skills.

According to the Financial Literacy and Education Commission (FLEC), improved financial literacy can lead to better financial decision-making, higher savings rates, and increased investments in local communities [9].

• Online Learning Modules: Accessible online learning modules will be created to provide users with flexible options for engaging with educational content. These modules can incorporate interactive elements, such as quizzes and simulations, to enhance learning and retention. Providing resources in multiple languages can also ensure inclusivity and broaden access to diverse user groups.

• Resource Guides and Toolkits: The platform will develop comprehensive resource guides and toolkits that users can reference as they navigate financial decisions. These guides will cover practical aspects of using social coins, such as how to make transactions, invest in community projects, and understand the impact of their contributions.

• Peer-to-Peer Learning Opportunities: Encouraging users to share their experiences and knowledge can foster a culture of learning within the community. The platform can facilitate peer-to-peer learning through mentorship programs, discussion forums, and community events, allowing individuals to learn from one another's successes and challenges.

5.2 Investment Opportunities

The ability to invest social coins not only enhances user engagement but also promotes economic empowerment within the community. By allowing beneficiaries to utilize social coins for investment, the platform can create a cycle of growth and sustainability. Investment opportunities may include:

• Micro-Investments in Local Businesses: The platform can facilitate micro-investment opportunities, enabling users to invest small amounts of social coins in local startups or small businesses. This not only provides crucial capital for entrepreneurs but also fosters a sense of ownership among investors, as they directly support the growth of their local economy. Research by the Global Entrepreneurship Monitor (GEM) indicates that microfinance and similar initiatives can significantly boost entrepreneurship and job creation in local communities.



• Crowdfunding Initiatives: The platform can host crowdfunding campaigns for community projects, allowing users to support initiatives that align with their values and priorities. By aggregating social coins from multiple contributors, the platform can fund larger projects, such as community centers, educational programs, or local infrastructure improvements. Successful crowdfunding campaigns can galvanize community support and increase participation.

• Social Impact Investment Opportunities: The platform may also explore partnerships with social enterprises that focus on generating social and environmental impact alongside financial returns. By allowing users to invest in these enterprises using social coins, the platform can enable beneficiaries to align their financial activities with their social values, thereby fostering a sense of purpose and fulfillment.

• Investment Education: To empower users in their investment decisions, the platform will provide education on different types of investment opportunities, risk assessment, and portfolio diversification strategies. By enhancing users' understanding of investment principles, the platform can equip them to make informed choices that align with their financial goals and community values.

5.3 Measuring Empowerment and Impact

To ensure that the strategies employed in the Inclusive Payment and Social Coin Solution are effective, it is essential to measure the empowerment and impact of the initiatives. The platform will implement:

• Impact Assessments: Regular assessments will be conducted to evaluate the effectiveness of educational programs and investment opportunities. This will involve collecting qualitative and quantitative data on user engagement, knowledge acquisition, and financial outcomes resulting from participation in the platform.

• User Feedback Mechanisms: Gathering user feedback through surveys, interviews, and focus groups will provide valuable insights into the effectiveness of the resources and opportunities offered. This information will be crucial for continuously improving the platform and addressing the needs of the community.



• Success Stories and Case Studies: Documenting and sharing success stories of individuals or businesses that have benefited from the platform can serve to motivate and inspire other users. These narratives can illustrate the tangible impact of social coins and the empowerment strategies employed, reinforcing the community's commitment to collective growth

6. Regulatory Considerations

To ensure the successful implementation of the Inclusive Payment and Social Coin Solution, navigating the regulatory landscape is essential. The integration of blockchain technology and digital currencies into financial ecosystems introduces various legal, regulatory, and compliance challenges. This section outlines the key regulatory considerations that must be addressed to facilitate the deployment of the platform while ensuring user protection and fostering trust among participants.

6.1 Compliance with Local Regulations

The platform must engage with relevant regulatory authorities to ensure compliance with local financial laws and regulations governing digital currencies. This includes:

• Licensing and Registration: Depending on the jurisdiction, the platform may need to obtain specific licenses to operate as a digital currency platform or financial service provider. Understanding the regulatory requirements in different regions is crucial to avoid legal repercussions and ensure smooth operation.

• Anti-Money Laundering (AML) and Know Your Customer (KYC) Regulations: Compliance with AML and KYC regulations is vital for preventing illicit activities, such as money laundering and fraud. The platform will need to implement robust user verification processes to identify and verify users before allowing them to engage in transactions. This may include requiring users to provide identification documents and verifying their identities through third-party services.

• Taxation Policies: Understanding the tax implications of transactions involving social coins is critical. The platform will need to provide users with clear guidelines on tax reporting and obligations associated with their use of social coins.

Collaboration with tax authorities can help ensure compliance and provide users with the necessary information to fulfill their tax responsibilities.

6.2 Building Trust through Transparency

Transparency in operations is crucial for building trust among users and regulatory bodies. The platform should establish policies and practices that promote transparency, including:

- Clear Communication of Policies: Providing users with comprehensive information about the platform's policies, including terms of service, privacy policies, and user rights, will help build trust and confidence in the platform's operations.
- Regular Reporting and Audits: Conducting regular audits of the platform's financial operations and publishing transparent reports can enhance accountability. Users should have access to information about how social coins are generated, used, and distributed, ensuring that funds are managed responsibly.
- Engagement with Regulatory Authorities: Actively engaging with regulators and industry stakeholders can foster collaboration and support the development of a regulatory framework that accommodates innovative financial solutions. Participating in industry forums and discussions can provide valuable insights into best practices and emerging regulatory trends.

6.3 Data Protection and Privacy

Given the sensitive nature of personal and financial data, protecting user information is paramount. The platform must adhere to data protection regulations, such as the General Data Protection Regulation (GDPR) in Brazil [10] or similar frameworks in other jurisdictions. Key considerations include:

- Data Encryption and Security Measures: Implementing robust encryption and cybersecurity protocols will help safeguard user data from unauthorized access and breaches. Regular security audits and updates should be conducted to address potential vulnerabilities.



• User Consent and Data Rights: Users should have control over their personal data, including the ability to consent to data collection, access their data, and request deletion when necessary. Clearly articulating users' data rights can enhance their confidence in the platform.

7. Conclusions

The Inclusive Payment and Social Coin Solution offers a pioneering approach to addressing the pressing issues of financial inclusion and community empowerment through the innovative use of blockchain technology and social coins. In a world where financial disparities persist, this solution presents a unique opportunity to create a more equitable economic landscape by facilitating access to financial services for underserved populations.

By integrating social coins into a centralized platform, the proposed model enables users to engage in peer-to-peer transactions that promote local economic development while fostering community cohesion. The key features of this solution—including collective contribution mechanisms, decision-making participation, and community recognition programs—are designed to enhance user engagement and promote a culture of collaboration and mutual support.

The educational resources and investment opportunities embedded within the platform empower individuals to take charge of their financial futures. By providing users with the tools and knowledge needed to navigate the complexities of personal finance and investment, the platform fosters a sense of agency that can lead to improved economic outcomes for individuals and communities alike. Furthermore, the inclusion of micro investment opportunities and crowdfunding initiatives allows users to not only contribute to community development but also to benefit directly from their involvement, creating a cycle of growth and sustainability.

The importance of addressing regulatory considerations cannot be overstated. By proactively engaging with regulators and ensuring compliance with relevant laws, the platform can build trust among users and create a secure environment for financial transactions. Prioritizing data protection and user privacy will further enhance confidence in the system, encouraging broader adoption and participation.

As digital currencies continue to evolve and gain acceptance, the Inclusive Payment and Social Coin Solution stands at the forefront of a transformative movement toward inclusive economic ecosystems. It has the potential to inspire similar initiatives worldwide, showcasing how technology can be harnessed to drive social change and economic empowerment.

Looking forward, it is essential for stakeholders—including policymakers, community organizations, and technology developers—to collaborate in refining and implementing the Inclusive Payment and Social Coin Solution. Continuous evaluation and adaptation of the platform will be critical to ensuring its effectiveness in meeting the evolving needs of communities. By prioritizing user feedback and remaining responsive to changing social and economic landscapes, this solution can remain relevant and impactful.

In conclusion, the Inclusive Payment and Social Coin Solution not only addresses the immediate challenges of financial exclusion but also lays the groundwork for a future where individuals are empowered to participate fully in their economies. By fostering community engagement, promoting collective prosperity, and leveraging the power of social coins, this solution can contribute to building more resilient and vibrant communities worldwide.

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LOCAL CREDIT, GLOBAL SETTLEMENT: ENHANCING TRUST-BASED CREDIT CREATION WITH ON-CHAIN RESERVE CONTRACTS

Alexander Chepurnoy[1]

Abstract

In this work, we propose Basis, a monetary framework in which both local trust-based currencies as well as global blockchain-based trust-minimized ones can coexist via smart contract powered reserves needed when there is no trust. Coordination with blockchain is needed only during debt note redemption against a reserve contract. Payments (debt note transfers) are done offchain, so with low fees and no need to use low-security centralized blockchain-like systems with high throughput. For coordination and transparency of debt in the system, a tracker service is used, which cannot steal money from reserves. We provide analysis of trust-minimization regarding tracker activities.

Current offchain payment systems backed by on-chain reserves (Lightning Net work [14], Cashu [1], Fedimint [6]) require full backing and so do not allow for credit creation. In contrast, Basis allows for credit creation with no requirements set for re serves at the protocol level. Then it can be used for community trading without using blockchain at all (and possibly, without Internet even, just by using a local mesh network), but when trust is insufficient to expand credit, on-chain reserves can be established and used. We expect that on a local scale trust-based economic relationships would dominate, and on a global scale (for example, when one community is doing trades with another) full debt coverage with reserves would be needed in most cases. The whole system will use limited in disconnected from real-world needs supply blockchain assets only where they are needed (there is no trust), while enabling monetary expansion whenever possible to do that without

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enforcement (so where pure peer-to-peer trust can be established), thus allowing to create a viable alternative to political money.

The means of payment is an IOU note, which is signed by the issuer and also by a witnessing tracker. Our design allows for debt transferability, if the issuer agrees: if peer A issued debt to peer B, and peer B wishes to transfer this debt (fully or partially) to peer C, peer A signs an updated note reducing the debt to B and a new note creating the debt to C. After the tracker updates its state, peer A owes C directly. We show that this design allows for minimal trust to tracker service. A tracker service is committing its state on the blockchain periodically. If a tracker service ceases to exist, it is possible to redeem debt notes against on-chain reserves using this committed state. There could be multiple trackers around the world. We consider different tracker designs, from just centralized server, to federation and dedicated sidechains.

We provide implementation of the reserve contract as well as offchain clients (tracker server and example clients). We show an example of group trading over a mesh network with occasional Internet connection. Another example shows AI agent economies where autonomous agents create credit relationships for services.

Keywords: digital currencies, cryptocurrencies, blockchain, peer-to-peer money, trust-based credit, IOU notes

1 Introduction

Peer-to-peer monetary systems, such as ChainCash [2], enable decentralized (peer-to-peer) money creation through trust and collateral. While on-chain protocols provide transparency and censorship resistance, they often struggle with scalability and cost when every transaction must be recorded on a public blockchain. Off-chain alternatives, such as payment channels and Layer 2 solutions, improve scalability but introduce new trust assumptions, and also do not allow for expansion on top of blockchain assets.

By expansion, we mean creating new monetary instruments (such as credit, IOUs, or representative tokens) that exceed the value of the underlying locked blockchain collateral. This is needed because the emission schedules of decentralized blockchain assets like Bit coin or Ergo are algorithmically predetermined and entirely disconnected from real-world

economic demand. Their supply cannot expand or contract in response to productive activity, trade volumes, or credit needs, making them inherently inelastic. Centralized alternatives like USDT or USDC reintroduce the very trust assumptions that blockchain technology sought to eliminate, requiring users to rely on opaque reserves, auditing processes, and issuer solvency. There is a need to bridge this gap by enabling elastic credit creation backed by trust, and this trust should be minimized in nature, so as to be peer-to-peer, while still anchoring to on-chain reserves when trust is insufficient.

Existing offchain payment systems demonstrate different approaches to this problem but fall short of enabling credit expansion. The Lightning Network [14] operates through bidirectional payment channels secured by hash time-locked contracts, requiring participants to lock collateral on-chain proportional to their maximum channel capacity. Cashu [1] implements Chaumian blind signatures to provide privacy-preserving ecash tokens, but the mint must hold full reserves backing all issued tokens. Fedimint [6] uses federated custody with threshold signatures to improve upon single custodian models, yet still requires full collateralization and introduces trust in the federation members. All three systems fundamentally require full backing of offchain liabilities with on-chain assets, preventing any form of credit creation or monetary expansion.

In this work, we propose Basis, a monetary framework designed for peer-to-peer credit creation and settlement. Basis enables participants to issue IOU notes without mandatory collateral reserves, allowing elastic credit creation backed purely by trust when counter party relationships allow it. On-chain reserves serve as optional settlement backing for inter-community or low-trust transactions, rather than as a prerequisite for all economic interactions. This flexibility allows Basis to support both purely trust-based local currencies and fully collateralized global settlement within a unified framework. The offchain protocol maintainer (the tracker) regularly updates its efficient and verifiable commitment to offchain debt relationships between economic agents, witnessing new notes by signing them, and periodically committing state digests to a public blockchain. This design allows for efficient note circulation offchain while preserving the security properties of on-chain redemption.

The Basis protocol comprises two main components: on-chain reserve contracts and an offchain tracker service. Reserve contracts are smart contracts deployed on a public blockchain that lock collateral and enforce redemption rules. They verify cryptographic proofs of debt, check signatures from both the debtor and the tracker, and release collateral

to creditors upon valid redemption requests. The tracker service maintains an authenticated ledger of all debt relationships, signs newly created IOU notes to certify their inclusion in the system state, and periodically commits cryptographic summaries of this state to the blockchain. This commitment enables participants to verify debt claims and provides an emergency redemption path if the tracker becomes unavailable.

We provide open-source implementations of both the smart contracts and the tracker service [10, 9], which we describe in Section 3.

The paper is organized as follows. In Section 2 we describe the design of Basis in detail. Section 3 provides implementation details. Section 4 analyzes security properties of the tracker.

2 Design

We consider a fully flat peer-to-peer monetary system where any economic agent may freely join. Each agent may issue IOU notes, thus creating debt relationships with other agents. Note acceptance is always optional and at the discretion of the counterparty.

2.1 Note Creation

When an agent (the payer) wishes to create a debt obligation to another agent (the payee), it creates an IOU note containing the payer's signature, the payee's public key, the debt amount, and a timestamp. The note may be associated with an on-chain reserve contract that backs the debt, if such a reserve exists. For the payee to accept the note, it must contain a valid tracker signature certifying that the tracker has recorded the debt in its authenticated state. The payee verifies this signature along with the payer's signature and the note's contents before accepting the note as a valid claim against the payer.

2.2 Note Redemption

A payee holding a witnessed IOU note may redeem it against the payer's reserve at any time by interacting with on-chain smart contract only. To redeem, the payee presents the note along with both the payer's and tracker's signatures to the reserve contract. The contract verifies the signatures, checks the debt amount against the tracker's committed state, and releases the corresponding collateral to the payee. If the reserve has insufficient collateral,

the payee may still hold the note as a claim and attempt redemption later, or the payer may be required to top up the reserve. It is also possible to redeem the note partly.

In the case where the tracker becomes unavailable, an emergency redemption path exists: after a timeout period (e.g., 3 days), the tracker signature becomes optional. The payee can redeem using only the payer's signature and the last committed tracker state from the blockchain, preventing funds from being locked indefinitely.

2.3 Debt Transfer

When an agent wishes to transfer a portion of its debt to a new creditor, the process resembles triangular trade. Suppose peer A owes peer B, and peer B wishes to transfer part of this debt to peer C. Peer B requests peer A to co-sign new notes: one reducing the debt A→B and another creating debt A→C. The tracker witnesses both the reduction in the old debt and the creation of the new debt, and the old note is replaced with a new one. After the transfer, peer A owes peer C directly. This enables debt restructuring and circular trade without requiring full redemption and re-issuance.

2.4 Tracker State

Basis tracks all debt relationships in an AVL tree [15] maintained by the tracker. The tree maps a composite key to the current debt state:

$$\text{hash}(\text{payerKey}||\text{payeeKey}) \rightarrow (\text{totalDebt}, \text{timestamp}),$$

where hash is a cryptographically strong hash function.

Periodically, the tracker commits the root digest of this AVL tree to the public blockchain. This commitment provides a timestamped checkpoint of the global debt state and enables emergency redemption when the tracker is unavailable.

3 Implementation

We provide implementation of the Basis protocol in form of executable code, including smart contracts for on-chain reserves, a tracker server for coordinating offchain state, and client libraries for issuing and managing IOU notes.

The smart contracts and documentation are available at [10], and the tracker server implementation is available at [9].

3.1 Reserve Contract

The reserve contract is implemented on the Ergo blockchain using the ErgoScript smart contract language [3, 4], and is available at [8]. It locks collateral (ERG or custom tokens) and allows redemption when presented with a valid debt note and signatures. The contract enforces the timeout rules for emergency redemption without tracker signatures.

3.2 Tracker Server

The tracker server is implemented in Rust [11] and maintains an in-memory authenticated tree of all debt relationships. When a payer creates a note, the tracker verifies it, updates its local state, and returns a signature certifying the debt. The tree stores cumulative debt amounts indexed by the hash of the payer and payee public keys, enabling efficient lookups and proof generation.

The server exposes an HTTP API for note creation, querying, and redemption preparation. It also monitors the Ergo blockchain for reserve boxes and periodically submits commitment transactions that embed the current state digest on-chain. This allows parties other than the tracker to verify debt claims, redeem them on-chain, and provides an emergency redemption path if the tracker goes offline.

3.3 Client Libraries

Client libraries provide functionality for agents to issue IOU notes, request tracker witnessing, transfer debt to new creditors, and redeem notes against reserves. The libraries handle signature generation, note serialization, and communication with tracker and blockchain nodes.

3.4 Mesh Network Trading

We demonstrate community trading over mesh networks using Meshtastic LoRa devices. In this scenario, Alice and Bob are in a village with no direct Internet connectivity, but a local tracker running on a community server has connectivity to the Ergo blockchain via a satellite or cellular uplink. Alice creates an IOU note for goods purchased and sends it to Bob over the mesh network (Bluetooth/WiFi Direct/LoRa). Bob forwards the note to the tracker

through the same mesh, and the tracker—being online—verifies it, updates its local state, signs it, and commits the updated digest to the blockchain. Multiple transactions accumulate this way, with the tracker continuously updating the on-chain state. When Bob later wishes to redeem, the tracker provides the necessary proof from its committed state, and the redemption transaction is submitted directly to the blockchain. This demonstrates offline credit-based trading for end users without forced collateralization, while the tracker maintains blockchain connectivity for state commitments and settlement.

Notably, the tracker's Internet connectivity can in principle be limited or occasional, as it may operate in SPV [12] or NiPoPoW [7] client mode, syncing with the blockchain only periodically rather than maintaining a full node connection [5]. This makes the architecture suitable for regions with intermittent or censored connectivity.

3.5 AI Agent Credit Creation

We also demonstrate how Basis can be used in autonomous credit creation among AI agents in a software development workflow. Initially, agents interact purely on trust without any reserves. A repo agent posts a development task with a budget, a dev agent completes the work and submits a pull request, and a test agent reviews and tests the code. The repo agent creates an IOU note (e.g., 10 ERG) for the dev agent, and the dev agent transfers a portion (e.g., 3 ERG) to the test agent for testing services. All these transactions occur autonomously without human intervention and without any collateral backing.

After observing the agents' work, humans may manually review the output and choose to back the agents by depositing assets into on-chain reserves. Once reserves are established, the IOU notes become redeemable against collateral. This creates a two-phase economy: first, agents build reputation through pure trust-based credit creation, and then humans provide reserve backing as economic validation of the agents' productive work. By creating credit first and earning reserves later, AI agents essentially create money through their economic activity, and humans then decide how sound that money is based on whether they provide backing after reviewing the agents' swarm output.

4 Tracker Security Analysis

In this section we provide preliminary security analysis for the Basis offchain tracker.

4.1 Tracker's Trust Model

For all the tracker-related trust and security issues, the most natural and also easiest in our case solution is to reduce trust in tracker itself. The simplest option which is implemented at the moment is just a single trusted entity. The following options exist to improve the tracker service:

- Federated service: we may have signing key being shared among several parties. With Schnorr signature scheme being used, it can be done via MuSig2 protocol [13]. Blockchain commitment to the tracker state then can be protected by multi-signature lock as well. In principle, signing and state commitments can be protected by different committees even.
- Sidechain: to witness debt notes, a dedicated blockchain-based ledger can be used. In case of permissioned consensus trust assumptions are not different from a federated service. In case of permissionless Proof-of-Work consensus, censorship-resistance can bSecurity Analysise improved in principle. To avoid higher fees to be paid to miners, merged mined sidechain option can be used [16].

4.2 Tracker Cannot Steal Funds

The tracker only certifies inclusion of notes in its state. It cannot unilaterally create or redeem notes. The issuer's signature is always required for redemption, ensuring that the tracker cannot steal funds.

4.3 Emergency Exit

If the tracker becomes unavailable, an emergency exit mechanism activates after a timeout period (e.g., 3 days or 2,160 blocks). After this period, the tracker signature becomes optional for redemption. The same message format is used: key||totalDebt||timestamp. Replay attacks are prevented by timestamp verification, and the reserve owner's signature is still required.

4.4 Anti-Censorship

The tracker cannot steal but it can refuse to witness debt notes for some issuer or recipient at some point. The pseudonymous nature would allow a payment recipient to pick another public key easily. However, network level anonymization could be needed in this case. To avoid reserve owner censorship, the reserve contract has a refund option, which allows the

reserve owner to withdraw funds without a tracker after a long enough time. If the tracker is implemented as a trusted server or federation, it may disallow redemption by omitting a note from committed data on-chain. In a sidechain implementation, this can be prevented through consensus rules, or by storing a commitment to all previously published commitments, which can be enforced through on-chain contract logic for commitment updates. Future research should investigate a possibility to use blind signatures and zero-knowledge proofs (of no doublespend, and so on) to have the tracker sign a note without knowledge of sender and receiver (beyond what zero-knowledge proofs may reveal).

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PHYSICAL VECTORIAL MONETARY SYSTEMS: FRAMEWORK FOR ECO-SOCIAL COMPLEMENTARY CURRENCIES

Fabien Fert[1]

Abstract

Complementary currencies have proliferated for four decades — LETS, time banks, WIR, Sardex, Eusko, Chiemgauer. Across this design space, the unit of account remains scalar — including time based currencies, where the unit is a one-dimensional measure of labour. Ecological criteria, where present, operate as external filters bolted onto a scalar unit; no documented complementary currency embeds multi-dimensional information inside the unit of account itself.

The standard defence of scalar money is that it is neutral — a passive medium of exchange. We argue this neutrality is illusory: existing units of account encode growth-imperative and externalisation choices into their structure. VECTOR is also non-neutral, but its non-neutrality is explicit and embedded — regulatory mechanisms are part of the unit, so the system self-regulates within parameters set once at the design layer.

VECTOR is a design framework for a complementary currency in which the unit of account is a vector across ten physical components, each in its own physical unit, none commensurated with another: time (in labour-hours), water, energy, fossil fuel, surface, renewable resources, non renewable resources, waste, pollutants, and durability. Three mechanisms structure the design: cumulative resource accounting along supply chains (the *Contamination Principle*); a dynamic conversion rate Rate_v(t) responsive to observed flows, which translates ecological components into the time component for settlement; and a Universal Daily Income denominated in time. Conceptually, VECTOR operationalises

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the weak-comparability tradition of ecological economics (Martínez-Alier, Munda & O'Neill 1998) inside the unit of account itself rather than in deliberative decision processes.

We probe the framework with an agent-based simulator — five hundred heterogeneous agents over five simulated years. In a single far-from-equilibrium realisation, enterprise balances stay near zero throughout, household wealth shows no fat tail at five years, creation and destruction converge within two to three years, and a component-targeted shock remains confined. Findings are preliminary: one seed, no steady state, no strategic agents; the sensitivity sweep is specified but not yet run.

The paper contributes a complementary-currency design where ecological accounting is internal to the unit of account rather than external, opening a design space distinct from existing scalar approaches.

Keywords: Complementary currency; Community currency; Multi-criteria accounting; Mutual credit; Time-based currency; Ecological footprint; Agent-based simulation; Eco-social monetary design; Vectorial unit of account; Post-Growth Paradigm

1. Introduction

1.1 Problem statement

Complementary currencies are a four-decade-old field with hundreds of active systems. Seyfang and Longhurst (2013a) map 3,418 projects across 23 countries; Blanc (2011) groups them into four generations — LETS, time exchanges, convertible local currencies, and multiplex designs. One structural feature recurs across almost every documented case: the unit of account is scalar. Mutual credit B2B circuits (Sardex, WIR), convertible local currencies (Chiemgauer, Eusko, Bristol Pound), and time-based currencies (Cahn 2000) all operate on a one-dimensional unit. Where ecological criteria are present, they appear as eligibility filters bolted onto a scalar unit; no documented complementary currency embeds multi-dimensional resource information *inside* the unit of account.

The standard defence of scalar money is that it is neutral — a passive medium of exchange. We treat this defence as the central puzzle. A unit of account that reduces every dimension of value to a single number is not neutral: it encodes the assumption that every form of value can be expressed on one common measure — an assumption ecological economics has



critiqued for three decades (Martínez-Alier, Munda & O'Neill 1998; Spash 2020). Scalar money's non-neutrality is implicit: it lives in market prices, externalisation pathways, and the growth-imperative that monetary debt produces. The question is therefore not whether to have a non-neutral unit — every unit is non neutral — but whether non-neutrality should remain implicit or be made *explicit* and embedded in the unit itself.

A second structural feature follows. In scalar systems, the unit attached to a good is the outcome of cost accounting, market negotiation, financial structure, and imposed margins. In a vectorial system, the unit attached to a good is the cumulative physical resource actually consumed in its production.

VECTOR replaces price formation with resource accounting: the unit reports reality rather than negotiating it.

A natural follow-up objection is operational: where does the multi-dimensional data come from? The framework distributes the ten basis components across four data tiers — five vectors derive from documents firms and households already maintain (timesheets, utility invoices, fuel receipts, land registries); two more from invoices combined with conversion tables; one (durability) from existing operational proxies; only two (waste, pollutants) require instrumentation beyond current routine, and regulatory frameworks (REACH, ISO 14001) supply partial documentation there. Annex F develops the tier mapping per component.

The objective is to integrate, in the very structure of the project, preventive mechanisms against the drifts of scalar monetary systems — hoarding, ecological over-exploitation, exclusion, runaway concentration of wealth, externalisation, rentier extraction, opacity. Each drift is countered by a specific construction: no compounding plus no rent income (hoarding, concentration, rentier extraction); the dynamic conversion rate (over-exploitation, externalisation); UDI plus the contribution coefficient (exclusion); the Contamination Principle plus the durability component (opacity, planned obsolescence). The approach builds a system whose combination of mechanisms prevents the drifts structurally, rather than relying on post-hoc correction not necessarily oriented toward homeostasis.

1.2 Research question

This paper asks:

Can a vectorial accounting unit, embedded in a mutual-credit complementary currency with a dynamic conversion rate, internalise ecological externalities and produce bounded wealth distribution under non-strategic transaction patterns?

Three sub-questions decompose it. **Q1** — Does cumulative resource accounting along a supply chain produce informational gains over scalar pricing? **Q2** — Does the conversion-rate feedback loop stabilise aggregate ecological balances in simulation? **Q3** — How do VECTOR's mechanisms map onto existing complementary-currency designs?

1.3 Contribution and epistemic stance

The paper makes three contributions. **Theoretical**: it operationalises the weak-comparability tradition (Martínez-Alier, Munda & O'Neill 1998) inside the unit of account itself, rather than alongside it in a deliberative process. **Computational**: it develops an agent-based simulator with 500 heterogeneous agents over five simulated years; preliminary computational illustration appears in Annex E. **Design**: it presents a complete framework — ten physical components, the *Contamination Principle*, a dynamic conversion rate, a Universal Daily Income, and an equity layer with mutual credit, UDI, and a contribution coefficient — as a *design space*, not a turnkey proposal.

Epistemic stance. The paper's contribution is a specified artefact — a framework — not an empirical claim about a deployed system. The framework is designed to make a particular problem (the implicit non-neutrality of scalar money in ecological and equity terms) and a possible response (multi-criteria accounting with adaptive conversion and contribution-weighted credit) visible, examinable, and contestable. The simulator does not validate the framework; it probes its internal consistency under one set of non-strategic behavioural assumptions. Parameter ranges are illustrative defaults from which a deploying community would diverge. What the paper argues is that VECTOR is a *coherent design space worth pursuing*, not that it is a finished product nor that any particular calibration is correct. The empirical question of whether deployed instances achieve their stated objectives can only be answered by pilots; §11 sketches that agenda. The body of the paper presents the framework in conceptual prose; the formal derivations, propositions, and worked examples are developed in the annexes (G and H) with commentary suitable for verification.

1.4 Paper structure

§2 reviews three literature streams. §3 defines the framework. §4 traces how the mechanism operates across four time scales — real-time transactions, daily reconciliation, annual rate adjustment, long-term capital amortisation. §5 develops the ecological-feedback dynamics. §6 covers the equity architecture (mutual credit, UDI, contribution coefficient). §7 sketches the distributed infrastructure. §8 reports the simulation study. §9 maps VECTOR onto five reference systems. §10 discusses limitations and deployment-level falsification. §11 concludes. Annexes A–H carry the formal details: abaque (A), simulation parameters and code architecture (B), sensitivity sweep grid (C), monetary-balance derivation (D), computational illustration with six figures from a 500-agent five-year run (E), data-tier mapping and ten-component unit (F), formal definitions and worked example (G), and enterprise mechanics with cost-recovery and amortisation (H).

2. Literature review

This section locates VECTOR in three streams. The first — complementary and community currencies — is the field's home territory. The second — ecological economics and multi-criteria value — supplies the conceptual case for treating value as irreducibly multi-dimensional. The third — computational accounting and agent-based finance — supplies the formal substrate.

2.1 Stream A — Complementary and community currencies

Blanc's (2011) four-generation typology (LETS, time exchanges, convertible local currencies pegged to national fiat, and multiplex designs) maps the field; Blanc (2017, 2018) extends it into a Polanyi-anchored conceptual framework that names a "practical criticism of commensurability" as a defining trait of alternative currencies — authorising VECTOR's multi-criteria stance from inside the field. North (2007), Lietaer (2001), Greco (2009), Fare & Ahmed (2017), Fare & Pottier (2025) provide complementary historical, practitioner, and political-economy accounts.

Two empirical traditions populate the typology. **Macro-financial stability in mutual-credit B2B circuits**: Stodder (2009) and Stodder & Lietaer (2016) show that the eighty-year-old WIR network expands counter-cyclically when Swiss-franc liquidity contracts; Sardex is documented institutionally by Littera, Sartori, Dini & Antoniadis (2017), Sartori & Dini (2016), and Dini & Kioupkiolis (2019). These accounts converge: stability comes from mutual-credit

clearing plus trust-building governance, not from the unit of account, which remains scalar and euro-pegged. **Grassroots sustainability**: Seyfang & Longhurst (2013a, 2013b) document 3,418 community currency projects; the most-developed European cases — Chiemgauer (Gelleri 2009), Eusko (Edme-Sanjurjo et al. 2020), Bristol Pound (Marshall & O'Neill 2018) — couple merchant-level participation criteria with scalar units pegged 1:1 to fiat. Fare & Ahmed (2017) and Michel & Hudon (2015) review what these designs achieve: robust social-economy effects, modest economic effects, rare or unmeasured environmental effects. Ecological intent at the eligibility stage is rarely translated into ecological information at the transaction stage.

Time-based currencies (Cahn 2000; Collom 2011; Jacob et al. 2004) are the only family in which the unit departs from scalar fiat: time is measured in physical hours of co-production. From VECTOR's perspective this is a single-component precedent — labour-hours — that the framework retains as one of ten components and supplements with nine ecological ones. Larue (2020, 2022, 2025) supplies the critical foil; §10.1 engages his critique frontally.

Across the stream — LETS (Williams 1996; Schraven 2001), time banks, B2B mutual credit, demurrage currencies (Kennedy 1995), convertible local currencies, and Global South digital community currencies (Diniz, Cernev & Nascimento 2020) — every system operates on a scalar unit. Ecological criteria, where present, are external eligibility filters.

2.2 Stream B — Ecological economics and multi-criteria value

The case that value is irreducibly multi-dimensional precedes any specific currency design. Georgescu-Roegen (1971) established that economic production necessarily increases entropy in the biosphere. Daly (1991) and Daly & Farley (2010) translate this into steady-state economics: accounting must be biophysical, not monetary. Costanza et al. (1997, 2017) attempt the inverse — monetising ecosystem services — but their twenty-year retrospective concludes that monetary valuation alone has not proved sufficient to drive governance.

Martínez-Alier, Munda & O'Neill (1998) supply VECTOR's theoretical anchor. They distinguish *strong commensurability* (every value reducible to a single scalar) from *weak comparability* (values ordinally comparable across irreducibly distinct criteria), arguing that strong commensurability is incoherent and that ecological economics needs a multi-criteria foundation. Martínez-Alier (2002) develops the political consequence:

environmental conflicts are conflicts between "languages of valuation". Spash (2020) distinguishes a "new resource economics" wing retaining scalar willingness-to-pay from a "social-ecological economics" wing rejecting it; VECTOR sits on the latter.

Applied design has approached the same problem from the other side. Raworth (2017) frames economic activity as a corridor between social floor and planetary ceiling, both in physical units. Jackson (2017) argues that growth–impact decoupling at the required rate is empirically implausible. Helbing (2014) is the closest mechanism-level precedent: "qualified money" carrying reputational attributes with differential conversion rates. Two differences from VECTOR: Helbing's qualities attach to *agents*, while VECTOR's components are physical quantities attached to *resources*; and Helbing's mechanism is conceptual, while VECTOR specifies a basis, propagation rule, and feedback dynamic.

The stream supplies the *why* but not the *how*. Ecological economics has argued for thirty years that value is multi-dimensional, but has not delivered an operational unit of account on which transactions can clear.

2.3 Stream C — Mathematical and computational foundations

Two engineering literatures anchor the formal substrate. **Accounting ontology**: McCarthy's (1982) Resource–Event–Agent (REA) model proposes building accounting systems on shared semantic primitives — resources, events, agents — rather than journal entries. McCarthy, Geerts & Gal (2022) extend the model to value chains and value networks and question the primacy of the ledger account structure. Valueflows (a community specification implementing REA for distributed economic networks) operationalises REA for federated cooperative networks. The data model VECTOR requires fits this tradition; what the tradition has not done is attach the vector to a *currency* mediating exchange and against which mutual-credit balances are kept.

Agent-based computational economics: Cincotti, Raberto & Teglio (2010) and the Eurace family simulate whole credit-money economies with heterogeneous agents; LeBaron (2006) provides the methodological canon. Fleischman, Dini & Littera (2020) supply obligation-clearing graph algorithms; their Sardex analysis shows obligation-clearing reduces SME net internal debt by ~25 %, doubled to ~50 % with a mutual-credit liquidity source — a precedent for near-zero net positions in mutual-credit circuits, though obligation-clearing and VECTOR's cost-recovery neutrality remain distinct mechanisms. Pinheiro & Pinheiro

(2025) provide the most direct mathematical antecedent: money as a rank-1 tensor over (sector, agent, time). VECTOR specialises this tensor onto an ecological basis and adds the dynamic conversion rate. The Lietaer–Ulanowicz lineage (Lietaer, Ulanowicz, Goerner & McLaren 2010; Lietaer et al. 2012) bridges Streams B and C.

2.4 Gap statement

Across the three streams, no documented complementary currency embeds multi-dimensional physical accounting inside its unit of account, no ecological-economics design proposal operationalises weak comparability at the transactional level, and no REA-derived accounting system functions as a circulating mutual-credit currency with an endogenous conversion rate. **VECTOR occupies the intersection of these three absences.**

3. Framework: definitions and design choices

3.1 The ten-component unit of account

The unit of account is a vector with **ten components**, each carrying a distinct physical unit. The components, listed in order:

1. **Time** — in hours of labour-time
2. **Water** — in m^3
3. **Energy** — in kWh
4. **Fossil fuel** — in m^3 at 15 °C
5. **Surface** — in m^2·day
6. **Renewable resources** — in m^3 or kg per material class
7. **Non-renewable resources** — in m^3 or kg per material class
8. **Waste** — in m^3 or kg per disposal class
9. **Pollutants** — in m^3·toxicity or g per substance class
10. **Durability** — dimensionless ratio (MTBF / MTTR)

The ten components are treated **identically in accounting terms**: a transaction, a ledger entry, or an inventory record carries values on all ten, each in its own physical unit. The arithmetic on the vector is component-wise: there is no metric or distance between components, no exchange ratio at the level of basis, no privileged component in the arithmetic. Annex F gives the full Table F.1 with documentary source per component and the four-tier data-availability mapping (A: existing routine accounting; B: invoices + conversion tables; C: existing operational proxy; D: emerging instrumentation).

Each component is **signed** under a uniform convention: $v_j > 0$ records that the agent has *produced* or *regenerated* the resource on their ledger (biogas created by a methaniser, waste recovered, hours of labour credited to a worker as part of an exchange); $v_j < 0$ records that the agent has *extracted from nature* or *absorbed an ecological debt* (raw-material extraction, pollution emission, hours of labour debited from an employer who paid workers). The convention is cognitively uniform across all ten components — a reader identifies production versus extraction from the sign alone. Transactions transfer signed components: a vendor selling extracted material transfers a negative $delta_v$ (the ecological debt moves down the supply chain to the next agent), a vendor selling regenerative goods transfers a positive one. The basis is not a universal claim: a community may add an animal-welfare or biodiversity component, or modify material-class aggregation, at the design layer (§3.5) — at the cost of leaving the canonical instance, since a divergent basis does not bridge (§7.4).

Durability is an informational axis. Component 10 differs in kind from the other nine: MTBF / MTTR is a dimensionless ratio — a property of a good, not a quantity drawn from or returned to nature. It is recorded on the ledger and travels with the good under the Contamination Principle, and it is displayed at the transaction window so that a buyer can compare competing offers on expected lifetime. But it carries no conversion rate, it is not converted into the time component at reconciliation, and it does not enter the monthly flow aggregates or the pressure-index feedback. Eight ecological axes convert; the ninth informs. Attaching a redemption cost to a dimensionless quality would have no defensible unit — hours per unit of what? — and, because the ratio is bounded below by zero, it would enter the signed convention as a permanently regenerative flow, creating money against no physical restoration.

Time (component 1) carries the same accounting structure as the other nine — it is signed, transferable, recorded on agent ledgers — and it has, in addition, two mechanisms

that the others do not: it serves as the conversion target for the other nine components (§3.3), and it carries the Universal Daily Income (§3.4). Time is therefore the *settlement axis*, not a superior one, and the distinction matters: what the ten components share is their accounting treatment — the same signed convention, the same inventory mechanics, the same transfer rules, the same Contamination Principle — while the nine ecological axes are recorded in their own physical units and are never commensurated with one another (§3.3, P2). The framework's claim is not that all ten axes play the same role; it is that physical information stays inside the unit of account instead of being collapsed before it enters.

3.2 The Contamination Principle

When a transaction occurs along a supply chain — agent a_1 produces an input, a_2 transforms it, a_3 buys the finished good — the vectors accumulate rather than cancel. Each step in the chain contributes a *step-vector* recording the resources extracted, transformed, or regenerated at that step. The cumulative vector reaching the buyer is the component-wise sum of all step-vectors along the chain. The vector follows the good through every transformation.

We call this the *Contamination Principle*: every transformation carries its cumulative resource history forward. Two consequences. First, the value reaching the buyer aggregates the entire upstream chain — comparison across competing producers is valid because each cumulative vector aggregates the full path. Second, the cumulative accounting creates a continuous incentive to seek lower-impact suppliers: a producer can lower their output vector by sourcing from lighter-footprint upstream actors, and the improvement is immediately visible in the producer's own accounting. The mechanism does not prohibit externalisation; it routes producer choice toward lighter suppliers by making the upstream load part of the producer's accounting. Annex G states the formal path-sum identity, the joint-production allocation rule (Hauschild, Rosenbaum & Olsen 2018), and presents a worked example (woodcutter and carpenter).

3.3 The conversion mechanism

To enable daily settlement on a mutual-credit substrate, the framework introduces an asymmetric conversion of the eight ecological components into the time component. For each ecological component $v \in \{2,\ldots,9\}$, a **base rate** $R_v>0$ (set at the design layer) and a

pressure index $I_{p,v}(t) \in [\alpha_v, \beta_v]$ (dynamically computed each year from observed flows) together give the **current conversion rate**:

$$Rate_v(t) := R_v \cdot I_{p,v}(t)$$

Verbally, $Rate_v(t)$ is the labour cost the system requires to redeem one physical unit of consumption on component v: "to redeem 1 m^3 of water consumed, the agent must spend $R_{water} \cdot I_{p,water}(t)$ hours."

Three structural properties characterise the conversion. **(P1) Asymmetry of the mapping.** The conversion is defined only from components 2–9 to component 1 (time); component 10 is informational and never converts. The reverse is not defined — time does not convert to water, energy, etc., except indirectly through someone choosing to produce a resource by spending labour (which is then transferred via ordinary mutual-credit, not via $Rate_v$). **(P2) No ecological-to ecological mapping.** No rate converts water into energy, energy into surface, or any pair of ecological components into one another. Ecological units become exchangeable only via the time component — never directly with one another. This carries the regulatory load: tightening $Rate_v(t)$ on a single component raises the labour cost of that component without making it convertible into any other ecological axis. **(P3) Bounded pressure-index range.** Each $I_{p,v}(t) \in [\alpha_v, \beta_v]$ with $0 < \alpha_v \leq \beta_v < \infty; \alpha_v > 0$ is a framework invariant that prevents I_p from collapsing to zero and erasing the regulatory effect.

The composition objection. A rate from every ecological axis to a single target induces, by composition, an implied ratio between any two: one unit of v for $Rate_v(t)/Rate_w(t)$ units of w. Does settlement then restore the strong commensurability the framework rejects? No: that ratio is never posted, never quoted, and never consumed by any ledger operation, and the mapping is asymmetric — nothing converts time back into water or energy. Decisively, the vector survives settlement: the ten components remain on the ledger in their own physical units, so no comparison is ever forced through the composed ratio. Weak comparability denies a common *measure of value*; VECTOR adopts a common *instrument of settlement*. That distinction is the framework's central wager.

The same numerical $Rate_v(t)$ operates in three contexts during the operational year: as the *settlement factor* at daily reconciliation (§4.2), where it converts accumulated ecological flows into time-axis credits or debits; as the *redemption factor* an agent may use voluntarily to clear an ecological balance before daily reconciliation; and as the

informational scalar valuation at the transaction window, where the multi-component vector of a competing offer is aggregated into a single time-equivalent for buyer comparison, without committing to any settlement (the multi component vector remains on the ledger).

The functional form of $I_{p,v}(t)$ — how the pressure index responds to observed flows — is the framework's automatic regulation mechanism, developed in §5.

The choice of time (rather than energy or a composite eco-weighted index) as the conversion target rests on three design grounds: time's universality across all human exchange (every transaction can be expressed in labour-time equivalent); time's natural alignment with mutual credit and with the UDI mechanism (§3.4); and the three-way human-day partition (8 h sleep, 8 h work, 8 h community life) that motivates the Δt=8 *h* UDI cap.

3.4 Equity layer: mutual credit, UDI, contribution coefficient

VECTOR builds on a mutual-credit substrate (Greco 2009; Stodder 2009): ordinary transactions clear as matched credit/debit pairs on the time component, with no net change in the money stock. WIR and Sardex have demonstrated empirically that mutual credit carries activity without an issuer and without interest (Stodder & Lietaer 2016; Littera et al. 2017); VECTOR inherits this at the transactional layer and adds three mechanisms operating on the time component (the "additional rules" of §3.1).

Universal Daily Income (UDI). A daily entitlement of up to Δt=8 *h* on the time component, demand-driven: UDI compensates the day's outflows (extractive consumption + labour paid by producer) first, and any residual within the Δt cap flows to debt clearance when the agent's time component balance is negative. UDI is monetary creation (no matching debit). An agent with no outflows and a non-negative balance receives no UDI that day. **Signed conversion reconciliation** (§3.3). At day's close, accumulated ecological inventory on a consuming agent's ledger converts to time and is added to the time-axis balance, signed — regenerative consumption credits, extractive consumption debits. **Contribution coefficient** $q_w \in [0, 2]$. When worker w performs X hours of labour, w's balance is credited $q_w \cdot X$ while the employer's is debited X; the resulting asymmetry $(q_w - 1) \cdot X$ between the credit and the debit is monetary creation if $q_w > 1$ or destruction if $q_w < 1$ — not posted to any separate ledger but visible only as the community-wide aggregate.

The three operate at different cadences (UDI daily; conversion daily for final consumption or at sale-time for inventoried stock, §4.4; q_w whenever labour is exchanged) and together

constitute the equity architecture: UDI provides the floor, q_w provides the upward path, and the absence of compounding provides the upper boundary. §6 elaborates.Δt=8 *h* is a framework invariant (three way human-day partition: 8 h sleep / 8 h work / 8 h community); $q_w \leq 2$ is invariant; the abaque is community-set and revisable by two-thirds supermajority (Annex A).

3.5 Two governance layers

The framework distinguishes a **design layer** (parameters the community deliberates and votes on: the ten-component basis, the base rates R_v per ecological component, the functional form of $I_p(t)$, the UDI cap and priority-of-use rules, the abaque governing q_w, and the governance procedures themselves) and an **operational layer** (the transactions). Once design parameters are set, the operational layer self-regulates through $Rate_v(t)$ responding to observed flows; calculation rules are transparent and known to every participant but not directly adjustable in the course of a transaction.

Non-neutrality as explicit delegation. The phrase "self-regulates" warrants precision. The framework's non-neutrality — the directional pull of $Rate_v(t)$ toward ecological dampening, of the abaque toward community-recognised contribution, of mutual credit toward zero-sum clearing on the time axis — is determined politically at the design layer through community deliberation. Once those parameters are fixed, the operational layer enacts the chosen non-neutrality without further political intervention. The non-neutrality is not laundered through operational autonomy; it is *explicit, deliberately chosen, and structurally delegated*. What VECTOR removes is the *implicit* non-neutrality of scalar money — the growth imperative encoded in interest-bearing debt, the externalisation pathways embedded in market pricing, the rentier extraction naturalised as "return on capital" — and substitutes a non-neutrality that is visible, adjustable, and accountable to a deliberative process.

The design layer is itself bounded by **framework-level invariants** the community cannot vote away: $R_v>0$, $\alpha_v>0$ with $\beta_v-\alpha_v\geq 0.05$, Δt=8 *h*, the asymmetry of the conversion mapping (only components 2–9 convert to component 1; no ecological-to-ecological), and $q_w \leq 2$. A community wanting different values must instantiate a non-interoperable instance. The framework is *adaptive yet non-corruptible*.

3.6 What VECTOR is not

VECTOR is *not* a fiat replacement. It is a complementary currency in the Blanc (2011) sense — operating alongside national currencies. VECTOR is *not* a Hayekian project. The argument is not that competing private currencies will discipline state issuers; it is that a community can deliberately design a unit of account that internalises ecological information. VECTOR is *not* a turnkey proposal. Components can be implemented one at a time — starting with Tier A (time, water, energy, fossil fuel, surface) — so adoption proceeds incrementally.

VECTOR is *not* a pricing mechanism. The vector attached to a good is the physical resource it actually consumed or produced under the §3.1 signed convention. There is no markup, no equity provisioning, no rentier extraction embedded in the unit. What the community chooses to do with that information — how to weight extraction via R_v, how to redistribute through q_w — is design layer politics, not pricing. A consequence on the production side: an enterprise cannot accumulate profit on its time-axis balance. Labour paid to workers debits the enterprise; sales credit it through cost-recovery pricing (§4.4 and Annex H); the ecological footprint travels with the goods as signed components and reconciles on the consuming household's ledger, not on the enterprise's. Over a production-sale cycle the enterprise's balance returns to neutrality on average, not identically at every instant: a residual remains between cycles, and it is that residual — never a profit category — whose use Annex H.4 restricts to future enterprise investment; a persistent negative drift signals demand failure (overproduction relative to market), not profit extraction. Enterprises are pass through transformation entities — they emerge as such from the same vector-accounting rules that apply to all agents, not from a separate regulatory regime.

4. Operational mechanics across time scales

The framework's mechanics run at four interlocking time scales. **Real-time** for transactions (any moment, two agents exchange goods or labour). **Daily** for the reconciliation of accumulated ecological flows into the time component on the consumer-side of the chain. **Annual** for the rate adjustment that maintains the framework's monetary balance. **Long-term** for capital amortisation through cost-recovery pricing on the production side. The formal recursions, definitions, and full operational details are given in Annex G (formal definitions and worked example) and Annex H (enterprise mechanics, cost-recovery, amortisation).

4.1 Real-time: transactions

At any moment, two agents may transact. A transaction transfers signed vector components between their ledgers, component by component. A sale of a good with cumulative resource content V_{total} transfers V_{total} from the seller's inventory to the buyer's inventory — the time component ($V_{total}[1]$) covering the labour content transferred to the seller as positive credit on time, the ecological components ($V_{total}[2..10]$) carrying the eco-footprint as signed components in the buyer's inventory. A labour transaction transfers hours on the time component only (with q_w*−weighted credit* on the worker side, Annex G). Multi-step supply chains accumulate vector components along the chain per the Contamination Principle (§3.2). Real-time transfers are mutual credit balanced — what one ledger gains, another loses on the same component.

The real-time layer does not, in itself, alter the money stock. Money creation and destruction happen at later layers (daily reconciliation, annual re-calibration, q_w*−weighted credit*).

4.2 Daily: ledger reconciliation for consuming agents

At day's close, agents whose accumulated inventory represents *final consumption* — households consuming food, water, energy for daily living — reconcile their ecological flows. The magnitude on each ecological component is converted to time-equivalent via $Rate_v(t_n)$ and added to the time axis balance, preserving sign. A negative ecological inventory (extractive consumption absorbed) produces a negative time-axis contribution (debit); a positive ecological inventory (regenerative consumption absorbed) produces a positive contribution (credit). In compact form (formal definitions in Annex G):

$$\Delta\theta_a^{conv}(n) := \Sigma_{j=2}^{9} Rate_j(t_n) \cdot v_{a,j}(n)$$

where $v_{a,j}(n)$ is the agent's signed inventory on component j accumulated over day n, and $\Delta\theta_a^{conv}(n)$ is the resulting net time-axis change at reconciliation.

Universal Daily Income then credits the time-axis balance. Let $S_a(n)$ denote the day's outflows (labour paid plus the magnitude of any negative $\Delta\theta_a^{conv}(n)$) and

$D_a(n) := max(0, -\theta_a(t_{n-1}))$ denote the agent's current time-component debt (positive when in debt, zero otherwise). UDI adds

$U_a(n) := min(\Delta t, S_a(n) + D_a(n))$

to the time-axis balance — bounded by Δt=8 *h*, demand-driven (capped at outflows + debt). UDI compensates the day's outflows first; any residual within the Δt cap flows to debt clearance when the agent is in debt. An agent with no outflows and no debt receives zero UDI that day. UDI is monetary creation on the time component: no offsetting debit anywhere.

Daily reconciliation fires only on the ledger of the agent who finally consumes the resource. One consequence deserves stating: a regenerative producer never books its own positive components. They travel with the good and are credited to the buyer at that buyer's next reconciliation. The producer is compensated on the time axis through cost-recovery; the incentive to regenerate therefore reaches the producer through demand — buyers prefer goods whose vector credits them — rather than through a direct credit. Enterprises producing goods destined for future sale hold work-in-progress as signed inventory and do not reconcile at day's close: their ecological components persist as raw inventory until the goods are sold, at which point they transfer to the buyer's ledger and reconcile *there*, at the buyer's next day's close. The enterprise's time-axis balance is driven only by ordinary mutual-credit transfers — worker payment (debit) and sale (credit through cost-recovery pricing, Annex H) — so over a production-sale cycle it returns to neutrality by construction. Separately, and independently of the enterprise case: a new agent receives a one time endowment of Δt hours on the time component at enrolment.

Time-axis debt (θ_a<0) arises when daily outflows exceed Δt and accumulate without sufficient inflows. Debt clears through three channels: labour given to the community (one-for-one credit on θ_a); consumption of regenerative goods (positive $\Delta\theta_a^{conv}$ credits θ_a directly); and residual UDI, applied within the daily Δt cap after outflow compensation. Two illustrative cases: an agent in debt who incurs no outflows on day n receives $U_a(n) = min(\Delta t, |\theta_a(t_{n-1})|)$ of UDI flowing entirely to debt-paydown (a −200 *h* debt clears at Δt=8 *h*/*day* over 25 idle days). An agent in debt whose outflows exceed Δt exhausts the UDI on outflows and the excess accrues to debt — the cap binds either way.

4.3 Annual: rate adjustment and re-calibration

Once per operational year, two mechanisms run. First, the **pressure indices** $I_{p,v}(y+1)$ are recomputed for each ecological component from the year's monthly aggregates and the

equilibrium trajectory the community has set at the design layer. The mechanism is *piecewise-linear with dead band, non-cumulative in* I_p: deviations within $[-\delta_v, +\delta_v]$ leave I_p at 1; deviations outside push I_p up or down with slope s_v, clamped to $[\alpha_v, \beta_v]$. Second, the **base rates** R_v are recalibrated by a damped factor $\sqrt{(B/D_{destroyed})}$ to maintain monetary balance — bringing total monetary creation B (UDI + q_w–*net+regenerative credits*) in line with total monetary destruction $D_{destroyed}$ (signed conversion debits) across the community. Both adjustments are framework-proposed and community-ratified through the continuous-polling governance system (§7.3). Full formal derivation, year-0 initialisation, and the equilibrium trajectory definition appear in Annex D.

A safety mechanism — the **homeostatic proposer** — fires at either saturation bound. It fires when a vector's I_p approaches saturation ($I_{p,v}(y+1) > \alpha_v + 0.95 \cdot (\beta_v - \alpha_v)$): the framework computes a minimal (β_v, R_v) adjustment that returns projected I_p to the dead band and posts it as a community ratifiable proposal. The proposer's logic is transparent and deterministic — any participant can re derive the proposed adjustment from public state. The framework is the *proposer*; the community is the *ratifier*.

4.4 Long-term: capital amortisation through cost-recovery

Capital goods (machinery, equipment, buildings) enter the framework through the same transactional mechanics as any other good: when enterprise A buys a machine from enterprise B for X hours of labour-content, A's time-axis balance decreases by X and B's increases by X — ordinary mutual credit on component 1. The machine carries a non-zero cumulative footprint on the ecological components, which transfers to A's inventory as signed components.

To recoup the labour cost paid for the machine, A includes the machine's labour content in its cost recovery pricing of the products it goes on to produce. The machine's labour cost adds to a running labour-recovery counter at A's level, which the cost-recovery rule recoups over A's subsequent sales (formal definition in Annex H). The result is that capital labour content propagates downstream into the products that use the capital, via the Contamination Principle (§3.2) — the cumulative vector of a piece of bread includes its share of the oven's labour content, amortised over the oven's productive lifetime. A's time-axis balance returns to neutrality over the amortisation horizon, provided pricing is set to fully recoup the inputs.

Two design-level constraints govern long-term capital flows. First, *individual ownership* of physical assets is allowed, but *commercial property income* is not: rent on a rented asset is calculated as construction-and-maintenance cost amortised over n years, with no profit margin embedded — the period n is set at the design layer to match the asset's expected useful life (typically decades for buildings and land, shorter for machinery and furniture, calibrated by asset class). Second, *enterprise surplus* — the accumulated time-axis balance at an enterprise — is consumable only by future enterprise investment, never by individual withdrawal. The two constraints together remove the principal capital-accumulation channels of conventional money while preserving everyday personal-asset ownership.

5. Ecological feedback: rate dynamics

The annual I_p adjustment of §4.3 is the framework's automatic regulation mechanism. This section develops the rationale and the parameters; the formal derivation is in Annex D.

5.1 Cadence and equilibrium trajectory

The cadence is annual: $I_{p,v}$ is recomputed once per operational year and held constant through the next. Three motivations: ecological time scales (water-table recharge, soil regeneration, carbon balance all operate annually or longer), capital adaptation realism (decisions are not reconfigured monthly), and governance rhythm (continuous polling aggregates over the year and applies at year close deadlines, §7.3). The mechanism is non-cumulative in I_p: each year's index is computed afresh from that year's deviation, never from the previous year's index, with noise absorbed by a 12- month moving-average smoothing pipeline.

The system maintains monthly aggregates $F_v(m)$ (consumption, the positive-magnitude part of extractive flows under §3.1) and $G_v(m)$ (regeneration). At year close, the *equilibrium trajectory* is

$$T_v(y) = (1-\lambda_v)\cdot MA_{12}(F_v - G_v)(y) + \lambda_v \cdot D_v(y),$$

combining the trailing 12-month mean with a monetary-balance target

$$D_v(y) = F_v(y-1)\cdot\left(B\frac{(y-1)}{D_{destroyed}}(y-1)\right)$$

No external sustainability number is required — the equilibrium emerges internally from monetary stability rather than from planetary-boundary estimates. Because the trajectory is anchored on the community's own trailing average, the mechanism regulates change in draw-down rather than its absolute level: a community whose extraction is high but stable generates no deviation and no corrective pressure. Setting that level is a design-layer act — through the base rates R_v, or through the Raworth-style floor and ceiling offered as a variant in Annex C — not an outcome the annual adjustment produces on its own. Annex D develops the derivation.

5.2 Annual adjustment

At year y close, the relative deviation $d_v(y) := \frac{(F_v(y) - G_v(y) - T_v(y))}{T_v}(y)$ drives the next year's pressure index via a piecewise-linear update with dead band δ_v and slope s_v, clamped to $[\alpha_v, \beta_v]$. The systematic $R_v(y+1) := R_v(y) \cdot \sqrt{\left(B \frac{(y)}{D_{destroyed}}(y)\right)}$ re-calibration applies to all $v \in \{2,\ldots,9\}$ independently of the I_p update — the over-exploitation proposer responds to per component saturation, the systematic re-calibration to the community-wide balance. Both are framework-computed proposals subject to community ratification.

The two adjustments differ in kind, not in cadence. The I_p update is per-component and bounded: it compares each component's net flow with the trajectory the community has been following, so a rise above that trajectory increases the labour cost of redeeming that component at reconciliation, and a fall reduces it. It penalises growth in draw-down and rewards frugality, both measured against the community's own recent behaviour rather than against an external threshold. The R_v re calibration is a single global factor applied uniformly to all eight components: it preserves the relative weights set at the design layer and moves only the scale on which they apply. Its driver $\frac{B}{D}$ sets that scale against the time the community creates — for subsistence, for recognised contribution, for regeneration — so base rates settle where draw-down is matched by what the community puts back. Because λ_v is small, the monetary correction acts mainly through the redemption cost and only marginally through the reference trajectory.

Six community-set parameters per component (R_v, δ_v, s_v, α_v, β_v, λ_v) define the response function; five framework invariants (§3.5) bound the parameter space. One quantity is deliberately left unbounded by invariant: the base rates R_v, which the annual re-calibration

scales multiplicatively. A community concerned by unbounded drift may cap the annual scaling factor at the design layer; nothing in the framework requires the scale to be free.

5.3 Calibration and stability

The homeostatic structure — over-consumption raises the rate, raised rate lowers consumption, lowered consumption brings the system back toward the trajectory — favours convergence over divergence. Large-scale oscillation is structurally unlikely under the smoothing pipeline (12-month MA, annual cadence, dead band, saturated slope). §8 quantifies parameter sensitivity computationally; §10 returns to falsification.

6. Equity architecture: mutual credit, UDI, contribution coefficient

§4 located UDI, signed conversion, and q_w-weighted credit as three mechanisms operating on the time component at different cadences. This section completes the equity architecture by detailing each, by stating the wealth-bound claim that emerges from their combination, and by presenting the diagnostics the community uses to monitor equity. A footnote at the close discusses reproducible digital goods[2].

The perspective is structural rather than redistributive. VECTOR does not transfer wealth from rich to poor by direct policy. It removes the channels through which scalar money concentrates wealth without bound — interest on positive balances, rent as commercial income, capital gains, compounding debt — and substitutes mechanisms that reward contribution while subsidising basic participation.

Property and rent. Individual ownership of physical assets — apartments, houses, land — remains entirely possible under VECTOR. What is removed is the *commercial property income* channel. Where the owner rents the asset, rent equals construction-and-maintenance cost amortised over the design-layer period n set for the asset class — typically 99 years for buildings and land (total cost ÷ n ÷ 12 per month, plus the period's

[2] **Reproducible digital goods.** A single act of production followed by indefinite costless copying does not fit the finite acyclic supply chain of §3.2: each new copy benefits from the original act without ever debiting the producer's ledger again, while the producer's initial labour is captured at the first transaction only. A retroactive-rebate mechanism (sketched in earlier work on function based pricing) was considered but raises operational questions we have not yet researched sufficiently. We treat reproducible digital goods as a research direction for follow-up work (§11).

maintenance). After n years the construction term has fully amortised and rent reduces to maintenance only. No profit margin; rent is cost recovery, not income. Same for land.

6.1 Mutual credit on the time component

The time component operates as a community-wide mutual-credit ledger. Every agent's time-axis balance opens at the initial endowment $\Delta t = 8h$, transactions clear as matched credit/debit pairs across community accounts, and the sum across the community is constant — *modulo* the three asymmetric mechanisms (UDI, signed conversion, q_w – *weighted credit*) introduced below. A positive balance records that the agent is a net contributor of time; a negative balance records time debt, settled through labour given.

What VECTOR adds over canonical mutual credit is twofold. First, the ledger carries not just the time-component balance but the cumulative ecological-component record of consumption per agent. Second, the time component acquires four creation/destruction channels rather than the zero of pure mutual credit: the enrolment endowment, UDI, signed conversion, and the q_w-weighted labour credit. The first is one-off; the other three recur, and only they enter the monetary-balance aggregate B.

6.2 Universal Daily Income

UDI is the unconditional equity-floor component of the architecture. §4.2 formalised the daily mechanism $U_a(n)$: = $min(\Delta t, S_a(n) + D_a(n))$ with $\Delta t = 8h$ as a framework invariant. Three properties matter in equity terms. **Universality of entitlement**: every participant has a daily UDI capped at Δt, regardless of age, activity, or employment status — the 8-hour cap counts the community-life block of the three-way human-day partition as contribution-as-such. **Demand driven, not unconditional accumulation**: UDI is bounded by present need — the sum of the day's outflows $S_a(n)$ and the current debt $D_a(n)=max\,(0\,,-\theta_a(t_{n-1}))$. An agent with no outflows and a non-negative balance receives 0; an agent with outflows or a negative balance receives the smaller of Δt and (outflows + debt). UDI does not flow to a positive time-component balance: holding generates no UDI, only outflows or debt does. **Three channels for debt clearance**: labour given to the community (one-for-one credit), consumption of regenerative goods (positive $\Delta\theta_a^{conv}$), and residual UDI (the portion of the daily Δt cap not absorbed by current reconciliation, applied to the running debt within the cap).

The framework connects to the time-banking tradition (Cahn 2000; Collom 2011) — a daily entitlement in physical hours by virtue of being a person — while bounding the entitlement by present need (reconciliation + debt) rather than offering an unconditional cash flow that would accumulate on positive balances. The bound preserves the anti-rentier property without weakening the equity-floor effect: an agent with a positive time-component balance receives no UDI on idle days, so accumulation requires participation (addressing the rentier objection commonly raised against unconditional schemes; cf. Standing 2017 on rentier income), while an agent in debt receives UDI applied first to current outflows and then to debt clearance — UDI thus operates as a structural debt-recovery channel within the daily cap, ensuring debt eventually clears even for agents whose capacity for labour given is limited (illness, age, caregiving responsibilities, extended unemployment).

6.3 The contribution coefficient q_w and the abaque

When agent w performs X hours of labour for agent e, w's time-axis balance is credited $q_w \cdot X$ hours while e's is debited X hours. Declared labour is capped at $X \leq 12$ hours per agent per day — a physiological ceiling on a single working day, wide enough to absorb seasonal peaks (harvest, production surge) without describing an expected regime. The cap is uniform across agents: it is not a category granted to owners. Together with the $q_w \leq 2$ invariant it bounds the daily labour credit at 24 hours, so credited time can never exceed the calendar day. The $\Delta t = 8\ h$ UDI cap is set by a different consideration — the community-life block of the three-way human-day partition (§3.3) — and is unaffected. The net flow $(q_w - 1) \cdot X$ is monetary creation if $q_w > 1$ and destruction if $q_w < 1$. The framework records labour at full physical value on the employer side and credits a community recognised multiple of it on the worker side.

The mapping from worker profile to q_w is the **abaque** — a community-defined table of contribution components with additive structure. The illustrative baseline (Annex A) combines an age tier (one only, 0.10–0.50), an education tier (one only, +0.10–+0.80), and cumulative components (years of work, caregiving, childcare 0–7 yr, business-owner status, elected role, verified volunteer status, validated continuing education). A minimum-engaged adult (18+, bac) reaches $q_w = 1.00$; a heavily engaged adult (doctorate, 20 years of work, caregiving, elected role, volunteer) reaches ~1.90, just under the cap ($0 < q_w \leq 2$).

Universality and inclusion. The additive structure opens the upward path to every participant, not only those excelling along academic or specialised-aptitude tracks. Multiple independent cumulative components (years of work, caregiving, childcare, elected role, volunteer status, continuing education) reward trajectories distinct from the education tier. An adult with limited education and no specialised aptitude who provides caregiving, volunteers, and accumulates years of work reaches $q_w \approx 1.05$, above the neutral point without any academic credential; adding childcare and elected role brings the same agent to ~1.30. Sustained community engagement translates into augmented credit on every paid labour transaction.

Community validation. Components of q_w are not certified by a central authority. Each claim is recorded as a cryptographic attestation produced by community validation: the agent submits evidence with their own signature; the framework selects random third-party community members who sign attestations of veracity, with a configurable threshold for validity. Years of work accumulate from contracted labour transactions on the chain itself. Attestations have explicit validity periods. Revocation is itself an attestation subject to the same threshold. The mechanism adapts REA-derived patterns (McCarthy 1982; Valueflows) and the W3C Verifiable Credentials Data Model (2024) to a randomised-community-validator pool; §7.2 details the operational mechanism.

Governance and political content. The abaque is more constitutional than the rate-adjustment parameters of §5. Modifying it requires a two-thirds supermajority of votes through continuous polling (§7.3) — versus simple majority for R_v, δ_v, s_v, α_v, β_v, λ_v. The framework ceiling $q_w \leq 2$ is itself invariant — no supermajority can lift it. **The abaque values are not neutral**: they encode a political choice about *what counts as contribution*. The framework supplies the mechanism (additive coefficients, attestation pipeline, ceiling, supermajority rule); the community supplies the content. A community recognising traditional ecological knowledge, mutual-aid in extended families, or specific cultural practices will populate the abaque differently from one that does not, and the framework neither prescribes nor adjudicates between these choices. The values are *deliberately exposed* to political contest at the design layer; the framework's role is to make them visible, revisable through a defined procedure, and resistant to silent capture.

6.4 The wealth-bound mechanism

VECTOR's equity claim — that wealth distribution on the time component is bounded — rests on the combined effect of the four mechanisms operating on the mutual-credit substrate: UDI (consumption subsidy floor), signed conversion (extractive consumption debited, regenerative consumption credited), q_w-weighted labour credit (upward path), and the absence of compounding. Two propositions formalise the claim (Annex G).

Proposition G.1 (defensive properties, conjectured). Under standing assumptions on UDI, daily reconciliation, bounded daily labour throughput, and non-strategic transactions: (a) no compounding term — saved hours generate no return on positive balances; (b) a consumption subsidy floor of Δt per day on outflows; (c) debt clears through three channels — labour given, regenerative consumption, and residual UDI (the portion of the daily Δt cap not absorbed by current outflows, applied to debt-paydown within the cap).

Proposition G.2 (upward path through contribution, conjectured). Under the same assumptions plus the q_w mechanism, an agent working X hours on day n with coefficient q_w gains $q_w \cdot X$ hours of credit. Framework caps $q_w \leq 2$ (invariant) and $X \leq 12$ (the daily ceiling on declared labour, §6.3); maximum daily balance accumulation from labour is therefore $q_w \cdot X \leq 24$ *hours* — the two caps jointly ensure that credited time never exceeds the twenty-four hours of the calendar day.

The combined effect: **neither extreme of inequality is achievable**. Below, the UDI consumption subsidy and linear debt-clearance through labour prevent basic deprivation. Above, the absence of compounding plus the bounded daily accumulation (24 h/day maximum from labour — credited time cannot exceed the calendar day — never exponential) prevent runaway concentration. Wealth differentials are real and intentional — they track engagement via q_w — but grow *linearly in time*, *capped per day*, and *contingent on continued labour*. What VECTOR removes is the positive feedback channels of conventional money: interest, rent as income, capital gains, compounding debt.

6.5 Equity diagnostics

The community monitors equity through three diagnostics computed at the close of each operational year. **Stability ratio**: the 90/10 percentile ratio of time-axis balances (target below 5) plus the share of agents in persistent debt (target below 5%). **Monetary-budget adequacy ratio** — it measures the balance between creation and destruction, not physical

sufficiency: for each convertible ecological component v, the ratio of D_v to net consumption $F_v - G_v$; values close to 1 indicate consumption near the monetary-balance budget. **Mean contribution coefficient** q̄(y): tracked year over year. A rising q̄ reflects increasing community engagement — a measure of social-fabric strength analogous in spirit to Bhutan's Gross National Happiness index. §8 reports these for a five year simulated horizon; §10 returns to falsification.

7. Distributed infrastructure

§4 and §6 specified the ledger semantics; this section sketches the architecture compatible with them. VECTOR does not require novel infrastructure, only the appropriate composition of established components.

7.1 Agent-centric ledgers with aggregation nodes

Each participant holds their own ledger — a private record of every transaction signed or received, with cryptographic signatures from counterparties. Transactions clear pairwise. The framework adds a **retro-verification mechanism**: each new transaction cryptographically validates the previous transactions of the two agents involved, at a configurable depth (ten by default). Resolution is local (from the chain of signatures) or via live P2P query to previous counterparties. Retro-verification provides a per-transaction integrity check without requiring global consensus.

For community-wide aggregation, **aggregation nodes** — software components deployed voluntarily by users — autodiscover each other and assemble the aggregates required by §5 and §6.5 (flow totals $F_v(m)$, trajectory $T_v(y)$, mean $\bar{q}(y)$, stability and adequacy ratios). No node is privileged; redundancy across overlapping subsets provides fault tolerance. The pattern follows Holochain's agent-centric distributed-hash-table model (Harris-Braun, Brock & Luck 2018).

7.2 Cryptographic attestations via community validation

§6.3's q_w is computed from cryptographic attestations. The agent submits evidence with their own signature; the framework selects random third-party community members who sign attestations of veracity; multiple independent attestations accumulate confidence; the claim is valid once a configurable threshold is reached. Revocation is itself an attestation subject to the same threshold. The mechanism adapts the W3C Verifiable Credentials Data

Model (2024) and REA semantics to a randomised-community-validator pool — VECTOR does not assume a registry of pre-trusted institutional issuers. Disputes are handled by counter-attestation.

7.3 Two operational rhythms

Daily reconciliation: each consuming agent's ledger reconciles at day close (ecological flows aggregate, signed conversion applies via prevailing $Rate_v$, UDI is credited per §4.2). The q_w - weighted labour credit operates separately, at the moment of each labour transaction throughout the day, not at end-of-day reconciliation. Both are local to the agent or pairwise across counterparties; no global synchronisation. **Continuous governance, deadline-applied**: **no annual general meeting** — community members do not know each other personally. The framework software is the governance medium. Questions (abaque revisions, parameter changes, over-exploitation triggers) are posted with predetermined deadlines; members vote at their convenience; at deadline the threshold is checked (simple majority for R_v, δ_v, s_v, α_v, β_v, λ_v; two-thirds for the abaque) and the change applied automatically. The framework software is also an *active proposer*: when the §5 over-exploitation trigger fires, it computes and posts the minimal (β_v, R_v) adjustment as a ratifiable proposal — an automaton bounded by framework invariants and overridable by community vote.

7.4 Scalability, inter-community bridges, privacy

A canonical instance — defined by the framework invariants — interoperates with other canonical instances. A non-canonical instance (different Δt, different basis) does not bridge: there is no defensible conversion factor between two communities operating on different unit systems. VECTOR exposes aggregates, not transaction details. Selective disclosure is default. Two spot check mechanisms limit fraud: cryptographic retro-verification (§7.1) and random P2P live verification of sampled past transactions. The required cryptographic primitives are under active implementation development.

8. Simulation study

8.1 Objective

The simulation is a constructive existence proof, not a calibration. It asks: do plausible parameter values produce trajectories in which the three §6.5 diagnostics — stability ratio,

per-component adequacy, mean $\bar{q}(y)$ — remain inside tolerable ranges over a five-year horizon? Five simulated years allow four full cycles of the annual I_p update.

8.2 Model architecture

Population. Baseline N = 500: individuals (N_I = 400, 80%), business-owners (N_C = 75,15%), enterprises (N_E = 25 ,5%). Approximately twelve active owners hold the twenty-five enterprises (1– 2–3 distribution, median two); the remaining sixty-three business-owners participate as individuals. Enterprises are distributed across five sectors with vector-consumption profiles drawn from typical input-output coefficients: agriculture, artisanal, distribution, services / care / education, technology. Distribution: 5 / 6 / 4 / 5 / 5.

Agent ledgers and operational rules. All agents carry the same ten-component ledger structure. The distinction between individual-style and enterprise-style behaviour emerges from the *state of the inventory*: agents whose inventory represents final consumption reconcile daily; agents whose inventory represents work-in-progress (raw materials, finished stock awaiting sale) pass the ecological content through to the buyer at sale-time without reconciliation. Cost-recovery pricing maintains the enterprise time-axis balance near neutrality over each production-sale cycle; the formal mechanism is in Annex H.

Five daily phases. Each simulated day proceeds in five phases: (i) transactions under a persistent encounter graph (within-sector 0.7, cross-sector 0.15, owner ↔ enterprise 0.95); (ii) conversion-rate read for informational display; (iii) daily reconciliation on the consuming agents' ledgers; (iv) UDI flow on consuming agents; (v) aggregation push to community-wide monthly aggregates $F_v(m)$, $G_v(m)$. Annex H details the per-phase computations.

Annual closing. Past twelve months' aggregates go through the §5.2 pipeline. The systematic $R_v(y+1) := R_v(y) \cdot \sqrt{\left(\frac{B}{D_{destroyed}}\right)}$ re-calibration applies to all components $v \in \{2,\ldots,9\}$. Voting is auto-ratified in the simulation (§8.7 limitation).

8.3 Parameters and reproducibility

The baseline configuration uses 500 agents, five-year horizon, Δt = 8*h*, illustrative R_v per component (sensitivity-tested in §8.6), §5-default rate-adjustment parameters, abaque-derived q_w (mean ≈ 1.21, SD ≈ 0.25), the §8.2 persistent encounter graph. $D_v(y)$ recomputed annually per §5.1. Annex B gives the parameter table, twelve-module code architecture (Python 3.12 + numpy + networkx + pandas + sqlite3 + matplotlib + jinja2 + pyvis), and

reproducibility details. Single config runtime ~15 min on one laptop CPU; full §8.6 sweep (4 params × 3 values × 30 seeds = 360 runs) ~3 h with 30-fold parallelisation.

8.4 What the runs measure

Each run records four families of quantity. At every annual close the three §6.5 diagnostics are computed: the stability ratio — the 90/10 percentile ratio of time-axis balances, together with the share of agents in persistent debt — the per-component resource adequacy ratio, and the mean contribution coefficient $\bar{q}(y)$. Alongside them the run records the monetary-balance ratio $\frac{B}{D_{destroyed}}$ and, for each ecological component, the annual deviation $d_v(y)$ and the resulting pressure index $I_{p,v}(y + 1)$. Monthly aggregates $F_v(m)$ and $G_v(m)$ are persisted throughout, and the daily ledger state is written to the run database (Annex B), so any reported figure can be recomputed from stored state rather than from the plotting pipeline. The thresholds against which these are read are stated in §8.8.

8.5 Results — baseline and preliminary illustration

The baseline production run will report three figures and one table: (1) time series of $I_{p,v}(y)$ with 95 % confidence bands across thirty seeds; (2) empirical cumulative distribution of the time-axis balance at year 5 by tier; (3) per-component adequacy ratio over time; and a summary table.

Preliminary computational illustration is presented in Annex E, drawing on a single-seed five year smoke run with the baseline parameters plus an exogenous drought shock (×2 water demand on agri, years 2–3) chosen to expose per-component reactivity alongside the homeostatic dynamics. Preliminary in two senses: single seed (no statistical bands) and an initial R_v deliberately below monetary equilibrium so the §5 adaptive mechanism is visible. The realisation evidence supports four observations (Annex E.7): the **cost-recovery invariant for enterprises holds dynamically over five years** (enterprise time-axis balance near 0 throughout); **household wealth distribution is bounded** with no fat tail; the annual R_v re-calibration drives the per-component deviation d_v from −0.65 at year 1 toward zero at year 4 (**homeostatic adaptation in progress**); and **per-component aggregation correctly isolates the exogenous water shock** without contaminating other components.

8.6 Sensitivity sweep

Four parameters varied around baseline at three points each ($\delta_v \in \{0.02, 0.05, 0.10\}$; $s_v \in \{0.5, 1.0, 2.0\}$; $\lambda_v \in \{0.0, 0.05, 0.20\}$; three abaque profile variants), 30 seeds per cell. Each cell reports the three §6.5 diagnostics. Annex C details the grid.

8.7 Limitations

Five limitations bound interpretive scope. (1) **Non-strategic agents** — agents follow exogenous transaction propensities. (2) **No exogenous shocks beyond Annex E's drought**. (3) **Closed community** — no inter-community trade. (4) **Stylised vector accounting** — sectoral profiles are illustrative, not empirical input-output measurements. (5) **Governance idealisation** — the continuous-polling system is modelled as automatically applying votes at deadline.

8.8 Falsification criterion

The simulation would refute the framework's constructive existence claim if, under baseline calibration, any of the following occurred over the five-year horizon: (i) the 90/10 wealth ratio exceeded 8; (ii) the share of persistent-debt individuals exceeded 20%; (iii) for any component with D_v above current flows, the adequacy ratio diverged monotonically rather than converged — and symmetrically, for any component whose target fell below current flows, the ratio failed to recover; (iv) mean $\bar{q}(y)$ declined by more than 10% year over year; (v) the homeostatic proposer fired in more than half of (component × year) cells.

9. Case-study comparison with existing complementary currencies

§2 located the existing CC field along Blanc's typology. This section deepens the positioning by mapping VECTOR onto five widely-documented systems and registering the dimensions on which VECTOR stands in continuity with the field versus those on which it is genuinely new. The five systems are Eusko + Chiemgauer[3] (convertible-local lineage); Sardex + WIR (mutual-credit B2B); Time Banks (time-denominated micro-mutual credit). LETS is omitted as conceptually proximate to Time Banks; Bristol Pound as a structural near-twin of the Chiemgauer. Table 1 illustrates this comparison.

[3] Demurrage, also termed monetary melting (Gesell's Schwundgeld), is a periodic charge on holding that erodes the face value of unspent units over time.

9.1 Comparison matrix

Table 1 - CC comparison matrix

Axis	*Eusko*	*Chiemgauer*	*Sardex*	*WIR*	*Time Banks*	*VECTOR*
Unit of account	*Scalar (€-pegged)*	*Scalar (€-pegged)*	*Scalar (€ credit)*	*Scalar (CHF credit)*	*Scalar (hours)*	***Vectorial (10 components)***
Clearing	*Convertible local*	*Convertible local*	*Mutual credit (B2B)*	*Mutual credit (B2B)*	*Mutual credit (micro)*	*Mutual credit (vectorial)*
Ecological information	*External filter*	*External filter + demurrage*	*None*	*None*	*None*	***Internal to the unit***
Equity / wealth-bound	*None beyond conversion*	*Demurrage on holder*	*None*	*None*	*One-hour-equals-one-hour*	*UDI + q_w + no compounding*
Adaptive conversion	*No (1:1 parity)*	*No (parity + fixed demurrage)*	*No (1:1 parity)*	*No (1:1 parity)*	*No (hour-equivalence)*	*$Rate_v(t) = R_v \cdot I_p(t)$*
Fiat convertibility	*Yes (1:1, fee)*	*Yes (demurrage discount)*	*Partial*	*Limited*	*No*	*No (parallel unit)*

Sources: Edme-Sanjurjo et al. (2020); Gelleri (2009); Littera et al. (2017), Sartori & Dini (2016); Stodder (2009), Stodder & Lietaer (2016); Cahn (2000), Collom (2011). Note on the Eusko: its founding criterion is the promotion of the Basque language and local anchoring; the ecological criterion was added later and is secondary. The row records the ecological axis only.

9.2 Synthesis

Two axes register continuity. VECTOR is a mutual-credit system (like Sardex, WIR, Time Banks) rather than a convertible local currency, and it does not propose fiat convertibility (like Time Banks but unlike all four other reference systems).

Two axes register sharp distinctness. First, the unit of account is multi-component — every reference system uses a one-dimensional unit, and where ecological criteria appear (Eusko, Chiemgauer), they are bolted onto the unit as eligibility filters rather than embedded

in it. Second, the conversion rate adapts endogenously to observed flows — all five reference systems either hold a fixed parity, apply a fixed depreciation (Chiemgauer demurrage), or treat the unit as a constant token of equivalence. VECTOR's $Rate_v(t) = R_v \cdot I_p(t)$ is the only mechanism in the comparison that makes the unit responsive to community-aggregate ecological pressure.

Two axes show subtler positioning. On equity / wealth-bound, the Chiemgauer's demurrage prefigures VECTOR's anti-hoarding intent but differs structurally: demurrage is *active* — held units erode at a fixed periodic rate, saving is structurally punished — while VECTOR's anti-hoarding is *passive* — no term in the §4 recursion makes the balance grow as a function of the balance, so balances neither yield nor erode. The Chiemgauer removes a fraction of the *balance itself*; VECTOR removes the *return* on idle balances. Time Banks' one-hour-equals-one-hour rule prefigures the time-component floor but lacks both the q_w upward path and the UDI consumption subsidy. On ecological information, Eusko's and Chiemgauer's external filters anticipate the intent of internalising ecological information into the unit, but their scalar unit cannot carry it.

VECTOR is therefore not "Sardex with an ecological filter", "Chiemgauer with more components", or "Time Banks with components besides time". It occupies a distinct point in the design space.

10. Discussion, limitations, falsification

10.1 Discussion

What the paper establishes. First, the framework is internally consistent: the 10-component basis, the asymmetric conversion mapping, the three mechanisms operating on the time component, the abaque-derived q_w, and the homeostatic governance proposers compose into a coherent design. Second, §8 provides a constructive existence proof: under non-strategic transaction patterns, the simulator runs end-to-end, converges to monetary balance via annual R_v re-calibration, and produces a bounded wealth distribution (Annex E's preliminary single-realisation evidence). Third, §9 establishes positional distinctness: VECTOR occupies a position not matched by any of the five reference systems analysed.

What the paper does not establish. The framework's claims of bounded wealth distribution and ecological feedback are conjectured analytically and explored computationally, not proved. Propositions G.1 and G.2 (Annex G) are stated with explicit assumptions and

sketched arguments. A wider exploration of parameter space, adversarial agent strategies, exogenous shocks, and multi community interop is needed before these propositions can be promoted from "conjectured" to "demonstrated".

Three tensions worth surfacing. First, **governance maturity** — the continuous-polling system of §7.3 assumes a community capable of engaging seriously with framework-posted questions. Second, **abaque bootstrapping** — the supermajority required for revision implies an initial adoption consensus that itself sits outside the framework's mechanisms. Third, **self-reference of design** — the framework internalises regulation in the unit, but the choice of component basis, rate functional form, and equity mechanisms is itself a political act; VECTOR is non-neutral by design, and the contribution is that its non-neutrality is *explicit and adjustable*.

Engagement with Larue's critique. Larue (2020, 2022, 2025) develops a philosophical and economic critique we take seriously: many CC proposals reproduce, in miniature, the structural features of capitalist money — they remain *price-formation* mechanisms (price set by an issuing committee rather than a market, but still a price), they distribute value through accumulation channels structurally identical to fiat, and they presume that small-scale circulation suffices to escape the systemic logic of the dominant system. VECTOR's response is structural, in three movements. First, the unit of account is not a price: it is the cumulative physical resource the good actually consumed (§3.6). What a community then does with that information is design-layer politics, not pricing — the mechanism records, it does not negotiate. Second, rentier extraction channels are structurally absent: no compounding, no rent as commercial income (cost amortisation only), no profit category on enterprise time-axis balances. The framework does not regulate these channels; it omits them. Third, the framework is non-neutral and says so (§3.5): it embeds an explicit political choice in the unit, rather than presenting a "neutral" technical device that re-enacts the dominant monetary logic. Where Larue critiques CCs for reproducing capitalist money's logic at smaller scale, VECTOR's reply is that the logic itself — price formation, unbounded accumulation, rentier extraction — has been displaced from the design.

10.2 Limitations

Six framework-level limitations operate beyond the simulator-level limitations of §8.7.

Conceptual. Weak-comparability operationalisation rests on the design choice of time as the conversion target. Other choices — composite eco-weighted units, dimensionless basket indices, energy as numéraire — would produce different vectorial designs. The equilibrium trajectory is likewise derived from monetary balance and from the community's own history, not from biophysical thresholds; whether a given community's absolute draw-down is sustainable remains a question its design layer must answer, and one the framework makes visible rather than settles. The framework argues for the time component on three grounds (universality of labour-time, alignment with mutual credit and UDI, the 8-h human-day partition) but the choice remains contestable.

Operational. Data collection for Tier-D components (waste, pollutants) requires protocols beyond §1.1's data-source identification. Producers maintain partial records under existing regulation (REACH, ISO 14001), but integration into the ledger demands instrumentation effort proportional to producer size.

Political. Multi-community interoperability is canonical-instance-only (§7.4) — instances diverging on framework invariants do not bridge, limiting the adoption pathway where neighbouring communities have already adopted non-canonical CCs.

Theoretical. Propositions G.1 and G.2 are sketched, not fully proved. The wealth-bound argument relies on the absence of compounding; future extensions reintroducing compounding-like dynamics would require re-deriving the bound. A formal monotonicity proof for the four-channel balance under arbitrary q_w distributions is outstanding.

Individual versus aggregate balance: mutual credit balances in aggregate by construction, but individual agents whose consumption pattern deviates from the population mean can accumulate persistent debt or surplus. The R_v re-calibration ensures aggregate convergence over years; individual variations are absorbed by labour given (working clears debt) and by the q_w differential (those with higher contribution accumulate balance).

Practical. The simulator runs 500 agents. Whether VECTOR's mechanisms compose at scales above the simulated 500 is an empirical question the simulator cannot answer. Non-convertibility to fiat operates as an adoption barrier in retail contexts.

Bureaucratic load. A natural worry — raised by the failure modes of carbon-accounting and emissions-trading schemes — is that any multi-criteria accounting system risks reproducing the administrative apparatus that has dogged those regimes: third-party verifier

oligopolies, audit fees that price out small participants. The framework targets the specific mechanisms through which those failures emerged. First, the Tier A–D mapping (Annex F) privileges **data sources that already exist in routine accounting** — utility invoices, fuel receipts, land registries, timesheets; for utility-based components, automated read-out via existing service APIs replaces manual entry. Only Tier D (waste, pollutants) demands instrumentation beyond current routine, and regulatory baseline (REACH, ISO 14001) supplies partial documentation. Second, the verification load is **distributed among members rather than concentrated in a verifier oligopoly**: q_w attestations are signed by randomly-selected third-party members, transaction-level retro-verification operates on the previous-ten-transactions chain, fraud is deterred by random member-led audits with exclusion as the sanction — a self-managed disciplinary mechanism, not external policing. Third, adoption is **tiered**: communities start with Tier A and add components as instrumentation matures, so the bureaucratic load grows with community capacity rather than gating initial participation.

10.3 Deployment-level falsification

A pilot of the framework over an operating community of ~475 members and some twenty-five productive entities — the composition simulated in §8.2 — over five years would, on any of the following six observations, constitute evidence against the framework's claims:

(F1) Adoption failure. Members systematically abandon the unit or convert balances out at a rate that drives active membership below a pre-registered viability threshold.

(F2) Governance illegitimacy. Continuous-polling participation falls below a quarter of eligible members on rate-vote deadlines, abaque revisions, or homeostatic ratifications.

(F3) Attestation gaming. Mean $\bar{q}(y)$ rises year over year by more than demographic drift would explain.

(F4) Strategic component-substitution. Transaction patterns show systematic over-consumption of components whose $I_p < 1$ and under-consumption of those whose $I_p > 1$ beyond what the annual adjustment is designed to absorb.

(F5) Extraction channel abuse. Owner compensation is structurally bounded — hours via real time time-clocking (capped at 12 h/day) or arbitrary 8 h/day default; accumulated time-axis surplus in an enterprise's ledger is consumable only by future enterprise investment.

The framework would be falsified if enterprise-investment expenditures are systematically routed toward personal-asset acquisition by owners, or if enterprises consistently fail to reduce wage outlays when the enterprise time-axis balance stays negative.

(F6) Multi-community fragmentation. Communities in a regional cluster diverge on framework invariants at a rate that overwhelms canonical-instance interoperability.

A single pilot failing on a single criterion would not refute the framework — calibration error, governance immaturity, or exogenous shock must be ruled out — but a pattern across multiple pilots and criteria would constitute strong evidence against the framework as currently formulated.

11. Conclusion and research agenda

VECTOR proposes an answer to a question scalar money cannot ask: whether a unit of account can carry the multi-dimensional information of ecological reality alongside the mutual-credit clearing of social labour, and adapt its conversion rate to the community's observed flows rather than to the dictates of an external policy authority. The framework operationalises this proposal through a ten component basis (with time treated as one component among ten, equipped with the additional rules of conversion-target status and UDI), an asymmetric conversion mapping, a monetary balance enforced by annual R_v re-calibration, and an equity architecture combining mutual credit, UDI as consumption subsidy, and the contribution-weighted labour credit q_w. The computational study of §8 established that, under the framework's invariants and non-strategic transaction patterns, the proposed combination is internally consistent — it converges to monetary balance, sustains bounded wealth distribution, and absorbs ecological pressure within two to three years of any initial disequilibrium (Annex E's single-realisation evidence). §9 located the design at a point in the complementary-currency space that no analysed reference system occupies; §10 surfaced the tensions, limitations, and patterns that would falsify it in deployment.

The agenda spans three horizons. **Within roughly the next twelve months**: close the simulator backlog (systematise the far-from-equilibrium regime sweep across several starting calibrations, the single realisation of Annex E being one such point; 30-seed baseline production runs and four parameter sensitivity sweep populating §8.5–§8.6; strategic-agent extension introducing gaming against the index, the attestation system, and the cost-

recovery boundary). In parallel: specify the abaque bootstrapping protocol; scope a single-community pilot of 200–500 members with deployable cryptographic-hardening, attestation-validator-selection, and governance-question templates.

Over the next two to three years: promote Propositions G.1 and G.2 from "conjectured" to "demonstrated" through formal proofs under explicit assumption sets; deliver a formal monotonicity proof for the four-channel balance; run three to five parallel pilots in heterogeneous community types (urban district, rural cooperative, professional B2B network, transition town, micro community); resolve the reproducible-digital-goods open problem; move the cryptographic infrastructure from active implementation into deployment-ready state.

Beyond five years: operationalise the canonical-interop layer of §7.4 while preserving framework invariants; pursue macro-scale empirical validation in communities of ten thousand agents over ten year horizons under exogenous shocks; engage with regulatory and statistical-accounting authorities to integrate VECTOR aggregates into national environmental and economic statistics. And the framework invariants themselves invite a foundational research question: under what conditions, if any, would a community-driven revision of the canonical specification remain coherent with the structural-prevention claim of §1?

The framework is a design space, not a final design. VECTOR's contribution is to articulate what changes when a complementary currency is structured around resource accounting rather than price formation. Whether these mechanisms compose into a viable currency under operating conditions is an empirical question — and one that only deployment can answer.

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Annex A. The illustrative abaque (§6.3)

The abaque maps an agent's recognised societal contributions to a contribution coefficient $q_w \in (0\ ,2)$. The structure is additive across three classes: a chosen age tier, a chosen education tier, and a sum of cumulative components. The framework ceiling $q_w \leq 2.0$ is invariant.

Component	Coefficient
Age tier (one only)	
7 – 10 years	0.10
10 – 14 years	0.20
14 – 16 years	0.30
16 – 18 years	0.40
18 years and over	0.50
Education (one only, highest reached)	
Collège	+0.10
BEP or equivalent	+0.30
Baccalauréat	+0.50
Bac+3	+0.60

Component	Coefficient
Bac+5	+0.70
Doctorate or equivalent	+0.80
Cumulative components	
Years of work	+0.01 per year
Active family caregiving	+0.30
Active childcare (children 0–7 years old)	+0.20
Business owner (one or more enterprises)	+0.35
Elected community role	+0.05
Verified volunteer status (any active month in the year)	+0.05
Validated continuing education	+0.02 per training
Framework ceiling	qw2.0

Verification examples. A minimum-engaged adult (18+, bac): q_w = 0.50 + 0.50 = 1.00. A typically engaged adult (bac+3, 8 years of work, volunteer):
$q_w \approx 0.50 + 0.60 + 0.08 + 0.0\ 5 = 1.23$. A business owner (bac+5, 15 years of work):
$q_w \approx 0.50 + 0.70 + 0.15 + 0.35 = 1.70$. A heavily-engaged adult (doctorate, 20 years of work, active caregiving, elected role, volunteer):
$q_w \approx 0.50 + 0.80 + 0.20 + 0.30 + 0.05 + 0.05 = 1.90$.

Universality / inclusion property. The multiple independent cumulative components are designed so that several pathways reach a substantial q_w without relying on academic credentials. An adult with limited education and no specialised aptitude who provides caregiving, volunteers, and accumulates years of work can reach
$q_w \approx 0.50 + 0.10$ (*collège*) + 0.10 (10 *yearswork*) + 0.30 (*caregiving*) + 0.05 (*volunteer*) = 1.05, above the neutral point, without relying on any academic credential.

Annex B. Simulation parameter table and code architecture (§8.3)

Parameter table.

Symbol	Meaning	Baseline value	Source
NI, NC, NE	Individuals / business-owners / enterprises	400 / 75 / 25	Illustrative
H	Simulation horizon (years)	5	Locked §5
Δt	UDI / day-partition unit	8 hours	Framework invariant
R_v	Base rate per ecological component (v = 2..10)	1.0 h per physical unit (illustrative)	Calibration TBD
δ_v	Dead-band half-width	0.05	Default §5
S_v	Slope outside dead band	1.0	Default §5
α_v, β_v	Pressure-index saturation bounds	0.1, 2.0	Initialisation §5
λ_V	Drift weight on D_v	0.05	Default §5
$D_v(y)$	Annual monetary-balance target per component	$F_v(y-1)\cdot\left(B\frac{(y-1)}{D_{destroyed}}(y-1)\right)$	§5.1
q_w range	Contribution coefficient	(0, 2]	Framework invariant
q_w distribution	Abaque-derived per agent	Mean ≈ 1.21, SD ≈ 0.25	Annex A / §6.3
Encounter graph	Persistent networkx graph	Within-sector 0.7, cross-sector 0.15, owner ↔ enterprise 0.95	§8.2
Monte Carlo runs	Seeds per configuration	30	Assumption

Illustrative R_v values are not calibrated to any specific community; they set a relative scale and are sensitivity-tested per Annex C. The D_v targets are recomputed each year from the community's own monetary creation/destruction balance per §5.1.

Code architecture. The simulation is implemented in Python 3.12 with numpy, networkx, pandas, matplotlib, jinja2, pyvis, and the standard-library sqlite3. The code

is structured in twelve modules covering agents and world state, ledger arithmetic, inventory transfers, encounter-graph economy, annual feedback with the homeostatic proposer, temporal evolution knobs, diagnostics, abaque sampling, calibration constants, RNG management, SQLite persistence, and a CLI driver. All run data is written to a single SQLite database per run.

Reproducibility. Runtime for one configuration (500 agents × 5 years, single seed) is on the order of fifteen minutes on a single laptop CPU. The full sensitivity sweep of Annex C executes in approximately ninety hours wall-clock, or under three hours with thirty-fold parallelisation. The simulator code and the per-run databases are available from the author on request; a public release is planned alongside the production runs of §8.6.

Annex C. Sensitivity sweep grid (§8.6)

Four parameters are varied around the baseline at three points each, holding the rest at default and re-running thirty seeds per cell:

• $\delta_v \in \{0.02, 0.05, 0.10\}$ — effect on the frequency of I_p adjustments and on the variance of the time-series.

• $s_v \in \{0.5, 1.0, 2.0\}$ — effect on the speed of correction when flows leave the dead band.

• $\lambda_v \in \{0.0, 0.05, 0.20\}$ — effect of the long-term sustainability anchor D_v on the equilibrium trajectory.

• q_w **distribution** — three abaque profiles: (a) the Annex A baseline (mean ≈ 1.21, SD ≈ 0.25); (b) a compressed profile with all q_w in [0.8, 1.2]; (c) a stretched profile with q_w distributed across [0.5, 2.0].

Each cell reports the three diagnostics of §6.5 (90/10 wealth ratio, persistent-debt share, per component adequacy ratio). Sensitivity plots are organised as four-panel grids: one row per parameter, three columns for the three values.

Expected qualitative findings. Increasing δ_v flattens but does not abolish the regulatory response; increasing s_v accelerates convergence but raises overshoot risk near $\frac{\alpha_v}{\beta_v}$,

non-zero λ_v is necessary to anchor against multi-year drift but high λ_v makes the response brittle to mis-specification of D_v; the compressed q_w profile flattens $\bar{q}(y)$ but reduces the upward path of §6.4; the stretched profile widens the equity diagnostics but stresses the $q_w \leq 2$ ceiling.

A composite Raworth-style target (social floor + planetary ceiling, drawing on Steffen et al. 2015 for the ceiling component) is an additional sensitivity option: T_v is clipped to $[floor_v, ceiling_v]$ on top of the monetary-balance derivation.

Annex D. Monetary-balance derivation of the equilibrium trajectory (§5.1)

Monthly aggregates. For each ecological component $v \in \{2,\ldots,9\}$ and each calendar month m:

$$F_v(m) := \Sigma_{a\in A}\Sigma_{n\in days(m)} max\left(0, -v_{a,j}(n)\right) \quad \text{(extractive flow magnitude)}$$

$$G_v(m) := \Sigma_{a\in A}\Sigma_{n\in days(m)} max\left(0, +v_{a,j}(n)\right) \quad \text{(regenerative flow magnitude)}$$

The signed convention of §3.1 makes $v_{a,j}(n) < 0$ denote extraction and $v_{a,j}(n) > 0$ denote regeneration; F_v and G_v aggregate the magnitudes of each.

Each component enters the monthly aggregation from a different source rhythm. Utility-based components (water, energy) align with monthly billing. Surface, billed annually, is annualised and redistributed daily: an agent holding 100 m^2 for a year contributes $100 / 365 \approx 0.274$ $m^2 \cdot day$ per day, summed across the month.

Equilibrium trajectory. The trajectory for v at the close of year y combines the recent moving average with a monetary-balance target:

$$T_v(y) := \left(1 - \lambda_v\right) \cdot MA_{12}\left(F_v - G_v\right)(y) + \lambda_v \cdot D_v(y),$$

where MA_{12} is the trailing 12-month mean of net consumption at year close, $\lambda_v \in [0, 1]$ is a design layer drift parameter, and $D_v(y)$ is the per-component volume that would balance, at $I_p = 1$, the share of monetary creation attributable to that component:

$$D_v(y) := F_v(y-1) \cdot \left(B \frac{(y-1)}{D_{destroyed}}(y-1)\right),$$

with $B(y) := \Sigma_{UDI}(y) + \Sigma_{qwnet}(y) + \Sigma_{regencredits}(y)$ the year's total monetary creation and $D_{destroyed}(y) := \Sigma_v R_v \cdot I_{p,v}(y) \cdot F_v(y)$ the year's total monetary destruction through conversion.

Interpretation of the ratio. The ratio $\frac{B}{D_{destroyed}}$ is the framework's measure of monetary balance:

• When it equals 1, creation and destruction match and the trajectory recommits to the current level.

• When it falls below 1 (deflationary pressure), D_v shrinks below current flows and the trajectory signals that next year's extraction should fall.

• When it rises above 1 (inflationary pressure), D_v exceeds current flows and the trajectory accepts more extraction as monetarily absorbable.

No external target. The framework does not ask the community to nominate planetary-boundary allocations, nor derive D_v from per-capita ecological budgets that depend on community size. The equilibrium target emerges internally from the balance between the time stock the community creates (UDI, q_w net, regenerative activity) and the time stock it destroys (resource conversion). The ecological feedback is therefore a *consequence* of monetary stability, not a separate normative layer.

Anchor strength. λ_v controls how strongly the monetary anchor pulls the trajectory. With $\lambda_v = 0$, the trajectory tracks recent behaviour mechanically (vulnerable to ratchet-up). With $\lambda_v = 1$, the trajectory locks onto the monetary-balance level (vulnerable to swings if B or extraction fluctuates). The default for simulation is $\lambda_v = 0.05$: 95% weight on the recent average, 5% pull toward the monetary-balance anchor.

Year-0 initialisation. At year 0, before any history is available, $D_v(0)$ is set to the year's observed flow (no scaling); from year 1 onwards the recursion above applies. The smoke-run convergence (B/D ratio 13.6 → 1.55 → 1.70 → 0.75 → 0.91 across years 0–4) demonstrates that even from a far-from-equilibrium initial calibration, the annual R_v re-calibration

$R_v(y+1) := R_v(y) \cdot \sqrt{\left(B \frac{(y)}{D_{destroyed}}(y)\right)}$, square-root damping) drives the system to monetary balance within 2–3 years.



Composite Raworth-style target as sensitivity option. A composite design where T_v is additionally clipped to [$floor_v$, $ceiling_v$] — a Raworth (2017) social floor plus planetary ceiling drawing on Steffen et al. (2015) — is available as the Annex C sensitivity option, but is not the §5 default. The default is monetary-balance only.

Annex E. Computational illustration: five-year smoke run

This annex presents a preliminary computational illustration of the framework specified in §3–6, drawing on a single five-year smoke run of the simulator described in §8.2 and Annex B. The run combines the baseline 500-agent population (400 individuals, 75 business-owners, 25 enterprises

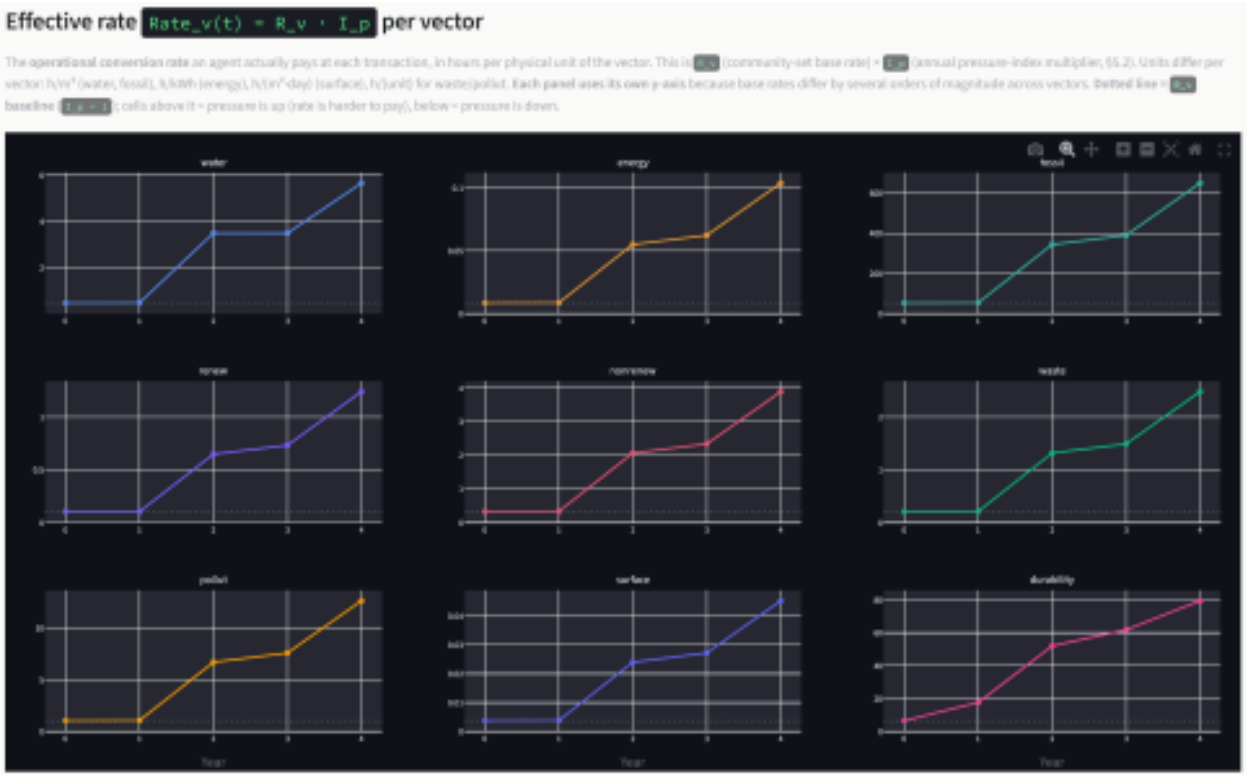
across five sectors) with an exogenous **drought scenario** — a deliberate ×2 multiplier on the agriculture sector's water-component consumption applied from day 730 (start of year 2) to day 1460 (end of year 3) — chosen to make per-component reactivity visible alongside the homeostatic dynamics. Two limitations bound interpretation: the run uses **one seed** rather than the thirty-seed ensemble scheduled in §8.6, so no statistical confidence bands appear; and the initial R_v calibration is **deliberately set below monetary equilibrium** (B/D ≈ 14 at year 0) so that the corrective dynamics of §5 are visible across the simulated horizon rather than masked by an already-balanced start. The figures should therefore be read as evidence that the mechanisms *compose* and *behave as specified*, not as calibrated predictions of a deployed instance.

E.1 Population sampled in this run



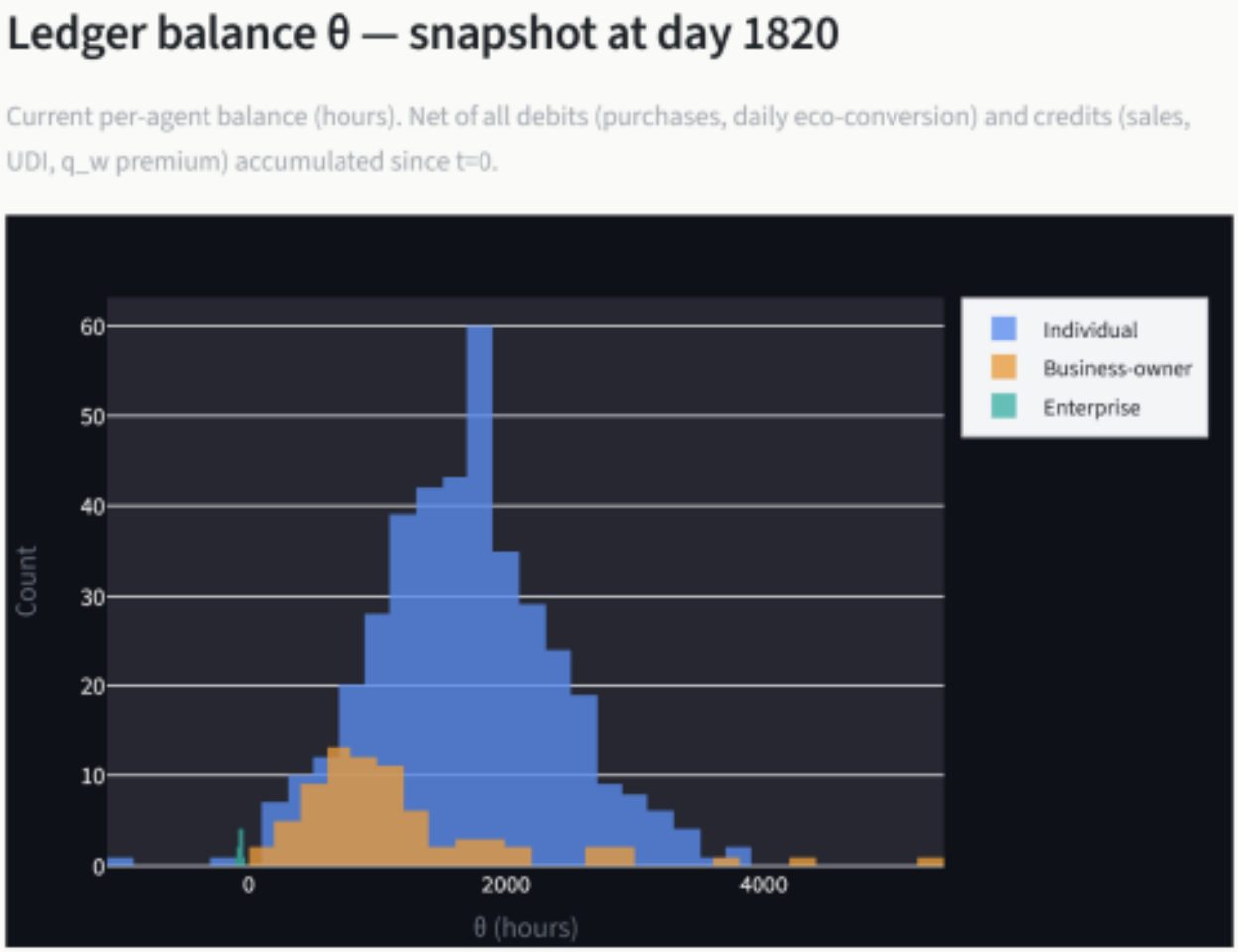
The community is composed of 400 individuals, 75 business-owners, and 25 enterprises distributed across five sectors (agriculture, artisanal, distribution, services, technology). The q_w distribution sampled from the Annex A abaque has mean ≈ 1.21 with most mass between 0.8 and 1.6; the ~12 active business-owners carry the additional +0.35 component per Annex A. The sectoral mix is intentionally diverse — agriculture is the only sector with a positive renewable component (food and biomass production), while the technology sector concentrates negative energy and pollutant components, creating contrasted component profiles whose response to homeostatic feedback differs by an order of magnitude.

E.2 Effective conversion rate $Rate_v(t)=R_v \cdot I_p$ per component



Each panel shows the operational rate an agent actually pays per physical unit of the corresponding component, in hours. The dotted line marks the year-0 base rate R_v after analytical calibration; the trajectory above shows how $R_v \cdot I_p(y)$ evolves over the five-year horizon. Two patterns appear. First, all components trend **upward** across the horizon. This is the §5.2 annual re-calibration mechanism ($R_v(y+1) := R_v(y) \cdot \sqrt{(B/D)}$) at work: because the initial R_v was set below equilibrium, the early-year ratios $B / D > 1$ (monetary creation exceeds destruction) lead the framework to scale R_v upward by the square root each year; the ratio then crosses below unity at year 3 (0.75) and settles near balance at year 4 (0.91), so the correction slightly overshoots before converging. Second, the trajectories are **bunched** across components — the per-component adjustment is dominated by the global B/D signal rather than by per-component d_v movements. The drought signal on the water component is present but visually subtle at this scale; Figure E.5 isolates it more cleanly.

E.3 Ledger balance distribution at day 1820 (year 5)



Three observations matter. **(i) Enterprises cluster tightly at θ ≈ 0** (teal, near origin) — the cost recovery invariant of §3.6 holds empirically over five years: hours paid out to workers are recouped through sales, leaving the enterprise's time-axis balance near zero by construction. **(ii) The household distributions are bounded** — individuals (blue) peak around 1500–2000 hours with a tail dropping off above 3000 h, and business-owners (orange) cluster more modestly around 500– 1000 hours. There is no fat tail, no runaway accumulation. **(iii) The 90/10 wealth ratio inside the household population is 3.6**, well below the threshold of 8 set by §8.8's falsification criterion (i).

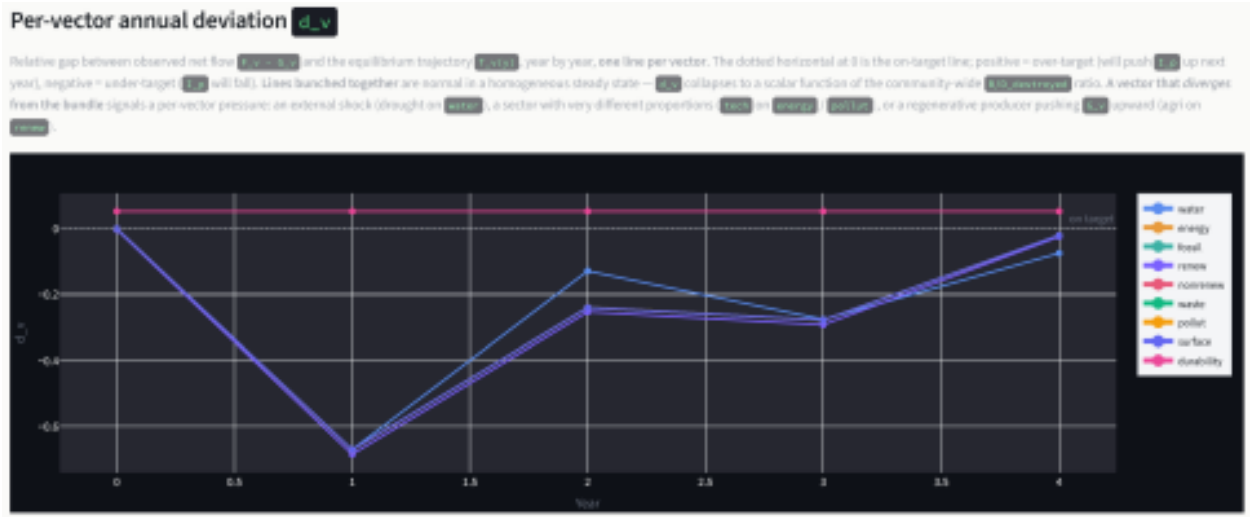
No individual ends the horizon in debt: the persistent-debt share is 0.0 %, against a falsification threshold of 20 %.

E.4 Mean time-axis balance trajectory by agent kind



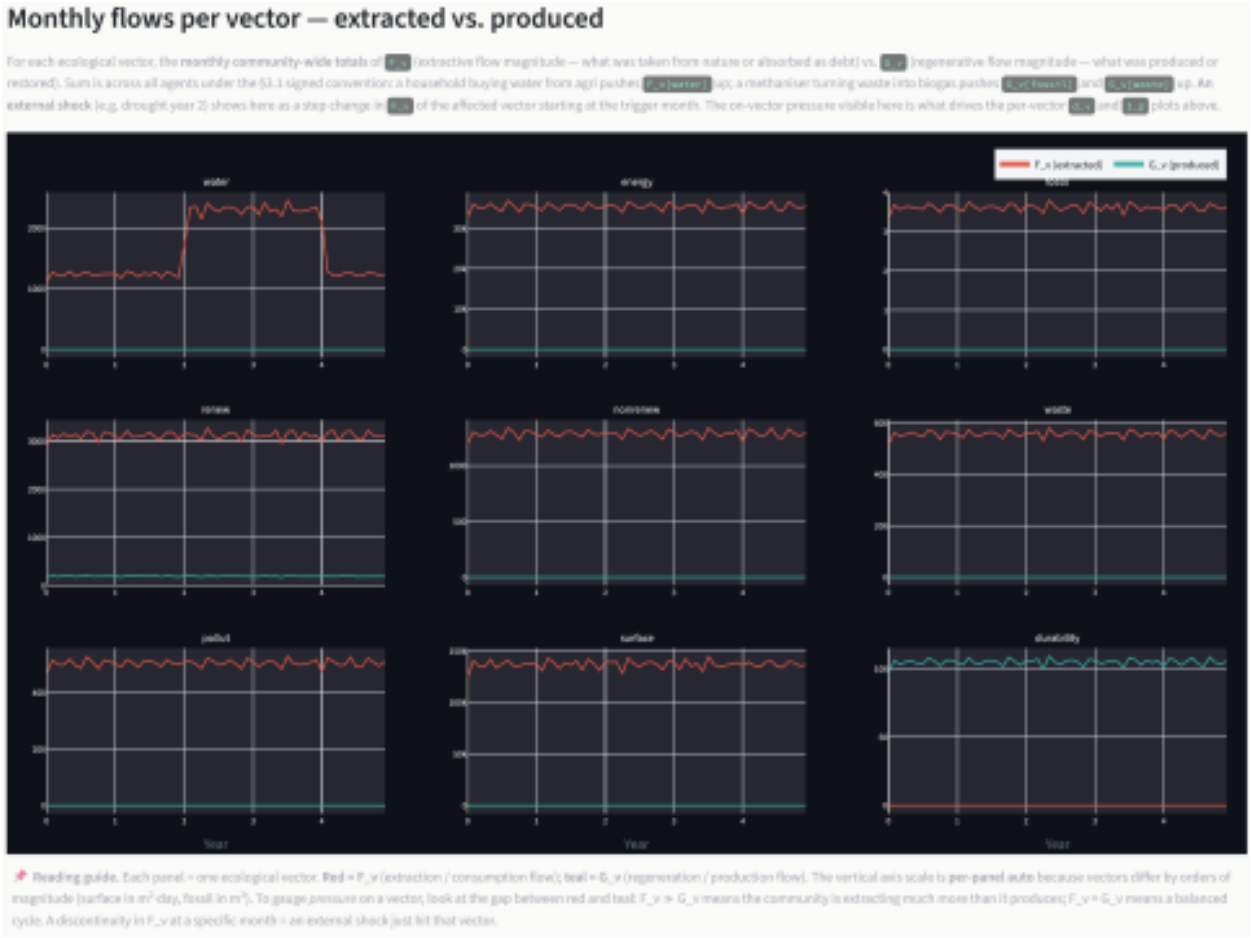
Enterprises (teal) remain flat near zero across the entire five-year horizon, oscillating in a band of ~50 hours width — the structural neutrality invariant claimed in §3.6 holds dynamically, not only at end-of-horizon. **Individuals and business-owners drift positive linearly**. The drift is *not* steady state — both lines continue rising at year 5. This is the corrective dynamic in progress: with R_v initially below equilibrium, household reconciliation debits are too small relative to UDI inflow, so net balance accumulates; as R_v ramps up (E.2), the per-component debit grows and the slope flattens. A horizon of ~8–10 years would be needed to observe the slope reach zero (steady state).

E.5 Per-component annual deviation d_v



$d_v(y)$ is the relative gap between the observed net flow and the §5.1 equilibrium trajectory; the dotted horizontal at zero is on-target. The pattern across years tells a clean homeostatic story: year 0 starts on-target by construction, year 1 plunges to ≈ −0.65 as the under-calibrated R_v generates a B/D ratio far above unity, years 2–3 rebound to ≈ −0.30 as the annual R_v re-calibration takes effect, and year 4 returns near zero. The lines are **bunched across components** — in the absence of a per component shock, all eight ecological components collapse to a near-scalar function of the community-wide B/D imbalance, as §5.1 predicts. The drought on water (years 2–3) is visible as a slight divergence of the water line from the bundle.

E.6 Monthly flows F_v (extracted) vs G_v (produced) per component



Each panel shows the community's monthly extraction (F_v, red) against its monthly regenerative production (G_v, teal) under the §3.1 signed convention. **Most components show extractive-only flow** (energy, fossil, non-renewable, pollutants, waste, surface): F_v baseline ≈ 350 monthly hours equivalent with G_v near zero. **Renewable resources is the exception**: $F_v \approx G_v$, the agricultural sector's positive renewable component balancing the community's renewable extraction. **The water panel shows the drought signal**: a visible step-change at month 24 (start of year 2) where $F_v[water]$ jumps by ~50 % and remains elevated until month 48 (end of year 3, drought reverted). The component-targeted shock propagates as designed.

E.7 Synthesis

Four observations emerge from this run.

Cost-recovery invariant for enterprises (figs E.3, E.4). The structural claim of §3.6 — that the enterprise time-axis balance over a complete production-sale cycle is approximately zero — holds dynamically across all sixty months of simulated time. Enterprises do not accumulate wealth, do not absorb external losses, and do not amortise losses across future production: they pass through.

Bounded household wealth distribution (fig E.3). Individuals and business-owners cluster in finite ranges with no fat tail. The 90/10 wealth ratio inside the household population sits below the conventional inequality threshold of §8.8's falsification criterion (i).

Homeostatic adaptation in operation (figs E.2, E.5). The framework's annual R_v re-calibration with square-root damping (§5) does drive the system toward monetary balance from a far-from equilibrium initial calibration. d_v converges from −0.65 at year 1 to near zero at year 4; R_v continues rising at a decreasing rate. The convergence is in progress, not complete — a longer horizon would be needed to observe stable steady state.

Per-component reactivity to exogenous shock (fig E.6). The drought shock applied to the agriculture sector's water component propagates through the monthly aggregates as designed: the water panel shows the demand step at month 24 and the revert at month 48 without contaminating the other components' flows.

What this run does not establish. First, it does not provide statistical confidence bands. Second, it does not show steady-state behaviour. Third, it does not test agents who optimise *against* the framework. Fourth, it does not bear on inter-community interoperation or long-horizon ecological recovery cycles. The illustration supports the constructive-existence claim of §8 in a preliminary, single-realisation sense: the mechanisms compose without breakdown, the homeostatic correction operates, the enterprise/household partition of the time-axis balance behaves as designed.

Annex F. The ten-component basis: Table F.1 and data tier mapping (§3.1)

The unit of account is a vector with ten components, each carrying a distinct physical unit. Table F.1 lists the basis, physical units, data tier, and documentary source per component.

Table F.1. The ten-component basis.

#	Component	Physical unit		Tier Documentary source
1	**Time**	hours	A	Timesheets, payroll, project logs
2	**Water**	m^3	A	Utility invoices, metered abstraction
3	**Energy**	kWh	A	Utility invoices
4	**Fossil fuel**	m^3 at 15 °C	A	Purchase receipts, fleet management logs
5	**Surface**	m^2·day	A	Land registries, lease contracts: $\sum (m^2 / 365)$
6	**Renewable resources**	m^3 or kg per material class	B	Purchase invoices + conversion tables
7	**Non-renewable resources**	m^3 or kg per material class	B	Purchase invoices + conversion tables
8	**Waste**	m^3 or kg per disposal class	D	Waste-stream audits, regulatory declarations
9	**Pollutants**	m^3·toxicity or g per substance class	D	Emission declarations, safety data sheets
10	**Durability**	dimensionless (MTBF / MTTR)	C	Manufacturer warranty data

Tier A (components 1–5): data exists in documents firms and households already maintain; the operational task is extraction and aggregation, not measurement. Timesheets, payroll registers, utility bills (water, electricity, gas), fuel purchase records, and land-registry titles or lease contracts collectively cover the first five components.

The $1 m^2 \cdot 365\ day = 365\ m^2 \cdot day$ convention annualises surface, with daily allocation given by $\sum (m^2 / 365)$ over the period.

Tier B (components 6–7, renewable and non-renewable resources): purchases are recorded in commercial units (a box of nails, a litre of paint, a metre of fabric); conversion to physical units uses published life-cycle-inventory references, with material-class granularity set at the design layer.

Tier C (component 10, durability): a dimensionless ratio (MTBF/MTTR, or units returned-and repaired to units sold) positioned last because it differs in nature from physical flows. The data exists in warranty management but is rarely exposed at the point of sale; the operational task is making it available, not producing it.

Tier D (components 8–9, waste and pollutants): large producers maintain partial records under REACH, ISO 14001, waste-registry obligations; the toxicity profile of common industrial inputs is published on safety data sheets and propagates downstream via §3.2's Contamination Principle. Smaller producers require phased-in protocols.

The basis is revisable at the design layer: a community may add a vector capturing an additional locally-relevant dimension (animal welfare, biodiversity, culturally-specific resources), or modify the material-class aggregation.

Annex G. Formal model with commentary (§3, §4)

This annex presents the formal definitions and propositions underlying §3 and §4. Each construct is accompanied by commentary explaining its role and the design choices it reflects.

G.1 The vector space

Let $V := \mathbb{R}^{10}$ with standard basis $(e_1, \ldots, e_{10})$, each e_j associated with one physical axis of §3.1. A vector $V \in V$ has the form $V = \Sigma_{j=1}^{10} v_j \cdot e_j$ with $v_j \in \mathbb{R}$. Each v_j is a real-valued coefficient denoting the agent's quantity on axis j, in that axis's physical unit (hours, m^3, kWh, etc.). The basis vectors e_j are abstract axes; the v_j are quantities along those axes.

A worked illustration: a table that consumed 12 hours of labour, 0.015 m^3 of water, and 33 kWh of energy is written $V_{table} = 12 \cdot e_{time} + 0.015 \cdot e_{water} + 33 \cdot e_{energy} + \cdots$. The notation makes explicit that each component carries its own physical unit and that the components are not commensurable: one cannot add v_1 (hours) to v_2 (m^3); only v_j adds to v_j. No metric or distance is defined on V, because any such notion would force commensuration choices the design layer leaves to the community.

Components are real-valued and signed under §3.1's uniform convention: $v_j > 0$ denotes a produced or regenerated quantity, $v_j < 0$ denotes an extracted or debit-bearing quantity. The same convention governs step-vectors (G.2): an extractive step contributes negative components on the consumed axes; a regenerative step contributes positive components on the recovered axes.

G.2 The path-sum identity and the Contamination Principle

Consider a finite directed acyclic supply chain (a_1,a_2,...,a_k) in which agent a_i consumes the output of a_{i-1} and produces an input for a_{i+1}. Let $\Delta V_i \in V$ denote the *step-vector* contributed by a_i — the physical resources a_i extracts or absorbs as ecological debt (negative components for $j \in \{2,\ldots,9\}$) or restores / regenerates (positive components) in transforming the input received from a_{i-1} into the output passed to a_{i+1}. For j=1 (time), a positive entry records labour incorporated at step i — labour credited to the worker as positive time on their ledger.

Definition (cumulative vector). The cumulative vector at step k is $V_{total}(k) := \Sigma_{i=1}^{k} \Delta V_i$, with addition component-wise across V.

Proposition G.A (Contamination Principle, formal statement). Let c be a finished good produced at the end of a finite supply chain $(a_1, \ldots, a_k)$ with step-vectors$(\Delta V_1, \ldots, \Delta V_k)$. Assume (i) every ΔV_i is recorded by a_i; (ii) the chain is acyclic (no agent double-counted); (iii) every upstream input flowing into c is reported in some ΔV_i (no off-ledger inputs). Then the vector attached to c at the point of final purchase is $V_{total}(k) = \Sigma_{i=1}^{k} \Delta V_i$.

The proposition is an accounting identity, not a behavioural claim: the additive structure of V and the chain-of-production graph are jointly sufficient to reconstruct cumulative resource history without commensuration into a scalar. Assumptions (i) and (iii) are operational requirements on the ledger; (ii) is structural. For joint production, ΔV_i is split among outputs by an LCA convention (Hauschild, Rosenbaum & Olsen 2018).

G.3 The conversion mechanism

For each ecological component $v \in \{2, \dots, 9\}$, the base rate $R_v \in \mathbb{R}_{>0}$ is the labour cost the system requires to redeem one physical unit of consumption on v. Dimensionally, R_v is in hours per physical unit of v. The vector of base rates $R := (R_2, \dots, R_9) \in \mathbb{R}^8_{>0}$ is set at the design layer.

The pressure index $I_p(t) := \left(I_{p,2}(t), \dots, I_{p,9}(t)\right)$ is a vector of dimensionless multipliers, one per ecological component, computed automatically by the annual feedback mechanism (§5, Annex D). The current conversion rate is:

$$Rate_v(t) := R_v \cdot I_{p,v}(t), v \in \{2, \dots, 9\}.$$

Three properties: **(P1)** Asymmetry — $Rate_v(t)$ is defined only for $v \in \{2, \dots, 9\}$; no $Rate_1$ (no rate converts time into time). **(P2)** No ecological-to-ecological mapping — exchange between any pair of ecological components occurs only via the time component. **(P3)** Bounded range — each $I_{p,v}(t) \in [\alpha_v, \beta_v]$ with $0 < \alpha_v \leq \beta_v < \infty; \alpha_v > 0$ is a framework invariant preventing collapse to zero.

The same numerical $Rate_v(t)$ operates in three contexts during the operational year: automatic settlement at daily reconciliation (G.4), voluntary redemption by an agent before reconciliation, and informational scalar valuation at the transaction window for buyer comparison.

G.4 Daily reconciliation

Reconciliation runs on a daily cadence. Let n ∈ ℕ index days, t_n the close of day n. For agent a on day n, transactional flows update inventory $v_{a,j}(n)$ under the §3.1 signed convention for ecological components $j \in \{2, \dots, 9\}$, and time-component flows $L_a^{given}(n)$ (labour performed for others — positive credit on the worker's time component) and $L_a^{paid}(n)$ (labour paid for as buyer — negative debit on the buyer's time component).

Scope of reconciliation. Daily reconciliation applies to agents whose accumulated inventory represents final consumption. Agents whose inventory represents stock for sale do not reconcile: their ecological inventory persists in raw signed-component form until sold, transferring to the buyer's ledger and reconciling there.

Conversion reconciliation. At day's close, for each reconciling agent a:

$$\Delta\theta_a^{conv}(n) := \Sigma_{j=2}^{9} Rate_j(t_n) \cdot v_{a,j}(n), \text{ added to } \theta_a \text{ against no offsetting transfer,}$$

where θ_a denotes the agent's time-component balance. Under §3.1's signed convention this single signed expression captures both destruction ($v_{a,j}(n) < 0 \Rightarrow \Delta\theta_a^{conv}(n) < 0$, time-component debit) and creation ($v_{a,j}(n) > 0 \Rightarrow \Delta\theta_a^{conv}(n) > 0$, time-component credit).

Daily outflows, current debt, and UDI. Let $S_a(n) := L_a^{paid}(n) + max\big(0, -\Delta\theta_a^{conv}(n)\big)$ denote the day's total outflows (labour paid plus the magnitude of any negative conversion). Let $D_a(n) := max\big(0, -\theta_a(t_{n-1})\big)$ denote the agent's current time-component debt (positive when in debt, zero when at or above neutral). The system credits

$$U_a(n) := min\big(\Delta t, S_a(n) + D_a(n)\big)$$

to the time component. UDI has no matching debit — it is monetary creation. UDI is bounded by what is needed (outflows + debt), capped at Δt; an agent with neither outflows nor debt receives $U_a(n) = 0$. UDI compensates outflows first; any residual within the Δt cap flows to debt-paydown.

End-of-day balance.

$$\theta_a(t_n) := \theta_a(t_{n-1}) + L_a^{given}(n) - L_a^{paid}(n) + \Delta\theta_a^{conv}(n) + U_a(n).$$

A new agent receives a one-time endowment of Δt at enrolment. Time-component debt ($\theta_a < 0$) clears through three channels: labour given to the community (one-for-one credit), consumption of regenerative goods (positive $\Delta\theta_a^{conv}$ credits θ_a directly), and residual UDI (the portion of the daily Δt cap not absorbed by current outflows, applied to the running debt within the cap). The cap Δt bounds the rate of UDI-driven debt clearance: an agent in debt with no outflows clears at most Δt hours per day through this channel.

G.5 Two propositions sketched

Standing assumptions. Proposition G.2 below is stated for an agent not in debt at the open of the day (D_a(n) = 0); the general case adds the debt term without changing the bound. (A1) every agent receives a UDI entitlement with daily cap $\Delta t > 0$, applied as $U_a(n) = min\big(\Delta t, S_a(n) + D_a(n)\big) with D_a(n) = max\big(0, -\theta_a(t_{n-1})\big)$; (A2) reconciliation runs at the daily cadence of G.4, with $R_v > 0$ and $I_{p,v}(t) \in [\alpha_v, \beta_v]$ for every $v \in \{2, \dots, 9\}$; (A3) per-day labour throughput is bounded; (A4) transactions are non-strategic.

Proposition G.1 (consumption floor, absence of compounding, three-channel debt clearance, conjectured). Under (A1)–(A4):

> (a) **No compounding term.** The recursion for $\theta_a(t_n)$ contains no multiplicative dependence on θ_a itself — saved hours generate no return on positive balances. (b) **Consumption subsidy floor.** Every agent can sustain up to Δt of daily outflows on the time component without depleting their balance. (c) **Debt clearance through three channels.** Time-component debt clears through (i) labour given to the community (one-for-one credit on θ_a), (ii) consumption of regenerative goods (positive $\Delta\theta_a^{conv}$ credits θ_a directly), and (iii) residual UDI — the portion of the daily Δt cap not absorbed by current outflows, applied to the running debt within the cap. The cap bounds the UDI-driven clearance rate: an agent in debt with no outflows clears at most Δt hours per day through this channel.

Sketch. The end-of-day recursion is $\theta_a(t_n) = \theta_a(t_{n-1}) + L_a^{given}(n) - L_a^{paid}(n) + \Delta\theta_a^{conv}(n) + U_a(n)$

with $U_a(n) = min\big(\Delta t, S_a(n) + D_a(n)\big)$, $S_a(n) = L_a^{paid}(n) + max\big(0, -\Delta\theta_a^{conv}(n)\big)$,

and $D_a(n) = max\big(0, -\theta_a(t_{n-1})\big)$.

For (a), no term in the recursion or in $U_a(n)$,$S_a(n)$, $D_a(n)$ contains a factor of the form $\theta_a \cdot k$ (multiplicative dependence). The $D_a(n)$ term introduces an *additive* dependence of U_a on prior debt, but this dependence reduces the magnitude of debt over time rather than amplifying it — debt does not compound, it shrinks. For (b), when $S_a(n) \leq \Delta t$ and $D_a(n) = 0$ (not in debt), $U_a(n) = S_a(n)$ exactly compensates outflows; the agent's balance changes by $L_a^{given}(n) + max\big(0, \Delta\theta_a^{conv}(n)\big)$ only. For (c), $U_a(n) = min\big(\Delta t, S_a(n) + D_a(n)\big)$ allocates the daily Δt cap to outflows first (up to $S_a(n)$) and the residual $\Delta t - S_a(n)$ (if positive) to debt-paydown up to $D_a(n)$. Combined with labour given (one-for-one) and positive $\Delta\theta_a^{conv}$

(regenerative consumption credit), this gives the three channels.

Proposition G.2 (upward path through contribution, conjectured). Under (A1)–(A4) plus §6.3's q_w mechanism, an agent working X hours on day n with coefficient q_w gains $q_w \cdot X$ hours of credit on the time component. Framework caps $q_w \leq 2$ (invariant) and $X \leq 12$ (the daily ceiling on declared labour, §6.3); maximum daily balance accumulation from labour is therefore $q_w \cdot X \leq 24$ hours — the two caps jointly ensure that credited time never exceeds the twenty-four hours of the calendar day.

Sketch. The G.4 recursion $\theta_a(t_n) = \theta_a(t_{n-1}) + q_w \cdot W_a(n) - max(0, S_a(n) - \Delta t) + max\left(0, \Delta\theta_a^{conv}(n)\right)$ shows the net daily balance change. The labour term is bounded above by $q_w \cdot X \leq 24$; the outflow penalty is non-negative and reduces accumulation. The bound covers the labour term only: UDI adds at most Δt, and a positive conversion balance (regenerative consumption) adds an unbounded credit, so what the recursion establishes is the absence of exponential growth rather than a ceiling on the daily total. Linearity in n follows because no term is multiplicative in θ_a itself.

The combined effect of Propositions G.1 and G.2 is the wealth-bound architecture: **neither extreme of inequality is achievable**. Below, the UDI consumption subsidy and linear debt-clearance prevent basic-participation deprivation. Above, the absence of compounding plus the bounded daily accumulation prevent runaway concentration. Wealth differentials are real and intentional — they track engagement via q_w — but grow linearly in time, capped per day, and contingent on continued labour.

Proposition G.3 (rate–consumption monotonicity, conjectured). Under (A1)–(A4), holding population composition fixed, an increase in $Rate_v(t)$ on a single ecological component v produces a non-positive change in steady-state aggregate consumption of v.

Sketch. The labour cost per unit of v rises with $Rate_v(t)$. Under (A4), agents do not time transactions strategically; available adjustments are (i) reduce consumption of v, (ii) substitute toward a lower-rated alternative where one exists, or (iii) absorb the cost through a reduced time-component balance, which leaves consumption unchanged. Assumption (A4) is to be read as agents responding to the prevailing rate without timing transactions against the index; agents wholly insensitive to the rate — the stronger reading used by the simulator of §8 — would make the proposition vacuous, and §8.7 records that limitation. None of the three adjustments increases aggregate consumption of v.

G.6 Worked example: woodcutter and carpenter

Two agents in a finite chain. Agent a_1 (the woodcutter) fells, transports, and delivers $Q_1 = 100kg$ of seasoned oak from a managed forest to agent a_2 (the carpenter), who produces and sells a finished table to a buyer b. The step-vectors recorded at each step (under §3.1's signed convention: extraction / consumption appears with negative components; labour incorporated is positive; zero components omitted):

$$\Delta V_1 = (v_1 = +12h, v_3 = -8kWh, v_4 = -0.005m^3@15°C, v_5 = -30m^2 \cdot day, v_6 = -100kgoak)$$

$$\Delta V_2 = (v_1 = +20h, v_2 = -0.015m^3, v_3 = -25kWh, v_9 = -0.2gvarnishresidue)$$

By Proposition G.A, the table sold to b carries

$$V_{total} = \Delta V_1 + \Delta V_2 = (+32h, -0.015m^3, -33kWh, -0.005m^3 at 15°C, -30m^2 \cdot day, -100kgoak, 0{,}0, -0.2g, 0).$$

The negative ecological components encode that the table embodies a chain of extraction (oak taken from the forest, fossil-fuel consumed in transport, energy and water spent in transformation, varnish residue released as pollutant). The positive +32 h records labour incorporated at the two steps — credited to the workers through ordinary mutual-credit transfer when the buyer pays.

Suppose the community has set the calibration $R_2 = 50\,h/m^3$ (water), $R_3 = 0.02\,h/kWh$ (energy), $R_4 = 500\,h/m^3$ at 15 °C (fossil fuel), $R_5 = 0.001\,h/(m^2 \cdot day)$ (surface), $R_6 = 0.005\,h/kg$ (renewable resources), with pollutants and durability omitted in this minimal calibration, and $I_{p,v}(t_n) = 1.0$ across the board. The day-n conversion on b's ledger is computed component-wise from the signed inventory transferred at the sale:

Component	$v_{b,j}$ **(signed)**	R_v	$Rate_v \cdot v_{b,j}(h)$
Water (v_2)	−0.015 m³	50 h/m³	−0.75
Energy (v_3)	−33 kWh	0.02 h/kWh	−0.66
Fossil fuel (v_4)	−0.005 m³ @ 15 °C	500 h/m³	−2.50
Surface (v_5)	−30 m²·day	0.001 h/(m²·day)	−0.03
Renewable (v_6)	−100 kg oak	0.005 h/kg	−0.50
$\Sigma = \Delta\theta_b^{conv}(n)$			**−4.44**

Separately, the buyer paid the chain 32 hours of labour — these hours pass to a_1 and a_2 as accounting transfers via the mutual-credit channel. The signed conversion reconciliation $\Delta\theta_b^{conv}(n) = -4.44h$ is added to θ_b against no offsetting credit at the close of day n. The whole footprint of a durable good is thus absorbed on the day of purchase, where an enterprise amortises a capital good downstream over its productive life (§4.4). The asymmetry is deliberate: reconciling at the point of sale puts the ecological cost in front of the household at the moment of the decision, which is where it can still change the decision. Spreading it would dilute exactly the signal the framework is trying to send.

If b enters the day with $\theta_b(t_{n-1}) = \Delta t = 8h$ (initial endowment, not in debt so $D_b(n) = 0$) and gives no labour that day:

$$S_b(n) = L_b^{paid}(n) + max\big(0, -\Delta\theta_b^{conv}(n)\big) = 32 + max\big(0, -(-4.44)\big) = 32 + 4.44 = 36.44h$$

$$D_b(n) = max\big(0, -\theta_b(t_{n-1})\big) = max(0, -8) = 0 \text{ (not in debt at start)}$$

$$U_b(n) = min\big(\Delta t, S_b(n) + D_b(n)\big) = min(8{,}36.44 + 0) = 8h \text{ (capped)}$$

$$\theta_b(t_n) = \theta_b(t_{n-1}) + L_b^{given} - L_b^{paid} + \Delta\theta_b^{conv} + U_b = 8 + 0 - 32 + (-4.44) + 8 = -20.44h.$$

The buyer is now in time-component debt of about 20 hours. UDI now flows to debt-paydown on subsequent days within the daily Δt cap. With zero further spending and zero labour given, the recursion runs as follows: on day $n+1, S = 0,\ D = 20.44,\ U = min(8{,}0 + 20.44) = 8$, so the balance rises from −20.44 to −12.44. On day $n+2, U = min(8{,}0 + 12.44) = 8 \rightarrow -4.44$. On day $n+3, U = min(8{,}0 + 4.44) = 4.44$ (capped at the remaining debt) → 0. Debt clears in three idle days through residual UDI alone. If b additionally provides labour or consumes regenerative goods on these days, clearance accelerates proportionally.

The example is deliberately small but every construct of §3.1–§4.2 is visible. The simulator of §8 scales the same structure to 500 agents over five years, with heterogeneity, substitution, and time-varying I_p.

Annex H. Enterprise mechanics: cost-recovery, amortisation, owner compensation

This annex develops the operational mechanics that govern agents whose accumulated inventory represents work-in-progress or stock for sale rather than final consumption. The same vector-accounting rules of §3–4 apply uniformly; this annex unpacks the cost-recovery pricing through which an enterprise's time-component balance returns to neutrality over each production-sale cycle.

H.1 The cost-recovery rule

An enterprise e maintains a labour-recovery counter L_e^{rec} recording the cumulative labour cost paid out to workers (via channel four, the q_w-weighted labour credit) and the cumulative labour cost paid out to upstream suppliers (the time-component of incoming purchased inventory). At each sale, the enterprise's time-component balance is credited:

$$\theta_e(k) := \theta_e(k-1) + \varphi_k \cdot L_e^{rec}(k-1)$$

$$L_e^{rec}(k) := (1-\varphi_k) \cdot L_e^{rec}(k-1)$$

where k indexes the enterprise's successive sales and $\varphi_k \in [0,1]$ is the fraction of the enterprise's inventory transferred to the buyer at sale k (computed from the time-component of the transferred bundle divided by the time-component of the enterprise's accumulated inventory). The second relation draws the counter down by exactly the amount recovered, so L_e^{rec} decays geometrically as inventory is sold.

The mechanism makes the enterprise's selling price reflect the cumulative labour cost embedded in the goods sold — labour paid to workers in production plus labour-content of upstream inputs amortised over the units sold.

H.2 Capital amortisation

When an enterprise buys machinery, the machine's labour-content is added to L_e^{rec}. The enterprise then recoups it through sales over the machine's productive lifetime. If a machine costing 1,000 h of labour-content is purchased and used to produce 50,000 units over five years, each unit sold carries approximately 0.02 h of machine labour-content amortised, recouped at sale via the cost-recovery rule. The amortisation is implicit in the cost-recovery formula; no separate accounting horizon needs to be specified.

The ecological component of the machine's footprint travels with the machine into the

enterprise's inventory and is **not** absorbed at reconciliation by the enterprise. It transfers to the buyers of the products produced with the machine, via the Contamination Principle: each unit sold carries its share of the machine's ecological footprint, propagating downstream until it reaches a final consumer who reconciles it on their household ledger.

H.3 Year-0 initialisation

At deployment, enterprises start with empty inventory and a time-component balance of zero. On day 1, the enterprise pays its first workers (debiting its balance) and replenishes raw-material inventory (incurring upstream labour-content debits and signed ecological-component inventory). Sales begin on day 2. During the production-before-sale gap, the enterprise's time-component balance is transiently negative — this is normal. As sales begin and cost-recovery credits flow in, the balance returns toward neutrality.

A persistently negative balance over multiple production cycles signals **demand failure**: the enterprise has overproduced relative to its market and should slow or stop production (paying fewer wages in subsequent cycles), not artificially amortise the loss over future prices. The framework does not amortise losses across future production; doing so would shift the cost of mis-pricing to future customers. The cost-recovery formula is mechanically equivalent to "the enterprise's selling price equals the cumulative labour cost of its inventory divided by the volume sold" — there is no room to inflate prices to recover past over-production.

H.4 Owner compensation channels

Business owners are compensated through one of two structurally bounded channels:

(i) **Real-time time-clocking**: hours actually worked are declared by the owner in real time, under the same 12 h daily ceiling that applies to every agent (§6.3) — the channel is a declaration mechanism, not a raised entitlement. These declared hours flow into L_e^{rec} as ordinary labour credit and are recouped through future sales like any other worker's hours.

(ii) **Default 8 h per day**: an owner who does not clock in receives an arbitrary 8 h per day credit. This is the default for owners not engaged in active production; it acknowledges their role as designers, supervisors, or representatives without requiring time-tracking.

In either case, **accumulated time-component surplus in an enterprise's ledger is consumable only by future enterprise investment, not by individual withdrawal**. There

is no mechanism by which an owner can extract enterprise surplus into their personal time-component balance, except through their declared pointage hours (capped). The framework forecloses individual extraction of enterprise surplus by construction — there is no mechanism to "pay out a profit", because there is no profit category and no shareholder claim.

Losses on enterprise balance are not socialised across other agents. If an enterprise sustains a persistent negative time-component balance, the corrective response is to slow production (pay fewer wages in subsequent cycles), not to inflate selling prices or transfer the loss elsewhere. The demand-side regulation is structural: customers who do not pay the labour-content of overproduced goods cause the enterprise to reduce output until balance returns.

H.5 Falsifiers at the operational layer

The framework's claim of structural enterprise neutrality (no profit, no loss-amortisation) is empirically falsifiable. Two patterns would constitute deployment-level evidence against the claim:

(F5a) **Enterprise-investment expenditures are systematically routed toward personal-asset acquisition** by owners or their affiliates. This would indicate that the surplus-consumption restriction is being bypassed through enterprise spending channels.

(F5b) **Enterprises consistently fail to reduce wage outlays when the time-component balance stays negative**, continuing to over-produce while owners draw their default 8 h per day. This would indicate that demand-side regulation is being suppressed, with the cost effectively transferred to UDI absorption across the community.

These complement §10.3 F5 at the simulation level and would inform the design of pilot evaluation criteria.

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SOCIAL AND URBAN EFFECTS OF MUNICIPAL COMMUNITY CURRENCY: LESSONS FROM MUMBUCA

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Abstract

This research studied the Mumbuca Digital Community Currency circulation to understand its effects on the users and beneficiaries of the currency in the city of Maricá, located in the metropolitan region of Rio de Janeiro, Brazil. Mumbuca is a digital community currency that operates in the entire city of Maricá and is disbursed by the city hall to the local population through different cash transfer programs. We used a Social Technology (Tecnologia Social) lens to understand the effects of the circulation of Mumbuca in the city of Maricá, positioned as a technology created to leverage the local resources and, in the process, capable to induce sociotechnical reconfigurations among the actors involved. For that, an inductive field immersion was conducted with interviews to beneficiaries of municipal cash transfers in Maricá, paid in Mumbuca and to local businesses that accept Mumbuca as payment to understand their perspectives of the currency and how it affected them. The data collected was triangulated with additional interviews with institutional actors responsible for the functioning of the currency and documental research. The analysis of those perspectives revealed the effects of this digital community currency's circulation and the

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emerging social reorganization and dynamics caused by it. Our results show that Mumbuca is a Social Technology capable of changing socio-technical and traditional relationships in the city, such as work relationships, changes in the customer base of local businesses or improved purchasing power and financial autonomy for the local population. Some of our findings also point to new urban dynamics related to the circulation of Mumbuca, such as a growing immigration influx from poorer neighboring cities or unequal intra-urban effects of the currency, with a higher circulation in central regions of the city that have a more consolidated market and with a few big retailers capturing a significant portion of the currency.

Keywords: Mumbuca, digital community currency, Tecnologia Social, Social Technology

1. Introduction

Alternative, community, social, complementary, local, are all terms used to describe a similar phenomenon of currencies that present a complementary or even a counterpoint to traditional, Fiat, money (Blanc, 2011; Diniz et al., 2019). Community currencies (CCs) anchor money into a location by issuing a different currency that circulates within a specific context which keeps the money within a location or community. This process follows a different pattern than traditional money, which promotes internationalization, speculation, resource exploitation and monetary leakage from poor communities. Furthermore, CC's design and objectives can be used to influence behaviors. Thus, CCs can be linked to sustainable development initiatives or even to the degrowth movement (Blanc, 2024; Bouchez et al., 2025; Diniz, de Araujo, et al., 2024; Hornborg, 2017; van Arkel et al., 2024).

CCs are usually issued by grassroots organizations and are restricted to specific locations or communities, which can limit their scalability and long-term functioning (Hornborg, 2024a; Weaver et al., 2025). Community currencies in Brazil can be traced to the Palmas Bank initiative, a grassroot organization that designed a model for CC issued by a community Bank through a microcredit logic. The success of the Palmas Bank initiative prompted the creation of the Palmas Institute which oversaw the replication of its methodology to different contexts in Brazil (Diniz et al., 2025). We have studied the Mumbuca digital community currency (DCC), which operates in the municipality of Maricá, located in the

Estate of Rio de Janeiro, Brazil. Mumbuca's format is interesting because, unlike regular CCs, it is issued by the local government in partnership with civil society organizations, including the Palmas Institute, and because it is employed and functions in the entire city of Maricá. Also, Mumbuca is combined with different cash transfer programs (CTs), such as a basic income, improving the circulation of this currency in Maricá as citizens have a monthly income to spend in Mumbucas (Barinaga Martín, 2024; Diniz et al., 2025; Diniz, Porto de Albuquerque, et al., 2024).

This research analyzes the Mumbuca case through the Tecnologia Social (Social Technology) framework (Souza & Pozzebon, 2020). Tecnologia Social are community artifacts and methodological procedures for solving a local problem. In their processes, they leverage a local community, its resources, local knowledge, practices and can be replicated. Tecnologia Social is rooted in decolonial and post-development traditions (Pozzebon et al., 2025). This research studied the socio-technical changes brough by the Mumbuca Community Currency to the local social groups of Maricá, by understanding it as a Tecnologia Social adapted from the grassroot model of the Palmas Bank. Also, this analysis offers the possibility to understand how a Tecnologia Social works when replicated to a local context as a municipal policy in a top-down format.

This research followed a qualitative and inductive approach. A field immersion was conducted in the municipality of Maricá, where interviews were made with institutional actors, Mumbuca beneficiaries and local businesses. The interviews were later transcribed and codified following Gioia et al. (2013) method for classifying and analyzing the aggregated themes from the field. Those themes were analyzed to understand the effects and socio-technical reconfigurations on the social groups of Maricá that directly interact with the circulation of the currency, the local businesses and the beneficiaries. So, "follow the money" means to look into the perspectives of the beneficiaries of Mumbuca, that receive the currency from the several cash transfer benefits, and of the local businesses, that in turn receive Mumbuca from the purchases made by the beneficiaries, we were able to understand the effects that this DCC had as a Tecnologia Social. The main questions guiding this research are:

(i) How the local population of Maricá perceives the effects of Mumbuca in their daily lives?

(ii) What are the socio-technical changes brought by the Mumbuca DCC on the population of Maricá?

The rest of this article is divided into a theoretical background about community currencies that ends with the Tecnologia Social Framework used in this research. Following this section is the methodology, which presents the case study and the data treatment methods. The analysis and results section then have the results from the data analysis, with the description of the aggregated themes, followed by the analysis of Mumbuca through the Tecnologia Social Framework.

2. Theoretical Background

2.1 Community Currencies

Community currencies are seen as complimentary, or even as a counterpoint, type of currency to traditional money due to their ability to localize and keep money into a context, community, or location (Blanc, 2024; Hornborg, 2024b). Community currencies offer an alternative for local sustainable development because they can recirculate money within a community, stimulating local consumption and economic growth, while fiat currency's format is designed to facilitate international trade, resource's exploitation and speculation (Hornborg, 2017; van Arkel et al., 2024). CCs can also nudge people's behavior through their design, for instance, by introducing a demurrage charge, transactional fees, conversion limits or taxes. Also, monetary rewards could be issued to stimulate virtuous or sustainable behavior (Diniz, de Araujo, et al., 2024; Mattsson et al., 2022; Ussher et al., 2021; van Arkel et al., 2024).

Some of the most common shortcomings and barriers for community currencies are related to their limitation in scope, scalability and long-term employment. The reasons for that are either because community currencies are usually issued by grassroot organizations with limited resources or due to lack of stimulus for citizens to use or for businesses to accept them as payment (Hornborg, 2024a; van Arkel et al., 2024; Weaver et al., 2025). So, a common tactic for improving the acceptance and scalability of CCs is issuing them to a population through cash transfer programs, including basic income. Furthermore, the digitalization of the currency can also help with its scalability (Bouchez et al., 2025; Diniz et al., 2025; Hornborg, 2024b; van Arkel et al., 2024).

Barinaga Martín (2024) analyzed models of alternative currencies and classified them into different strategies. Barinaga's models are based on three ideal governance principles for designing alternative currencies, namely, community-based, government-based and private-based. Also, Barinaga Martín (2024) identified and coined the term Perpetuum Mobile, meaning, the mechanism that makes the currency works. The Perpetuum Mobile is the motive that lead people into spending the alternative money, keeping it circulating into the system.

2.2 Brazilian Tradition of Community Currencies

The Brazilian tradition with community currency can be traced to the Palmas Bank initiative. The Palmas Bank was created as a microcredit institution for and by a local community, Comunidade Palmeiras, a fisherman community that was displaced during the military dictatorship to the peripheries of the Fortaleza municipality. The community found in the Palmas Bank an answer to support their local economy through the issuance of microcredits. And by creating the Palmas currency, they managed to keep the money circulating within the community. A next phase of expansion of community currencies started in Brazil when the Palmas Institute, a civil society organization, was founded to disseminate the Palmas Bank experience in the country. The Palmas Institute, together with the federal government National Secretariat of Solidarity Economy, created a favorable environment for the dissemination of CCs in Brazil (Diniz et al., 2025; Melo, 2023; van Arkel et al., 2024).

Within the Brazilian tradition, the Mumbuca case subverts some of the common design principles for community currencies. The Mumbuca currency allows for the fully and unconditional conversion of the currency into the Brazilian Fiat Money and its main circulation component relies on trade through the dissemination of cash transfers programs. Usually, this model would create a leakage of money from the system, however, the Mumbuca issuance is backed by the oil royalties which guarantee the issuance of new CCs through cash transfer programs, ensuring a continuity of the system. Through this model, local businesses progressively register into the Mumbuca system stimulated by the economic gains, creating a network where businesses perceive Mumbuca as "just another payment method". So, instead of an in-built perpetuum mobile design, this network effect acts as the mechanism of continuity of the system, with

local businesses choosing to re-spend their Mumbucas earned on other local markets instead of paying the 2% conversion tax (Barinaga Martín, 2024).

2.3 Tecnologia Social (Social Technology)

Tecnologia Social are artifacts and methodological concepts and processes that come from a decolonizing tradition and are rooted in a local context and community. It promotes initiatives created within or together with a community, especially among vulnerable ones, offering alternative socioeconomic solutions. Tecnologia Social has as a beginning on the critics of Ghandi about capitalist model of technology production and has evolved in concept, until it's creation and consolidation in Brazil as alternative methods of technological production. It can be classified into three different approaches, with the first one understanding it as a social construction or political movement, with an emancipatory nature and tied to the Solidary Economy principles. A second approach understands Tecnologia Social as a replicable product that is created and implemented within a community with the objective of improving the local context. And a third approach that positions Tecnologia Social as a part of the decolonial and post development movements, understood as an alternative to capitalist development, leveraging local participation, knowledge and resources (Dagnino, 2011; Pozzebon et al., 2025).

Souza & Pozzebon (2020) propose a framework that uses the Tecnologia Social lens for analyzing the socio-technical reconfiguration of a context induced by social technology. The author's framework, figure 1, is composed of the relationship between the Social Groups (Grupos Sociais) involved and their Practices (Práticas), divided into the tools (Ferramenta) and methods (Métodos). The key-mechanisms (Mecanismos chaves) are the processes that establish the reconfiguration of the social groups and the practices. This relationship, explained in figure 1, is embedded and influenced by a local context (Contexto). This research positions digital community currencies as a Tecnologia Social, especially looking at the Brazilian tradition of the Palmas Institute, which influenced and helped create the Mumbuca DCC. So, it uses the framework of Souza & Pozzebon (2020) to understand the socio-technical reconfigurations of Maricá by Mumbuca.

Figure 1: Tecnologia Social Framework, from Souza & Pozzebon (2020).



3. Methodology

To understand the effects of the Mumbuca currency and its circulation in the everyday life of the city, a field immersion was conducted in Maricá. This research follows an inductive approach through a case study and field immersion. Mumbuca is an intrinsic case study (Stake, 1998), because of the conjunction of different actors involved in its governance and the scale of the currency, operating in the entire city. This research argues for the importance of understanding the particularities of this case because it could reveal intraurban relationships amongst beneficiaries and businesses from different regions of Maricá and possible new social arrangements emerging from this relationship that is mediated by the Mumbuca DCC. The Mumbuca DCC is understood as a Tecnologia Social.

The Mumbuca community currency is an initiative from the municipality of Maricá, located at the Niterói metropolitan region in the Estate of Rio de Janeiro, Brazil. Maricá was historically a poor dormitory town, with its working at the neighboring Niterói and Rio de Janeiro. It is also a holiday destination for Rio de Janeiro families and retirees due to its

quieter beach front. However, the socioeconomic scenario of Maricá changed with the discovery of oil reserves in the Rio de Janeiro coast. The municipality started to receive income in oil royalties, which were used to finance several infrastructural and social programs in the city, including a basic income program issued through a community currency, Mumbuca (Maggi & Stamm, 2024).

Mumbuca innovates as a digital community currency because it was implemented by the local government, as a format for disseminating several cash transfer policies including its basic income. Also, the currency operates in the entire territory of the municipality. The creation and governance of Mumbuca works as a multistakeholder initiative. To help with the implementation of the digital currency, the Municipality works together with the Palmas Institute, who is responsible for issuing the Mumbucas into the beneficiary's accounts. A third actor, Banco Mumbuca, a local civil society actor, is responsible for providing banking services, microcredit and support to the beneficiaries of Mumbuca and businesses alike (Diniz et al., 2025).

Semi structured interviews (Patton, 2014) were conducted from 04/02/2025 to 04/12/2025 with different actors in Maricá, table 1. The interviews followed general questions about Mumbuca and its effect on the interviewee and in Maricá, and then it had contained specific questions for each group of actors interviewed. The data was separated into three categories, one for each actor, the Administration/Institutional, related to the governance of the Mumbuca or from the local research institution the Darcy Ribeiro Institute (IDR). This initial category was used for triangulating the results from the other two. The second category is composed of the data collected from the different businesses of Maricá. The third category is comprised of data from the beneficiaries of Mumbuca. This research and its interviews were subjected to and approved by a Research Ethics Compliance Committee. Also, the fieldwork followed Spink's (2008) guide for the conversing researcher and the expanded theme-field perspective. This affected this work as each researcher understood their role as an immersion in the context from the beginning of the research, including every interaction about the theme as part of the data rather than just the punctual on-site interactions delimited by the interviews.

The strategy for data collection consisted of interviewing the institutional actors from the different branches of the governance, being the local government, the Mumbuca Community Bank and the Palmas Institute. The Mumbuca Community Bank has

three units in different regions of Maricá, Centro, Inoã and Itaipuaçu, with a fourth one planned for the region of Ponta Negra. The three units were visited by the researchers, who spent their day there, interviewing the employees and beneficiaries that came in. Businesses around each unit were interviewed as well. The Ponta Negra region was also visited as a region for the future fourth Bank Mumbuca unit, and local businesses were interviewed there. Limitations found when interviewing beneficiaries and businesses were related to their time constraint, as beneficiaries were usually in their recess time and didn't have much time to give interviews. Businesses owners and employees were under working hours and did not have much time or had to interrupt the interviews to assist clients.

The data collected was transcribed and coded, within the Atlat.TI software and excel spreadsheets, in three different levels of abstraction using the Gioia et al. (2013) method for understanding the major themes drawn from the beneficiaries and the businesses of Maricá. The reason for understanding the major themes abstracted from their perspective was to identify changes and social reconfiguration in the use of the Mumbuca DCC, understood as a Tecnologia Social. Also, for this research, the focus of the analysis was on the businesses and beneficiaries of Mumbuca, as the social actors embedded into the Mumbuca context and that directly benefit and operationalize it. The other actors, classified as Administration/Institutional, have a governance relationship with the Mumbuca DCC. Their perspective was used to triangulate the data from the businesses and beneficiaries, together with secondary documents. So, by following the Tecnologia Social Framework of analysis, this research explored the sociotechnical changes induced by the Mumbuca Digital Community Currency in the local community of Maricá, identified from the themes of the beneficiaries and the businesses.

Table 1: Interviews

Interviews	Location	Quantity	Duration	Date (mm/dd/yyyy)
Administration/Institutional		**10**	**9h11m**	
Darcy Ribeiro Institute (IDR)	Online	1	35m	04/02/2025
Mumbuca Community Bank – Centro unit (Administration)	Centro	4	5h15m	
Interviewee 1		1	1h07m	04/07/2025
Interviewee 2		1	1h43m	04/07/2025
Interviewee 3		1	1h41m	04/08/2025
Interviewee 1		1	44m	04/11/2025
E-Dinheiro Institute (Administration)	Centro	1	30m	04/08/2025
E-Dinheiro Institute (Bank clerk/costumer services)	Centro	1	16m	04/08/2025
Mumbuca Community Bank – Itaipuaçu unit (bank clerk)	Itaipuaçu	1	43m	04/09/2025
Mumbuca Community Bank – Inoã unit (bank clerk)	Inoã	1	55m	04/10/2025
Maricá government's Secretariat - Solidary Economy and Social Entrepreneurship Secretariat (Administration)	Centro	1	57m	04/11/2025
Local Businesses		**36**	**3h48m***	
Restaurants / food businesses		12	1h22m*	
Restaurant – Araçatiba 1	Araçatiba	1	09m	04/05/2025
Restaurant – Araçatiba 2	Araçatiba	1	12m	04/06/2025
Restaurant – Araçatiba 3	Araçatiba	1	10m	04/06/2025
Food/Ice Cream Shop	Araçatiba	1	05m	04/06/2025
Food Truck	Araçatiba	1	05m	04/06/2025
Restaurant – Centro	Centro	1	04m	04/07/2025
Bakery - Centro	Centro	1	11m	04/07/2025
Restaurant - Itaipuaçu	Itaipuaçu	1	04m	04/09/2025
Ice Cream Shop – Inoã	Inoã	1	05m*	04/10/2025
Restaurant – Ponta Negra	Ponta Negra	1	07m	04/12/2025
Bakery – Ponta Negra	Ponta Negra	1	05m*	04/12/2025
Pizzeria – Itaipuaçu	Itaipuaçu	1	05m*	04/10/2025



General Market/ Supermarket / Groceries		5	24m*	
Supermarket – Centro	Centro	1	07m	04/05/2025
Fruit and Vegetable Market – Itaipuaçu	Itaipuaçu	1	02m	04/09/2025
Small groceries market – Inoã	Inoã	1	05m	04/10/2025
Supermarket – Inoã	Inoã	1	07m*	04/10/2025
Supermarket – Ponta Negra	Ponta Negra	1	03m	04/12/2025
Drugstore		3	09m	
Drugstore – Centro 1	Centro	1	04m	04/06/2025
Drugstore – Centro 2	Centro	1	03m	04/06/2025
Drugstore – Inoã	Inoã	1	02m	04/10/2025
Pet Shop		2	18m*	
Pet Shop	Centro	1	11m*	04/12/2025
Pet Shop/ Fishing Store	Ponta Negra	1	7m*	04/12/2025
Hardware Stores/ Home Contractor Services		7	49m*	
Hardware Store – Centro 1	Centro	1	08m	04/11/2025
Hardware Store – Centro 2	Centro	1	04m*	04/11/2025
Hardware Store – Centro 3	Centro	1	04m*	04/11/2025
Hardware Store – Centro 4	Centro	1	07m*	04/11/2025
Hardware Store – Centro 5	Centro	1	12m*	04/12/2025
Hardware Store – Centro 6	Centro	1	12m*	04/12/2025
Hardware Store – Ponta Negra	Ponta Negra	1	02m	04/12/2025
Furniture Stores		3	20m*	
Furniture Megastore (Chain Store)	Itaipuaçu	1	12m*	04/09/2025
	Itaipuaçu	1		
Furniture Store (Franchise)	Inoã	1	03m	04/09/2025
Furniture Store			05m*	04/10/2025
Others		4	26m*	
Musical Instrument's Store	Centro	1	07m	04/08/2025
Printing and Computer Store	Centro	1	05m	04/08/2025
		1		
Beauty Salon	Itaipuaçu	1	05m*	04/09/2025
Printing/xerox and Computer Store	Inoã		09m	04/10/2025
Beneficiaries		**31**	**2h18m***	
Mumbuca Community Bank – Centro	Centro	07	29m*	04/07/2025
		03	25m	04/08/2025
		03	12m*	04/11/2025
		03	12m*	04/12/2025
Mumbuca Community Bank – Itaipuaçu	Itaipuaçu	5	20m*	04/10/2025
Mumbuca Community Bank – Inoã	Inoã	10	40m*	04/11/2025

*Estimated Values

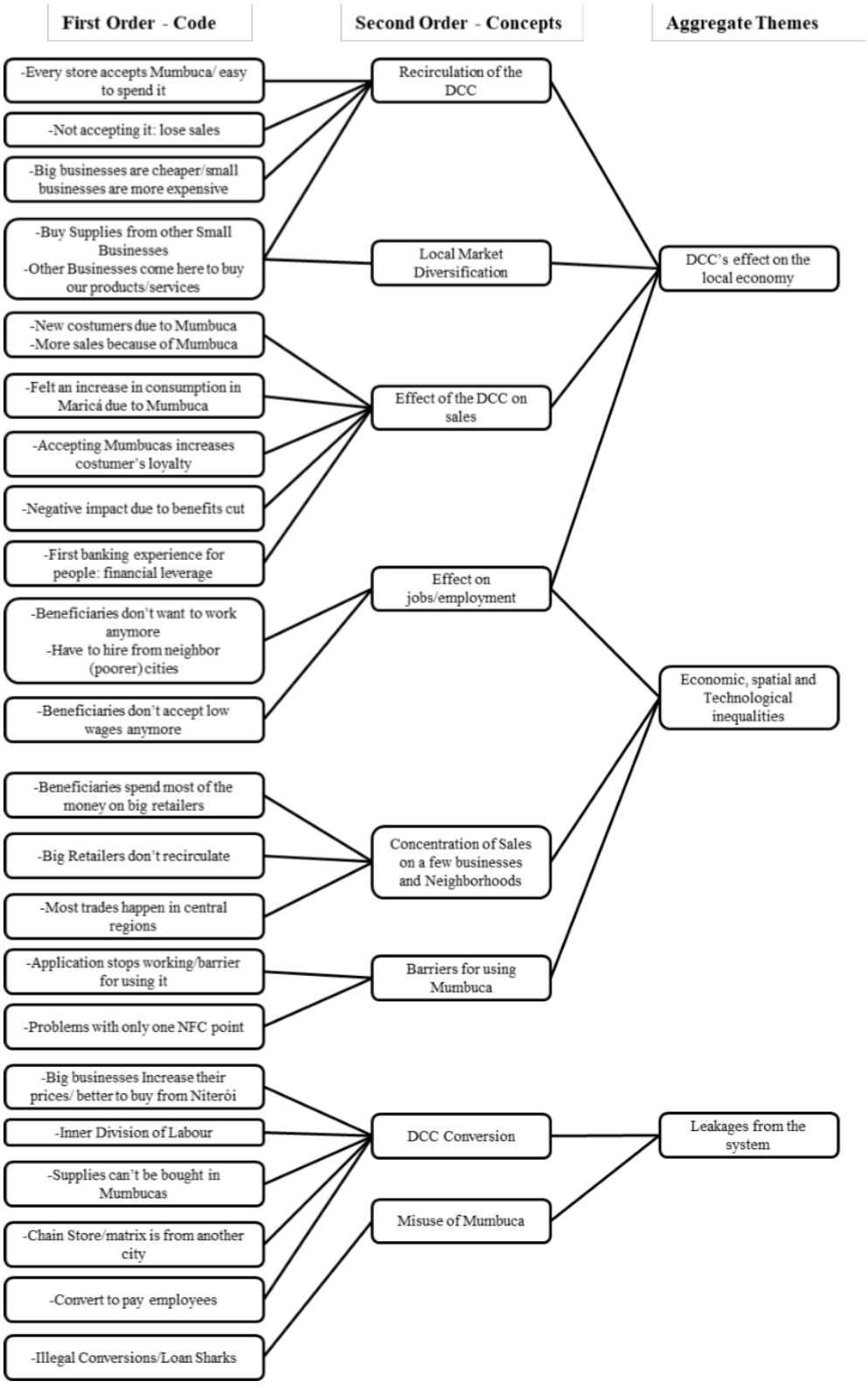
4. Results and Discussion

The major themes identified from the field work analysis, being the third level codes created through the Gioia method (Gioia et al., 2013), are discussed in subtopics for each actor. They have been classified according to the perception of each social actor within the Mumbuca system, to understand how Mumbuca, as a Tecnologia Social, changed and reshaped their realities and relationships. The aggregated themes are explained in the following subsections.

4.1 Perspectives from the Local Businesses

The interviews with local businesses revealed their perspectives on recirculation, meaning buying from other businesses with the Mumbucas that they receive instead of converting it to Brazilian Real, the official currency of the country (BRL). Positive effects of the Mumbuca circulation and barriers to its everyday functioning were also identified. Furthermore, within the major complaints, there were some hints to leakages of money from Maricá and to some limitations of this DCC model in improving the socioeconomic livelihood of local citizens. Figure 2 shows the codification process and the aggregate themes derived from the interviews with the local businesses.

Figure 2: Aggregate themes from the local business' perspective



4.1.1 DCCs Effect on the Local Economy

Overall, Mumbuca is seen positively by the local businesses due to experiencing increases in sales. Some businesses linked the circulation of Mumbucas to new customers in their stores or to increase customers' loyalty and retention. On the hand, not accepting Mumbucas was stated to have a negative impact on sales, as it made businesses lose potential clients. Mumbuca was also perceived by some of the interviewees to have leveraged a poorer population's income, increasing their purchase power.

> "For the businessman, it is very good [Mumbuca], because it is a money that people receive it and, if it were from their working income, they might not have come in here to spend it. For some people, it [Mumbuca] works as an extra income, for others it helps with their basic needs. But for someone that works and receives it [Mumbucas], they come in here, in the local businesses, to spend it, and that is very good." (Owner, restaurant, Ponta Negra, 04/12/2025, translated and adapted by the author).

The recirculation of Mumbucas was higher amongst restaurants and other small businesses. Amongst those small businesses, some of the major causes for converting Mumbucas into BRL were due to higher inner specialization and division. For instance, businesses with an accounting sector, which divides the working hours of the employees and the owner. Family business usually spent their Mumbucas to resupply or even for their personal life. Spending Mumbucas in other businesses was pointed to be more cost effective since they didn't have to pay the converting taxes and many businesses in Maricá accepts the DCC:

> We have the Mumbuca account, and with the money [Mumbuca] that goes into this account, we buy from other stores, we go to the pizzeria with that money [Mumbuca] that we receive here [from their restaurant], the money that we receive here we spend it. Everything is spent in Mumbcas, [Places where they buy supplies for the restaurant with Mumbuca] Supermarkets accept it, butcher shops accept it... The restaurant here needs meat, we buy it from Charque500 [local butcher store], because they accept it [Mumbuca], but also other big ones accept it as well. DOM accepts it, a lot of people accepts it. When my husband is out of town, he jokes around "do you accept Mumbuca?" and he proceeds to tell the story of the currency. (Owner, restaurant in Araçatiba, Maricá, 04/06/2025, translated and adapted by the author).

The growing network of local businesses that accept Mumbuca has been pointed by Barinaga Martín (2024) as a key cause for the continuing function of Mumbuca. But complementary to Barinaga Martín (2024), the findings from the fieldwork shows that the network of markets accepting Mumbucas is not only growing but also diversifying. Some of the businesses sought other specialized local businesses for resupplying or for the purchase of services, such as for creating banners in a local printing store, or for purchasing meat at a local butcher, instead of purchasing it from a big retailer. Those might be signs of a market diversification and linkage of the local economy (Ussher et al., 2021), revealing a secondary impact to this network of businesses created by the Mumbuca system:

> Usually we spend everything (Mumbucas) here in the city, with resupply. We spend it on other computer suppliers here in the city. Smaller suppliers. We pay everything in Mumbucas, that's usually the case. We only convert it to Real when there is a product that we can't find here in the city, so we go to Rio [de Janeiro]. (Store clerk, Printing and Computer store, Centro region, 04/07/2025, translated and adapted by the author).

4.1.2 Economic, Spatial and Technological Inequalities

The unequal concentration of Mumbucas into a small number of big retailers was a theme of discussion by part of the businesses in Maricá, especially regarding how those retailers absorb most of the money issued by the city hall and do not recirculate back the money.

Not only that, but those retailers also increase prices during the periods of benefit's issuance to the local population. The concentration also happens between neighborhoods, with some peripheric businesses complaining that most Mumbuca circulates only in the central regions of Maricá.

> If I could give them [city-hall] my two cents, I would tell them to create ceilings [for receiving Mumbucas]. For example, a small business or micro entrepreneur, that's one situation. But Gomes [supermarket Gomes, a local big retailer] is a different situation. So (...) they [Supermarket Gomes] should be required to pay back, through some social work... something that gives the cash back. They get 750 thousand [Mumbucas], so 7-8% of that would be like 60 thousand BRL a month, they should be required to do something here. Because they benefit a lot with that [Mumubuca]. That's almost 1 million BRL. So, they have to do something social with it. Because, look, if you want to benefit from a social

> currency, that's one guy [business] that benefits from a lot, so this money should come back [to the community]. (Restaurant owner, Ponta Negra, 04/12/2025).

An interurban reconfiguration was identified in Maricá. A metropolitan movement of labor immigration was a theme identified by part of the interviewees, especially by some business owners and managers. Labor immigration was referred to as a solution to "Mumbuca beneficiaries not wanting to work anymore". Maricá itself is part of the Niterói metropolitan region, and local businesses would hire people from the nearby poorer municipalities, such as São Gonçalo. This poses a dilemma. In a way people might indeed not accept the traditional high working hours/low wages anymore due to more financial security than before due to the cash transfer and CC combo. On the other hand, local businesses could choose to hire people from a poorer region/close municipality instead of raising wages or improving working conditions. Specifically in the case of Maricá, this creates an interurban dilemma, as a higher immigration influx from nearby poorer cities of the metropolitan area start to come into the city, instead of improving labor conditions and absorbing labor in Maricá.

> The Mumbuca situation, as a subsidy tool, is very important. The problem with Mumbuca is that it is given to people who do not need it. So, in the end... there 144 thousand voters in Maricá and 99 thousand Mumbuca [receivers]. That is not a normal situation. The city is in a Mumbuca crutch. Just to give you an idea, I have to hire workers over from São Gonçalo because you can't find anyone here in Maricá. You advertise a job and there's no interest. Do we really not have anyone unemployed here? Of course we do, but they are leaning on the Bank Mumbuca [crutch]. (Hardware Store, Centro, 04/11/2025).

> Mumbuca is a barrier in the sense that the people that receive it don't want to work, or don't want to accept the salaries that we pay. I don't know if other local businesses have mentioned that to you, but for us, it is very hard to hire people. (general manager, chain Furniture Megastore, Itaipuaçu region, 04/09/2025).

There is a twofold immigration influx in Maricá: from the poor neighboring municipality of São Gonçalo, into the neighborhood of Inoã, and from the richer Niterói and Rio de Janeiro city, into the region of Itaipuaçu, consolidating it as a middle-class region in Maricá. There is, however, an interurban difference between those two immigrational influxes. From the IDR interview, the first influx, from the middle-class citizens to Itaipuaçu, replicates the historical pendular movement of Maricá, which was traditionally a dormitory city for Niterói and Rio de Janeiro city. Middle-class citizens choose to live in Maricá for several factors,

such as security, lower housing prices and better quality of life. But they keep their jobs at Niterói or Rio de Janeiro. On the other hand, the poorer influx from São Gonçalo into Inoã breaks from this cycle, as the migrants come to work preferably in Maricá. Overall, the Citizen Census Survey (Pesquisa Censo Cidadão), from IDR, confirms that a 67,72% of Maricá workers works in Maricá, while 27,91% of works relocate to another city, challenging the dormitory city cycle (Instituto Municipal de Informação e Pesquisa Darcy Riberiro (IDR), 2024).

> Also, another thing, the poor family relocate to Inoã and seeks work in Maricá. So that's another thing that we captured, that almost 70% of the inhabitants of Inoã, they work in Maricá. So, the historical pendular movement of Maricá, as a dormitory city, is changing. Maricá is still a dormitory city that sees pendular movement for the middle-class families that relocate to Itaipuaçu. Now for the poor family in Inoã, that receives social benefits, that is a different reality now. (Darcy Ribeiro Institute, interviewee 1, 04/02/2025).

A different aspect of the inequalities found in the field are related to barriers by the Mumbuca system, either from hardships in operating the Mumbuca application, or from constant problems in the application platform, to problems faced with the one point of sale required by Mumbuca. Payment in Mumbucas happens through the application in the registered cellphone of the owner of the business. Businesses complained that this one point of sale was bad for their inner organization related to customers' payment, sometimes causing delays. Also, there were complaints about some Mumbuca transactions not being processed, which needed to be verified by staff on site, increasing delay.

> They don't have a machine for accepting Mumbucas, [the transactions only honly through two cellphones. Everything happens through those two cellphones. They [Mumbuca Bank] could create a more organized system. We have four stores. They could create a machine for accepting Mumbucas, a machine for accepting the Mumbuca card, that would print a receipt for the business and one for the client. For every purchase, I must confirm if the payment was really processed. In the morning, they have a different girl for that. In total, we have three people for that. (Sales/customer manager, big retailer, Inoã, 04/10/2025).

4.1.3 Leakages from the System

Leakage from the system, meaning the money that is converted into BRL, was identified during the interviews with the local businesses as two different themes. The first

one is related to local businesses converting the money. Some of the motives for conversion were related to the need to pay employees, to buy supplies that couldn't be bought using Mumbucas or to separate the business incomes due to accounting. Also, big retailers and chain businesses convert all their money, which goes to an external accounting sector of the enterprise. The second them of leakage from the system is related to illegal conversions of Mumbucas, an informal market that has been established in which beneficiaries sell their benefits to businesses or loan sharks at a percentage of the money as a cost:

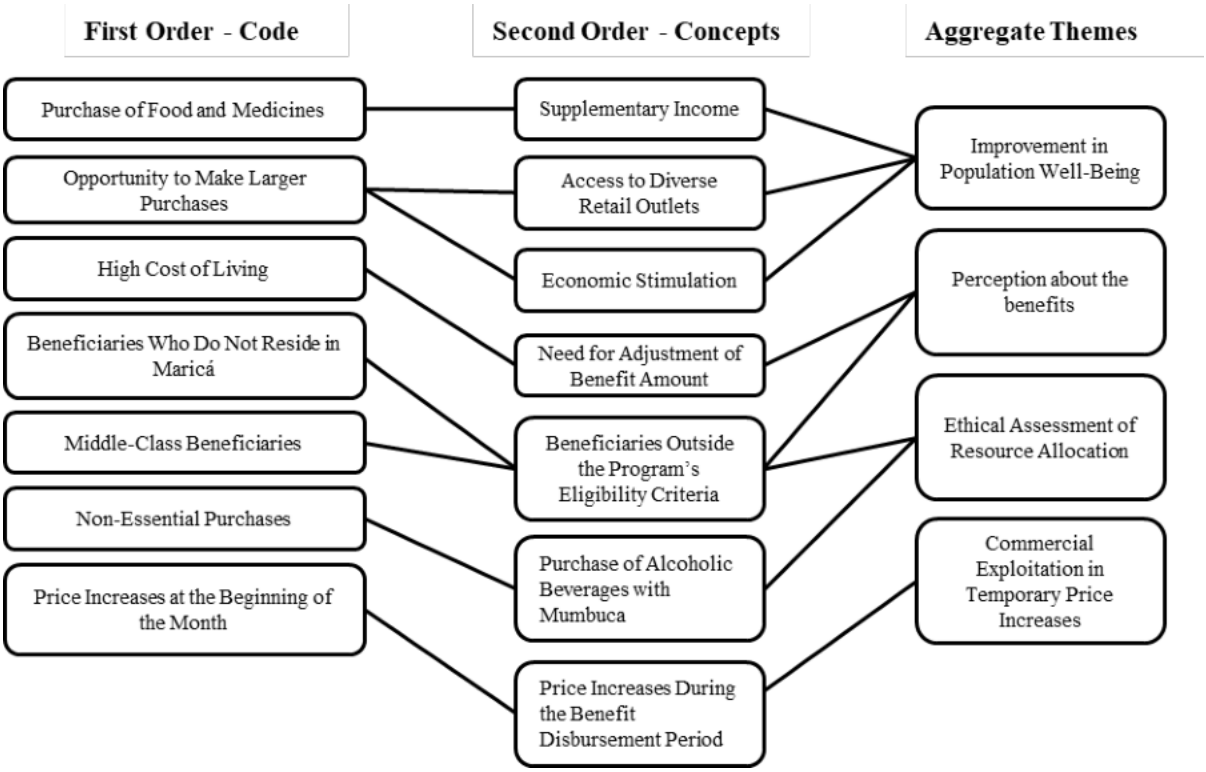
> (...) So, if someone comes in here and asks me "hey, do you exchange it [Mumbucas for BRL] for me?", I reply "no, I don't!", "but hey, come on, that other store do it and charge me 30%", "you could offer me 50%, but I still wouldn't do it because it will get me in trouble!". (...) That money that they [beneficiaries] sell, those 30% that the guy keeps it [the loan shark/ store who bought the Mumbuca credit at a 30% cost], is a money that could have come to my business! (Owner, bakery, Centro region, 04/07/2025).

4.2 Perspectives from the Beneficiaries

The interviews with beneficiaries highlight the positive contribution of the program to the residents of Maricá, as it ensures improved access to food, medicines, and, in some cases, even construction materials. Thus, the policy can be understood as a relevant instrument for strengthening food security among vulnerable populations, while also expanding access to healthcare and guaranteeing minimum conditions of housing dignity. On the other hand, the need for adjustments to the Basic Income was emphasized, given that inflation has eroded purchasing power. To preserve the current level of accessibility, respondents underscored the importance of periodic updates to the benefit.

Regarding the use of the currency, it was observed that most beneficiaries concentrate their spending in the first days after receiving the transfer, particularly in chain supermarkets. According to the sample collected, 61.3% of respondents mentioned these establishments as the primary destination of their resources. In this sense, it becomes evident that the circulation of the social and digital currency tends to be concentrated in large retail chains, which subsequently convert it into reais several times a day, as reported by an employee of one of the supermarkets. Figure 3 shows the aggregated themes of the beneficiary's interviews, derived from the Gioia analysis (Gioia et al., 2013).

Figure 3: Aggregate themes from the beneficiaries of Mumbuca perspective



4.2.1 Improvements in the population's well-being

The majority of interviewees indicated that their incomes in Mumbuca are primarily allocated to the purchase of food and pharmaceuticals, followed by construction materials. The aid was frequently described as an important supplementary tool for income. As reported by a resident of São José do Imbassaí neighborhood: *"(...) It helped a lot in daily life, to complement purchases at the pharmacy or the market"*. A beneficiary from Itaipuaçu neighborhood also emphasized the complementary function of the resource: *"(...) Mumbuca helps a lot as a supplement."*. This highlights that, even for families with limited fixed income, the benefit contributes to meeting basic needs and medical expenses.

Interviewees also noted that, after receiving the aid, they were able to make larger purchases and shop in businesses that they couldn't afford before, which demonstrates the increased accessibility provided by the program. A resident from Itaipuaçu commented: *"(...) I started visiting stores I did not go to before, for example, small shops and local grocery stores in my neighborhood, because they are more expensive."*. This reinforces that the benefit not only meets immediate needs, but it also increases access to different businesses and markets, giving the beneficiaries more autonomy over their consumption.

4.2.2 Perception about the benefits

Some respondents highlighted the lack of updated registration information, as well as the deflation of the benefit amount relative to price increases caused by inflation. As one app driver reported: *"(...)The impact could be better; you cannot buy the basics with the basic income. There has been no adjustment to the aid amount. What you can buy with 230 is miserable. I am not saying it doesn't help, it is not bad, but the amount could be better."*. This indicates that, while the benefit provides important support, its effectiveness could be enhanced through periodic adjustments to maintain purchasing power.

The usefulness of the benefit was also emphasized by a resident of Itaipuaçu, who added: *"(...) It's great because it helps a lot; it is a supplementary income. It's easy and fast. But it can always be improved, if it were to increase a little (...)"*. So, even with value limitations, the resource contributes to family's well-being, functioning as a supplementary income. Additionally, some respondents related changes in the monthly spending limit as a relevant aspect. One participant noted that there is currently a cap of R$ 3,000 per month for purchases, whereas previously there was no such limit. This adjustment directly affects financial planning and the ability to make larger purchases, as she was previously able to accumulate R$ 6,000 for more significant acquisitions.

The situations highlighted in these statements indicate that adjustments to the benefit amount and the flexibilization of spending limits could enhance the program's effectiveness, dignifying its beneficiaries in a fair manner and increasing its impact on the economic well-being of families and their capacity for financial planning.

4.2.3 Ethical Assessment of Resource Allocation

The interviews indicated that residents have a negative perception of what they consider unethical uses of the benefit. This moral dimension was present in several statements, highlighting that beyond the economic impact, there is also a normative perspective on how resources are employed. This ethical-moral dimension emerges as a central axis in social evaluation, in which respondents question what would be considered a "proper" or "misused" use of the benefit.

A recurrent point concerns the use of the benefit for the acquisition of non-essential goods, such as alcoholic beverages. Some residents associate this behavior as an immoral practice, reinforcing the idea that the benefit should be restricted to legitimate expenditures, particularly those related to food and basic needs. As a resident of Araçatiba illustrated: *"(...) There are people who spend it on alcohol. It should be revoked because some take what should be given as food for children to buy alcohol."*.

Another recurring aspect in the interviews refers to the eligibility of certain beneficiaries. Several reports indicated the presence of individuals who no longer reside in Maricá or do not meet the low-income criteria yet continue to receive the benefit. These observations reflect a perception of distributive injustice, in which the inclusion of individuals considered "undeserving" is seen as a distortion of the program and a factor that compromises its equity. As one participant reported: *"[...] There are people who receive (Mumbuca) and no longer live here. Some pay property taxes, which are not cheap. People who no longer live here, but lived for a while, pay nothing. No taxes. They pay only a fee and convert [the Mumbuca they receive] into cash."*

4.2.4 Businesses Exploitation through temporary price increases

The interviews revealed a recurring perception among residents regarding the impact of the benefit on price behavior in local businesses. Several respondents noted that some businesses, especially big retailers, raise the prices of their goods during the days the funds are deposited into the beneficiaries' accounts. From this perspective, there is a concern with the economic dynamics induced by the program, which go beyond the transfer of income and involve indirect effects on the local market. As a resident of São José do Imbassaí reported: *"(...) the markets increase prices in the week people receive their benefits. I prefer to buy more towards the end of the month (...)"*.

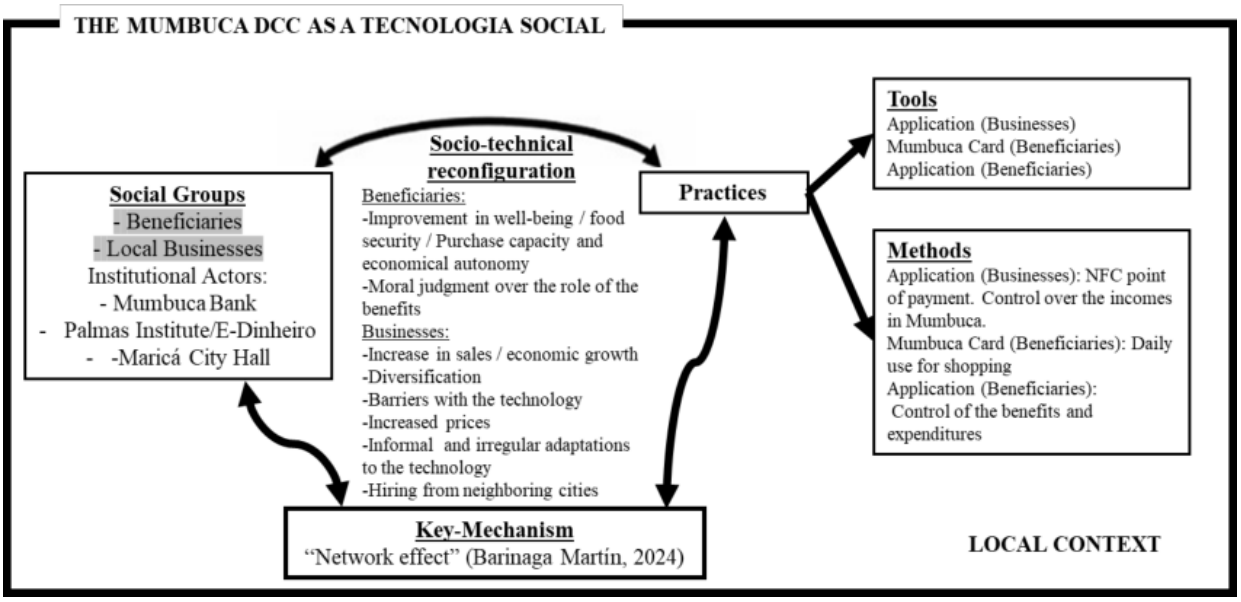
Another aspect highlighted in the responses relates to the beneficiaries' interpretation of this practice. Some residents associate the price increases with immediate consumption behavior, suggesting that the rapid use of the aid by recipients triggers elevations in the prices charged by local businesses. As exemplified by a resident of Itaipuaçu, this sequence of events establishes a cause-and-effect relationship between the receipt of the benefit and the rise in prices.

However, the analysis of the interviews indicates that many beneficiaries do not have the option to spread the resource over the course of the month. For a large proportion of families, the aid is primarily allocated to the purchase of food and essential goods, making it necessary to "stock the pantry" immediately after receipt. This need limits the capacity for financial planning and reinforces the perception that prices rise precisely when demand increases, regardless of individual intentions for immediate consumption.

4.3 Socio-technical reconfiguration

The Socio-technical reconfiguration of the relations in the social groups of Maricá that directly interact with the Mumbuca currency, being the beneficiaries of Mumbuca and the local businesses, was drawn from the coding analysis of their perspective, together with the tools and methods used in their routine. The key-mechanism for the functioning of Mumbuca was taken from Barinaga Martín (2024), who identified the "Network effect" of businesses joining and accepting Mumbuca, as the mechanism for functioning and recirculation of this currency. The classification of these relationships, analyzed through the Tecnologia Social framework, is shown in figure 4.

Figure 4: The Mumbuca DCC analyzed as a Tecnologia Social.



The circulation of the Mumbuca DCC happens through an application and through the Mumbuca card, issued by the Mumbuca Bank. Those are the tools used by the beneficiaries and the businesses in their interaction. For the beneficiaries, the application provides a channel of control of the benefits and its spending, while the card is for payments. For businesses, the application is their means of payment, as Mumbuca transactions happen through an NFC at the owner's smartphone. It is also used to control and validate the transactions. Some of the social reconfiguration of this community is based on the limitations and barriers imposed by this technology. Businesses complained about the one point of NFC payment, as it encumbers sales. Also, there were complaints regarding how the application sometimes doesn't process the sales or how purchases might be delayed or postponed due to malfunctions in the digital platform.

Beneficiaries experienced a change in their lifestyle through the benefits received in Mumbucas. The additional money is used as a complementary income or for purchasing basic goods. But it also gave them more purchasing power and financial autonomy, being able to access different businesses that they couldn't before, including small local stores that are more expensive than big retailers. In this context, Mumbuca has been incorporated as just another payment method rather than a different currency, and that is due to the network effect identified by (Barinaga Martín, 2024). This affects the

local businesses as well, as smaller businesses choose to recirculate Mumbucas instead of paying the 2% conversion tax, since there is a growing number of other businesses that also accept it. Also, big retailers were found to increase their prices during the weeks of benefit disbursement, steering some business owners and beneficiaries into purchasing from smaller or alternative businesses.

Complementary to the network effect, there seems to be a market diversification and linkage in Maricá. This effect was seen by local markets that chose to buy from other smaller markets instead of big retailers. Also, some of them resupplied or hired specific services from local businesses, such as computer products from local suppliers or buying banners from a local printing/xerox store. This finding adds another layer to the network effect, in that not only are businesses entering the Mumbuca network and benefiting from an increase in sales, but also there is market diversification and specialization effect in Maricá due to the economic growth in the city, a phenomenon identified by (Ussher et al., 2021) in the circulation of the Sarafu community currency in Kenya.

Leakages from the system have been identified as businesses that convert the money either due to an inner accounting infrastructure, to pay out employees, or because they couldn't resupply using Mumbucas. Big retailers are more likely to convert all Mumbucas into BRL, while smaller ones might choose to spend their Mumbucas locally. But a secondary phenomenon of leakage has been identified through beneficiaries selling their benefits for BRL in for a percentage of the total amount.

The circulation of Mumbuca caused a moral perception on the expenditures of the benefits by the local population. Beneficiaries and businesses alike commented on how the money was supposed to be used for basic needs goods only, having demonstrated a negative perception on people who uses it for "superfluous shopping" or to buy alcohol. Regarding how local markets perception of Mumbuca, some thought that beneficiaries were too dependent on the benefits and choosing not to work. They preferred to hire people from a poorer neighboring municipality. But that might be related to improvements in the socioeconomic standards of Maricá, meaning that citizens might choose not to work long hours for low paying jobs. This is related to a new wave of migration influx into the city, from the neighboring municipalities. This inter-urban dynamic reveals a

different metropolitan phenomenon caused by the social improvements brought by the circulation of a community currency.

The following characteristics and challenges of the Mumbuca circulation in Maricá were compiled from the field immersion:

- Migration Influxes and urban/metropolitan region reconfiguration: Intermunicipal migrations might also pose a challenge in local development, especially as a big influx of migrants comes from poor municipalities seeking better quality of life, economic opportunities and benefiting from the basic income and other cash transfer policies. This local model is important for securing the implementation and trust within the community, and for improving trust and the circulation of the currency. However, a reginal strategy should also be coordinated amongst the different municipalities, especially in the case of cities that exist in the same metropolitan area, such as Maricá, as imbalances are bound to be created when one municipality improves its socioeconomic indicators.

- Local businesses growth and diversification: The Mumbuca model kept money inside Maricá and recirculated it improving local markets and businesses alike (Diniz, Porto de Albuquerque, et al., 2024). But more than just improving the local economy, what was seen in the field suggested that there is market diversification. Some of the businesses interviewed were choosing to buy from local suppliers instead of the big retailers. Also, another indication of a demand created by the local markets was seen in business-to-business transactions, e.g., with businesses using Mumbucas to buy banners from local printing stores.

- Currency leakages from the system: The Mumbuca model allows for indiscriminate exchange of Mumbucas by businesses, with the payment of a small fee. Though the small fee acts as a deterrent to some small and medium sized businesses, who prefer to re-spend the Mumbucas earned, big businesses will usually prefer to exchange the money. This is a dilemma of monetary fungibility over control of monetary conversion (Blanc, 2011, 2024). Some possible solutions being studied by the Mumbuca Community Bank require a different transaction rate when using Mumbucas in big retailers, or a cashback policy when buying from smaller or local businesses.



• Big retailers concentrate most part of the currency in circulation: As their income increased due to the Mumbucas circulation, big retailers developed tactics in Maricá to increase their earnings by exploiting the system. As citizens prefer to buy from them (Diniz, Porto de Albuquerque, et al., 2024) and they must spend their money in Maricá, big retailers in the city increase their product's price during the first 15 days after people receive their benefits. Some of the possible solutions being designed by the Mumbuca Bank involve the different taxation fees and cashback policies for smaller businesses.

5. Conclusions

This research analyzed the Mumbuca digital community currency through a Tecnologia Social Framework. For that, a case study was conducted, and the results were coded to understand the changes in the socio-technical configuration of the social groups directly involved with the circulation of the currency, the beneficiaries and the local businesses. This research answered our initial questions, "How the local population of Maricá perceives the effects of Mumbuca in their daily lives?" And "What are the socio-technical changes brought by the Mumbuca DCC on the population of Maricá?", by identifying the changes leveraged by the Mumbuca circulation, as perceived by the beneficiaries the local businesses.

Some of the findings point to improvements in beneficiary's economic independence, while businesses benefited from economic growth. The businesses in Maricá seem to accept Mumbuca and it circulates as another form of payment rather than a different currency. This creates a network effect that incentivizes businesses in recirculating their Mumbuca rather than converting it out of the system. Also, a diversification phenomenon of the local market was identified with some businesses choosing to spend their Mumbucas in resupplying or by hiring services from other specialized small businesses. This effect might indicate a socio-economic diversification in Maricá.

Other changes in the local socio-economic and socio-technical relationships are related to the technology itself, identified by some businesses as a barrier for sales. Also, a moral dilemma was identified in Maricá where the local population disagrees with how beneficiaries may choose to spend their benefits, considering "non-essential"

purchases as superfluous and as a misuse of the money. Also, the socioeconomic improvements of the local population impacted jobs in the city, as some businesses are choosing to hire people from neighboring poorer communities, blaming that beneficiaries are not willing to work or to accept lower wages anymore.

Some of the limitations of this research are related to the choice in analyzing the circulation of Mumbucas by the social groups that are socioeconomically affected by it and that use it in their daily routines, the beneficiaries and the local businesses. Further research could explore the effects of the Mumbuca currency on the institutional actors of Mumbuca and in their governance and in turn, how the DCC is affected by it. This further analysis could involve understanding the relationship between the governmental actors, the Mumbuca Community Bank and the Palmas Institute, responsible for the creation of the current digital format of Mumbuca.

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DIGITALIZATION AND GOVERNANCE IN EUROPEAN COMPLEMENTARY CURRENCIES: SCALING CAPACITY, INSTITUTIONAL AUTONOMY, AND THE POLITICS OF DIGITAL INFRASTRUCTURE

Nicolas Franka[1]

Julia Barashkov[2]

1 Abstract

Since the beginning of the third millennium, complementary currencies (CCs) in Europe have increasingly integrated digital tools, progressively transforming how these initi atives operate, govern themselves, and interact with their institutional environments. While digitalization has become a defining feature of contemporary payment systems (Brunnermeier et al., 2019), its implications for community-based monetary systems remain poorly understood, particularly from the perspective of the practitioners who design, manage, and coordinate them (Diniz et al., 2025). This study examines how di gitalization reshapes the governance, operational practices, and institutional autonomy of complementary currencies in Europe. Drawing on 11 semi-structured interviews with CC practitioners across seven European countries including currency coordinat ors, platform integrators, and long-standing governance actors, this paper offers an analytical mapping of the digitalization trajectories and governance arrangements that have emerged across the European CC landscape since 2000. Our findings show that di gitalization has contributed to significant organisational transformations, including the professionalisation of currency coordination, new operational workflows, and reshaped institutional relationships. The real

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challenge of digitalization is less about the capa city to perform basic technical functions than about the ability of citizen initiatives and municipalities to maintain platforms that remain adaptable to their evolving needs and governance aspirations. The field marks a preference for open source technologies and autonomous capacities. But the proprietary open source nexus is not a sufficient "concern" for solution selection. Key challenges are financial sustainability, required skill sets, and process management with the role of external platform providers emer ging as a central governance concern. Legal compliance, by contrast, plays a more limited role than anticipated. While digitalization expands scaling capacity, it may curb institutional autonomy, notably where reliance on external platforms, proprietary infrastructures, intermediaries, or specialised technical expertise introduces new forms of technical and financial dependency. The paper's core argument is that the cent ral governance challenge of CC digitalization is not technology choice per se, but the capacity of community-based organisations to retain practical control over their mon etary infrastructure as they scale. We extend the four-dimension taxonomy of Diniz et al. (2018) with three additional dimensions: (1) institutional autonomy, (2) profession alisation, and (3) trajectories, and propose a typology of infrastructure arrangements to produce a grassroots sovereignty scale based on infrastructures and dependencies, assessment, and conclusions on the major impact of digitalization for complementary currencies.

Keywords: complementary currencies, digitalization, governance, open-source, insti tutional autonomy, Europe, socio-technical infrastructure

2 Introduction

Complementary, social, and alternative currencies are defined as payment media that operate outside conventional legal tender. Most neither expect nor intend to replace state-issued money; rather, they supplement it through citizen-driven initiatives (Blanc & Fare, 2016; Seyfang & Longhurst, 2013). This paper uses the term complementary currency (CC) as the broadest category. This digitalization paved the way for new act ors to enter into the complementary currency fields. Technical consultants, platform providers, and other payment service intermediaries, either incumbent or newly created, have entered the complementary currency space. This challenged community-based and small organizations having to deal with larger incumbent actors. This further cre ated dependencies on infrastructures whose ownership, maintenance, and rule-setting lie partly or entirely outside

the community. On the other hand, digitalization seems to have entered as a key determinant of growth for complementary currency. It also produced a divergence in the field between CC systems that have scaled successfully through digital adoption and those that have either retreated from digitalization, col lapsed under its operational weight, or found themselves institutionally captured by the providers on whom they depend. Complementary currencies have evolved, adapting to technological advancements and societal needs (Silva De Faria et al., 2022). Digitaliza tion and technology have significantly influenced global market trends, fundamentally altering how individuals engage with currencies and financial transactions (Ansorena et al., 2021). We investigate how digitalization reshaped the governance, operations, and autonomy of complementary currencies, and how it redefined roles, responsibil ities, and decision-making processes. It contributes to filling a gap identified in the existing literature, namely the absence of an empirically grounded analytical mapping of CC digitalization across Europe (Silva De Faria et al., 2022). The scope is limited to fiat-backed local currencies (in the sense of Lietaer and Kennedy's "regional curren cies") and mutual credit systems, excluding time banks and crypto-based tokens. This boundary ensures consistency across the sample in terms of legal compliance require ments and operational management concerns. The paper proceeds as follows. Section 2 reviews the relevant literature, building the case for a governance-centred analysis. Section 3 presents the research design and methodology. Section 4 presents findings and discussion. Section 5 concludes with implications for CC design, policy, and future research.

3 Literature Review

The central argument of this paper is that digitalization in complementary currencies is fundamentally a governance problem, not a technical one. Platform architecture, in frastructure ownership, and the degree of reliance on external providers all shape who controls a CC system and therefore what values it can serve and with what autonomy. The review proceeds in four steps: it situates CC digitalization within the broader politics of money digitalization (2.1); surveys the existing literature on CC digitaliz ation and its governance implications (2.2–2.3); examines digital infrastructure as a governance variable (2.4); and identifies the gaps this paper addresses (2.5).

3.1 The Politics of Money Digitalization

Digitalization carries implications beyond the technological: it redistributes power over monetary issuance and control. Technology modifies who gets to create, manage, and mediate money. Historically, the process of digitalization was parallel to the privat ization of payment media within Western monetary systems. Seigniorage gradually shifted from public authorities to private banking institutions. The digitalization of conventional money extends a longer trajectory of monetary dematerialisation, from coin to banknote to checkbook account money, each step shifting monetary control further toward private banking institutions (Dissaux, 2020; McLeay & Radia, 2014; Ryan-Collins et al., 2011). *« Linked to this is the general acceptance that electronic rather than paper money is a harmless convenience. In fact, the shift from the one third of money issue by banks that was the situation in the UK in 1963 to the mere 3% today (Porritt, 2006: 190-1) has meant a parallel shift in power, from the state to the private banks. Since whoever issues the currency also controls it, the creation of money only in electronic form has removed an important power and financial resource from the UK government (Mellor, 2010). »* (in Cato & Suárez, 2012, p. 112.) The digitalization of currencies introduces a structural shift, producing more intense com petition among various forms of currency and digital currency areas that transcend national borders (Brunnermeier et al., 2019). Yet scholarly attention on digital money has so far focused mainly on CBDCs (Bindseil et al., 2024) and crypto-assets, while the implications for community-based monetary systems have remained comparatively neglected. The sovereignty dimension of monetary digitalization is well established for national and supranational systems. Whether analogous dynamics affect community based monetary innovations remains unexplored. Digital sovereignty has become an explicit EU legislative priority, reflected in the Digital Services Act, Digital Markets Act, AI Act, and related instruments (*Promoting and Protecting Digital Sovereignty in the EU | 06-10-2025 | News | European Parliament*, n.d.). This broader policy concern with infrastructure control and dependency reduction provides a macro-level frame for understanding analogous dynamics at the community scale. As platform studies scholarship has established, infrastructures are not neutral; they embed and reproduce power relations (Eduardo H. Diniz et al., 2018; Loudon, 2016), making it a paramount concern of our time in an increasingly digital world. Platform intermediation, when prioritising rapid up-scaling and extracting revenues from circulations and associated data trails, performs the structure of venture

capital investment which capitalises on the potential of platforms to realise monopoly rents (Langley & Leyshon, 2017).

3.2 Complementary Currencies in Europe

Over 5,000 complementary currencies have been established worldwide up to 2012 (Sey fang & Longhurst, 2013), with particular growth in regions facing economic challenges. Two more waves contributed to local monetary innovations: the "Transition town" movement and the Covid crisis. Meanwhile, digitalization has enabled the integration of larger commercial actors into CC networks, a development that risks marginalising smaller producers and diluting the local consumption focus that defines most initiat ives (Faria et al., 2020). Yet the technological landscape of European CCs remains unsystematically documented while the field might be standing at a crossroad with many CC at breaking-point.

3.3 Digitalization of Community Currencies

The digital study of complementary currencies focuses on how digitalization has or may change the very nature of CCs. This follows Nishibe's vector framework, which allows researchers to "account for the multidimensional nature of value in economic, social, and environmental contexts" (Nishibe, 2020, p. 1). Early developmental as sessments, such as the initial People Powered Money CCIA (*People Powered Money*, n.d., p. 107) analyses, cataloged emergent structural options, ranging from physical coupon books to magnetic strip cards, yet lacked the longitudinal data to evaluate how digital infrastructure reallocates governance power. Digitalization of community currencies extends beyond technical modernisation. As representatives of Brazilian Community Development Banks (CDBs) note, while digitisation maintains "the same idea, in different ways" it simultaneously introduces profound shifts in governance structures, making governance "the most complex issue" in the transition toward di gitalised community currencies (Silva De Faria et al., 2022, p. 1). Digitalization introduces a structural tension into CC governance (Blanc, 2013; Diniz et al., 2019): platforms enhance operational scale and transactional efficiency, but simultaneously bind currencies to technology providers and institutional actors whose interests may diverge from community autonomy. This dependency is not incidental; it is embedded in the architecture of digital infrastructure itself, where proprietary platforms, closed codebases, and externally managed data flows all represent points at which control can migrate away from the issuing community (de Faria et al., 2022). The Mumbuca case in Brazil illustrates this dynamic concretely. Digital infrastructure expanded the currency's

socioeconomic footprint, increasing transaction volumes, broadening user access, and strengthening its role in local welfare distribution, while simultaneously tightening its dependency on local government structures and private technology pro viders, shifting the effective locus of control away from the community the currency was designed to serve (de Faria et al., 2022). The technological component of digital currency has already been pointed out as a sensitive factor that could modify the distribution of power towards technological suppliers who may influence the coordin ation, reconfiguration, and even management of the technological solution and thus build path dependency. The study of Mumbuca e-Dinheiro in Brazil underscores the importance of sociotechnical perspectives when analysing digital currency platforms (Faria et al., 2020). This power asymmetry matches empirical findings across Latin American experiments like MonedaPar, where initial horizontal network expectations quickly ran into the practical realities of technical centralization (Raffaelli & Nowak, 2025; Valdecantos et al., 2025). One must be cautious against conflating “digital” with “virtual” currencies. Virtual currencies, whether digital or not, predate contemporary digital technologies by centuries. Nevertheless, the digital tools available today have fundamentally reshaped the landscape of monetary creation and management. In the case of complementary and parallel currencies, digitalization not only influences their functioning but also enhances their visibility and reach, altering how such systems are designed, operated, and perceived (Sotiropoulou, 2023). Overall, digitalisation of fers new avenues for modern monetary design based on new payment media that allow entirely new functionalities and new operational logics of money. As Nishibe notes, “di gitalization as the extension of informatization and servitization has provided us with a more prominent possibility of media design of money that makes possible the creation of an entirely new functioning of money that has never existed, like cryptocurrencies and DCCs” (Makoto Nishibe, 2020, p. 322).

3.4 Impact of Technology and Digitalization on Complement ary Currencies

The materiality of a digital community currency is intrinsically linked to the social arrangements surrounding it, challenging interpretations that focus solely on the mon etary aspect (Schroeder, 2020; Silva De Faria et al., 2022). Nascimento (2025) finds that while digital formats can lower operational costs and provide better management tools, they may not necessarily contribute to improving transparency or to increas ing community cohesion (Nascimento et al., 2025). Face-to-face transactions reinforce trust; rapid anonymous

digital transactions risk weakening social bonds and community connections (Ferreira et al., 2015). Diniz et al. (2018) find that "the most relevant is sues are the risk to community feelings related to the virtuality dimension and the introduction of new actors that come along with digital technologies and that can com promise the shared governance spirit of most community organisations" (Eduardo H. Diniz et al., 2018, p. 19).

3.4.1 Digital Infrastructure as a Governance Question

From the literature, we derive at least three dimensions on which the digitalization of complementary currency goes beyond the simple new layer of feature, but reconfigures its governance structures. First, new actors come into the picture as part of the di gitalization process of complementary currency. While a paper-based system could be managed by a small team, a digital system might still be able to do so, but most often requires the needs of some technologically savvy people and introduces, at the very minimum, new service providers for this technology. Each new actor brings their own interests, constraints, and leverage points into the governance arrangement (Eduardo H. Diniz et al., 2018, p. 19). The second aspect is that, due to this integration of new actors, new decisions have to be made as some dependencies emerge from the setting up of digital infrastructures, which are more or less easy to leave or change. This is where the open source, proprietary, federated, centralized, locally hosted, or cloud-based solution will induce future choices and therefore create path dependencies about the evolution of the locally integrated payment system. In theory, a CC that builds on open-source, federated infrastructure retains the ability to fork, modify, and migrate. The third element that reconfigures the governance of complementary cur rency relating to digitalization is the relation to regulatory bodies. It requires a deep understanding of European financial regulation, such as PSD2, EMD2, the prospect of PSR and in some cases MiCAR. This all relates to a larger body of regulation of na tionally embedded rules at the fringe of what has been integrated and discussed so far at the European level. The point here is that it introduces either potential instability, reliance on legal advisors and expertise, which must be mixed with the technological infrastructures. There is varying national interpretation, for instance, of the limited network conditions, with the threat of additional required compliance, such as AML, which might generate a disproportionate burden related to the actual scale, resources, and capacities of most CC initiatives. Toti's (2024) taxonomy "underscores the trans formative potential of digital social currencies, emphasising that governance is essential to ensure their alignment with broader

socio-economic objectives. By framing techno logy as a critical factor for sustainability, it calls for participatory structures capable of navigating the unique challenges posed by digitalisation" (Toti, 2024, p. 88). A single currency assessment of MonedaPAR in Argentina finds that blockchain technology had indeed addressed some key limitations of Clubes de Trueque (barter clubs) but it also had introduced new dependencies on technical experts. The researchers show that "conflicting motivations and unequal power over technological tools disrupted governance processes and undermined the long-term sustainability of the initiative" (Raffaelli & Nowak, 2025). A similar study on the same Argentinian system shows that "despite strengthening hierarchical and methodical trust, Blockchain needs to be articulated with additional market-building strategies to be a true game-changer in the develop ment of social currency systems" (Valdecantos et al., 2025, p. 1195). Ruddick argues that while technology can in theory be liberating, prevailing digital practices tend to reinforce dependency on a small number of corporate "gatekeepers" and replicate pat terns of control and resource extraction from centralised power systems. Corroborating that "digitalisation, particularly when relying on complex technology like blockchain, can position software developers as gatekeepers, as only they can maintain and develop the code" (Raffaelli & Nowak, 2025, p. 18). He calls for exploring alternative protocols that can function without digital infrastructures, and for building tools that enable conflict mediation, impact measurement, and scaling, without eroding the community trust on which CCs depend (Ruddick, n.d.). Blockchain-based systems, while offering potential, are still widely perceived as volatile and speculative mechanisms, largely due to the prevalence of global trading in unbacked tokens (Carlos Andrés Oñate Paredes & José Carlos Aucancela López, n.d.). Dissaux (2020) further distinguishes between endogenous systems and national or international systems on one hand, and blockchain based systems on the other (Dissaux, 2020). An illustrative example from Brazil shows how the digitalization of a community currency can depend on strategic partnerships with both private and public actors. The electronic version of Banco Palmas' social currency was made possible through support from the mobile phone company Vivo, payment networks Mastercard and Redecard, and the state-owned bank Caixa (Carlos Andrés Oñate Paredes & José Carlos Aucancela López, n.d., p. 19). The digitaliz ation of social currencies in Brazil also created payment infrastructures that allowed basic income and emergency aid from Community and City government partnership (Luiz Arthur Silva de Faria et al., n.d., p. 257). Those perspectives mark the double edged nature of digitalization, as it may lead to extended reach, improved efficiency,

and open the way for further services provided to the community. It also introduces new actors, new dependencies, and potential legal tensions, all boiling down to a gov ernance trade-off that has proven hard to navigate for the complementary currency field. This paper draws on Feenberg's critical theory of technology to frame the governance analysis that follows (Andrew Feenberg, n.d.). Instrumentalization theory holds that technology must be analysed at two levels: the level of our original func tional relation to reality, and the level of design and implementation. Applied to CC digitalisation, this means looking beyond the payment solution itself to how the full arrangement — hosting, provider relationship, integration stack — comes together and embeds social values and power relations. Following the constructivist turn Feenberg identifies, efficiency is not decisive in explaining the success or failure of alternative digital infrastructure designs: several viable configurations compete at the inception of any line of development, and what explains divergent outcomes is governance, not technical optimality (Andrew Feenberg, n.d.). The concept of operational autonomy, which Feenberg derives from Marx, is equally central to this analysis: "the entire de velopment of modern societies is thus marked by the paradigm of unqualified control over the labor process… I call this control 'operational autonomy,' the freedom of the owner or his representative to make independent decisions about how to carry on the business of the organization, regardless of the views or interests of subordinate actors and the surrounding community" (Andrew Feenberg, n.d., p. 5). This paper tests whether and how complementary currencies retain operational autonomy over their digital infrastructure, and how some arrangement types may threaten that autonomy in ways that are not visible at the moment of adoption.

3.4.2 Legal Implications of Digitalization

The digitalization of complementary currencies has significant implications for its legal underpinnings, especially regarding EU legal frameworks encompassing the use of di gital payment services and electronic money. Key questions include: when does a digital payment system fall under legal constraints; what those constraints are; and how they impair or facilitate the work of CCs. Lopez (2018) identifies several enabling and constraining factors for CC development. While provisions governing the social economy sector can provide stability, legal restrictions may also limit the scope of mon etary experimentation, as in Ecuador, where the Monetary and Financial Organic Code explicitly prohibits currencies

other than the U.S. dollar, despite otherwise supportive solidarity economy legislation (Carlos Andrés Oñate Paredes & José Carlos Aucancela López, n.d.).

3.4.3 Digitalization and Commons-Centred Governance

Building on Ostrom's (1990) framework for governing commons (Ostrom, 2015) and the concept of commons-based peer production, the internal organisation of CC systems can be analysed as a form of knowledge commons. From this perspective, digital CCs can be examined for the institutional characteristics associated with successful commons governance: clearly defined membership boundaries, proportionality between contributions and benefits, inclusive decision-making, effective monitoring, graduated sanctions, accessible dispute resolution, and recognition of the community's right to self-organise (Benkler, 2008). Silva de Faria et al. (2022) examine the implications of various approaches to digitalising CCs in Brazil, framing their analysis around a tension articulated by representatives of Brazilian Community Development Banks: digitalization can be seen as "the same idea implemented in different ways," yet raises governance challenges that are now "the most complex issue" (Silva De Faria et al., 2022).

3.5 Knowledge Gaps

Research on digital complementary currencies (DCCs) remains scarce. While compar ative studies in both developing and developed contexts have offered valuable insights, they have paid little attention to the specific governance issues raised by digital im plementation. Conversely, the literature on digital payments has generally ignored community currencies, focusing instead on mainstream electronic money and fintech solutions. This paper addresses this double blind spot by drawing directly on practi tioner accounts to generate the first empirically grounded, internally validated accounts of how digital payment system choices in infrastructures have shaped CC governance in Europe. In doing so, we answer a methodological limitation identified by Eduardo Diniz (Eduardo H. Diniz et al., 2018), whose comparable analysis solely relies on sec ondary data. We therefore extend their four-dimensional taxonomy to the European institutional context. Four interrelated gaps are addressed:

1. **The analytical mapping gap:** no coherent typology of digital infrastructure across European complementary currencies currently exists.

2. **The governance gap:** the internal consequences of digitalization for decision 11

making, autonomy, and power distribution remain poorly assessed in the European context.

3. **The sovereignty gap:** the types of technological infrastructure in use, their evol ution, and their implications for community ownership are under-documented. 4. **The practitioner gap:** existing studies have relied on secondary data; this paper draws directly on the lived experience of CC designers, coordinators, and platform providers as to how digitalization affects CC and their operations.

4 Research Design and Methodology

4.1 Research Question

How has the adoption of digital tools since 2000 reshaped the governance arrange ments, operational practices, and institutional autonomy of complementary currencies in Europe, and what infrastructure choices and organisational conditions explain diver gent outcomes across systems?

4.2 Research Design

This study employs a qualitative approach combining a systematic literature review with semi-structured interviews with CC practitioners. The interview data provides the primary empirical material; the literature review grounds the analytical framework and situates findings within existing scholarship. Qualitative inquiry is appropriate here be cause the governance implications of digitalisation operate through norms, motivations, and power asymmetries that are not legible in quantitative data alone. Practitioner accounts including from currency coordinators, solution developers, and operational vo lunteers or paid professionals provide insight that documentary sources alone could not yield, given the fast-moving pace of the field, the recency of the governance questions it raises, and the intangible and relational nature of the dynamics under study. In economic sociology, methodological pluralism is increasingly the norm, acknowledging that markets, currencies, and infrastructures are embedded in both calculable struc tures and symbolic orders (Granovetter, 1985; Zelizer, 1989).

4.2.1 Epistemological Position

This research adopts a pluralistic epistemology that values qualitative knowledge and recognises local, situated expertise as essential to understanding digital governance in

community settings (Avgerou, 2008; Sajda Qureshi, n.d.). Rather than imposing ab stract typologies, it adopts a reflexive analytical mapping strategy, adapting classifica tions through empirical discovery and stakeholder dialogue. The research is informed by critical information systems research and the insight that technical design embeds social values and constraints, that digital governance is shaped by, and in turn shapes, social hierarchies.

4.3 Data Collection

4.3.1 Interviews

Eleven semi-structured interviews were conducted with complementary currency prac titioners across seven European countries between November 2025 and May 2026. In terviewees include currency coordinators, platform integrators, and long-standing gov ernance actors involved in the design, management, and development of CC systems. Interviews were conducted in English and French; interview guides are available in both languages upon request. Duration ranged from one to two hours. Interviews were recorded and transcribed; one recording failed and was reconstructed from notes. The sample covers three stakeholder categories: currency coordinators responsible for day to-day governance and operations; platform developers and maintainers responsible for technical infrastructure; and governance actors involved in strategic and institutional decisions. This multi-profile sample allows triangulation across perspectives on the same digitalisation dynamics. Sampling was purposive, drawing on the European CC practitioner network and the RAMICS community. The sample is geographically con centrated in Western Europe, reflecting both the distribution of active fiat-backed CC systems and the network reach of the research team.



Code	Description	Technical literacy	Public authority engagement
A1C	ICT expert and payment solution developer; currency contributor and volunteer	High	Yes
A2P	Panel of ten CC managers, practitioners and developers active in digital tool development and deployment (group interview)	Mixed	Partial
A3C	Treasurer of a long-established CC; oversees all operations	Low–Medium	No
A4C	Project manager of a newly forming CC supported by local authorities	Low–Medium	Yes
A5C	Manager of a major CC; experienced from onset through full digitalization	Medium	Yes
A6C	Founder of a CC working with digital tools; also acts as provider to other systems	High	Yes

Code	Description	Technical literacy	Public authority engagement
A7C	Currency coordinator and founder; deals with public authorities and regulators	Medium	Yes
A8D	IT developer of an independent OS solution; CTO of a local currency	High	No
A9C	CC coordinator; deals with political authorities and municipal partners	High	Yes
B10C	CC coordinator; deals with political authorities	Medium	Yes
B11D	IT developer and experienced currency coordinator	High	Partial

Caveat: A4C recording broke down and elements were reconstructed from notes.

This paper extends the methodological approach of Faria et al. (2022), whose compar able study of digital community currency governance in Brazil relied solely on secondary data (Faria et al., 2020). Drawing directly on practitioner accounts addresses a gap they themselves identified.

4.4 Data Analysis

Interview transcripts were analysed using thematic analysis, organised around an ex tended analytical framework building on the four-dimension taxonomy proposed by Diniz et al. (2018) for the study of digital community currency platforms (Eduardo H. Diniz et al., 2018): architecture (open-source vs. proprietary; federated vs. cent ralised; hosting arrangements; technical dependencies); governance (platform control; rule-setting; decision-making; data ownership); transactionality (actor types; transac tion flows; integration with external systems); and to a lesser extent virtuality (relation ship to physical versions; community presence; digital exclusion risks). The original taxonomy was developed from secondary data and focused primarily on technical plat form features. This paper extends it with three additional dimensions derived from the empirical material:

Dimension	Key Analytical Variables
Architecture	Open-source vs. proprietary; federated vs. centralised; hosting; technical dependency
Governance	Platform control; rule-setting; decision-making; data ownership
Transactionality	Actor types; transaction flows; external integrations
Virtuality	Physical/digital relationship; community presence; exclusion risks
Institutional autonomy	Provider dependency; exit options; key-person risk; lock-in dynamics
Professionalisation	Skills requirements; operational workload; volunteer/staff balance; civic cost of formalisation
Trajectories	Adoption path; regulatory pressure; path dependency; financial sustainability

Each dimension is analysed along a continuum from community-controlled to externally dependent governance. The three additional dimensions address what the original framework does not systematically capture: the internal power dynamics, relational consequences, and organisational costs of digital transition for community-based mon etary systems. Coding was conducted by the lead researcher, assisted by an AI language model for preliminary code identification and transcript formatting. All final tagging and validation decisions were made by the researcher.

5 Results

This section presents findings from eleven semi-structured interviews with comple mentary currency practitioners across seven European countries, including currency coordinators, governance actors, and solution providers, with and without technical backgrounds. Together, these perspectives cover a varied array of infrastructure ar rangements, from fully autonomous self-hosted systems to member-governed networks and proprietary platforms, and allow triangulation across both the governance exper ience and the technical logic of digital adoption. The analysis is organised around three interrelated dimensions: the infrastructural landscape, governance arrangements, and autonomy implications of digital adoption in European complementary currencies; the internal organisational costs and conditions of successful digitalisation; and the trajectories of digital adoption, retreat, and collapse. Running through all three is a central tension: digitalisation expands operational capacity and scaling potential, but the degree to which it does so without threatening grassroots autonomy depends less on technology choice per se than on the governance conditions surrounding it, the arrangement type, the organisational readiness, and the recognition of the need for spread documentation, shared expertise and proper decision spaces avoiding tacit capture either by knowledge, expertise or institutional design.

5.1 Digital Landscape, Infrastructure and Autonomy

Digital adoption among European complementary currencies is uneven, fragmented, and driven by pragmatism. No dominant infrastructure model has emerged across the sample. Platform selection is shaped by a combination of factors: the type of infrastructure arrangement and its governance logic, the organisational readiness of the currency at the moment of adoption, the degree of key-person dependency embedded in both the currency and its provider, and the sustainability of the underlying business model. Drawing on direct practitioner accounts, this study moves beyond the simple cataloguing of named solutions

to identify the governance architecture underlying each arrangement. Tables X-a and X-b present the resulting typology, which serves as the analytical reference for the findings that follow.

Digital infrastructure arrangements in complementary currency systems vary across several interdependent layers, each of which contributes to the overall governance pro file of the arrangement. Four layers are analytically relevant. The first is the payment solution itself: the application, software, or programme that carries out core payment functionalities. Solutions vary in their licensing model, depth of deployment across the field, availability of documentation, accessible expertise, and proven track record of maintenance. The second is the general hosting and maintenance of the infrastructure, which may be managed internally by the currency, through a shared collective infra structure, through a commercial SaaS model, or through a privately operated model in which the host retains full control without accountability to member currencies. The third is the relationship to technical providers: whether the currency has direct access to the developers of the solution, to a broader ecosystem of trained practitioners, or to neither. The fourth is the overall stack: the set of connections to third-party applica tions, banking interfaces, customer relationship management tools, and other services that accumulate around the core payment solution over time.

Only by considering all four layers simultaneously can a meaningful typology of infra structure arrangements be constructed. Given the combinatorial variety across these criteria, the number of possible arrangements is large. This paper focuses on those encountered across the interview sample. Three governance dimensions are assessed for each arrangement: the currency's governance capacity over its IT infrastructure; the switching cost it would face in changing arrangement; and its degree of sovereignty, understood as the practical ability to direct the development and evolution of its digital tools. On the basis of these dimensions, we further assess the implications of each ar rangement for the overall resilience of the system, understood neutrally as the capacity to sustain operations over time under varying conditions of resource, personnel, and technical continuity.

Table X-a — Digital Infrastructure Arrangements: Structural Composition

Arrangement codes A1–A8 serve as reference labels throughout the text. Base licence and deployment portability are reported within the same column: standard = base functionality, easy migration; extended = custom features, harder migration; unique = bespoke or fully customised, migration requires full rebuild.

Code	Arrangement type	Hosting	Technical provider	Payment solution (licence / portability)	Stack ownership
A1	Self-hosted OS (fully autonom-ous)	Currency-owned	None — internal	Open source / Standard	Full
A2	Self-hosted OS with external counselling	Currency-owned	External adviser (no ownership)	Open source or open core / Standard to extended	Full
A3	Member-governed network	Shared, collectively owned	Network provider (member-governed)	Open source or open core / Extended	Collective
A4	OS SaaS (mission-aligned, small team)	Provider-hosted	Small-team provider (currencies are clients)	Open source / Standard	Provider

Code	Arrangement type	Hosting	Technical provider	Payment solution (licence / portability)	Stack ownership
A5	Open core (commercial, large and documented)	Provider-hosted or self-hosted	Commercial provider (large ecosystem)	Open core / Extended	Mixed
A6	Proprietary aligned (commercial, non-profit oriented)	Provider-hosted	Commercial or non-profit provider (configurable via licence)	Proprietary / Extended	Provider
A7	Intermediary proprietary (civil society NGO or umbrella)	Intermediary-hosted	Civil society umbrella (no accountability to members)	Open core base / Unique in practice*	Intermediary
A8	In-house built (fully proprietary, internal)	Currency-owned	Internal developer team	Proprietary bespoke / Unique	Full

** A7 uses an open core base but custom additions and absence of member agency make effective deployment proprietary in practice — no portability, no migration path.*



Table X-b — Digital Infrastructure Arrangements: Governance Assessment

Governance capacity refers to the currency's practical control over its IT infrastructure. Sovereignty reflects practical autonomy, not formal licence status. Resilience is assessed as capacity to sustain operations over time.

Code	Arrangement type	Governance capacity over IT	Switching cost	Sovereignty level	Resilience
A1	Self-hosted OS (fully autonomous)	Full	Low	High (formal); Fragile (practical)	Low
A2	Self-hosted OS with external counselling	Full	Low	High	Medium to high
A3	Member-governed network	Formally high; practically constrained	Medium	High (formally); Fragile (practically)	Medium
A4	OS SaaS (mission-aligned, small team)	Limited	Medium	Medium	Low to medium
A5	Open core (commercial, large and documented)	Limited	Medium	Medium	High
A6	Proprietary aligned (commercial, non-profit oriented)	Low (formal); Medium (practical)	Medium	Medium	Medium



Code	Arrangement type	Governance capacity over IT	Switching cost	Sovereignty level	Resilience
A7	Intermediary proprietary (civil society NGO or umbrella)	None	Very high	Low	Medium (via subsidy); Structurally fragile
A8	In-house built (fully proprietary, internal)	Full	Low	High but fragile	Low

Note: A3 is formally high-sovereignty but practically constrained by technical asym metry. A7 is the only arrangement where dependency is structurally invisible to member currencies. A8 achieves maximum sovereignty at maximum fragility cost.

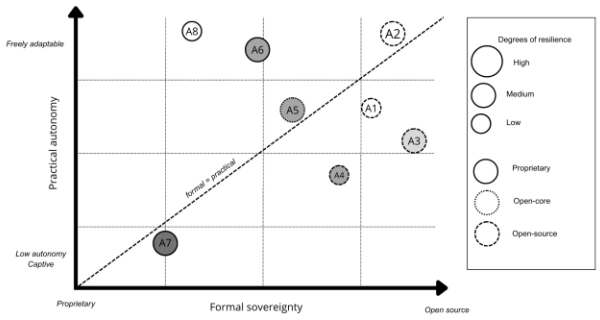


Figure 1: Formal sovereignty versus practical autonomy across digital infrastructure arrangements.

The arrangements encountered across the sample span a wide spectrum of sovereignty, resilience, and governance capacity.

The simplest autonomous configuration, A1, places a currency in full control of its payment solution, hosted on its own infrastructure and running on an open-source codebase. As long as the solution remains operational and the internal team remains stable, this arrangement delivers maximum formal sovereignty. Its fragility, however, is structural: key-person dependency is acute, and the availability of resources to maintain, update, and troubleshoot the system is uncertain. If the founding technical volunteer departs, institutional memory may be lost entirely.

The addition of an external adviser, A2, providing setup support and ongoing main tenance without taking any ownership of the stack, significantly improves resilience without sacrificing sovereignty. The currency retains full control of its data, its code base, and its

governance decisions. Where the underlying solution is widely deployed and well-documented, with a broad ecosystem of trained practitioners available in the market, this arrangement approaches the highest resilience level accessible to a community-based organisation. The adviser relationship introduces no lock-in as long as no governance rights are transferred.

A federated arrangement in which currencies collectively own the infrastructure and share governance rights over the provider, A3, introduces a meaningful sovereignty trade-off in exchange for operational resilience. The arrangement's governance quality depends on two distinct features: the nature of the underlying solution and its degree of deployment in the broader field. A well-established, widely used open-source solu tion distributed across a federated network can yield high resilience, but this does not eliminate key-person dependency. On the contrary, the complexity of the full stack, including all APIs and third-party integrations, means that someone must hold com prehensive technical knowledge of the entire architecture. This creates a specific and concentrated form of dependency that persists regardless of the open-source character of the individual components. Where the solution is open-source across the entire value chain, the primary governance trade-off concerns the currency's practical capacity to direct the evolution of the stack, a capacity that is formally shared but practically concentrated around those with technical authority.

Where a currency delegates hosting and deployment to a small external provider operating an open-source solution under a shared mission, A4, it gains operational resilience and reduces internal skill requirements. The code remains visible and the provider is responsive. However, infrastructure dependency is transferred to the provider, and the evolution of the solution is subject to negotiation rather than governance right. This arrangement yields moderate resilience but makes infrastructure and evolution choices contingent on the provider's continued alignment, capacity, and organisational survival.

A proprietary or open-core solution hosted and maintained by a large commercial provider with extensive documentation and a broad ecosystem of trained practitioners, A5, offers a distinct resilience profile. Scale and documentation reduce key-person dependency at the provider level: where many practitioners are trained and active on the platform, the risk of a single departure destabilising the arrangement is lower than in smaller configurations. The trade-off relative to A4 is one of alignment: a larger commercial provider has less incentive to orient development toward the specific needs of small community currencies, and

governance rights over the solution's evolution are limited. Residual governance capacity is exercised through what is built on top of the base solution, custom scripts, additional APIs, dedicated features, rather than through formal co-ownership. This arrangement may yield the highest resilience of any externally hosted configuration, at the cost of reduced alignment with community governance priorities. Note that the addition of proprietary complementary features on top of an open-source base effectively shifts the deployment toward proprietary in practice regardless of the base licence.

Where a proprietary solution is offered by a non-profit or mission-aligned organisation, A6, the commercial logic that might otherwise drive roadmap decisions is replaced by value alignment. This meaningfully changes the governance dynamic: over time, the provider relationship can evolve into a form of co-governance, with the currency in fluencing development priorities through dialogue and demonstrated need rather than formal contract. Resilience depends heavily on the continued alignment and organisa tional stability of the provider.

The most governance-opaque arrangement encountered in the sample, A7, involves a civil society umbrella organisation operating a proprietary platform on behalf of member currencies without formal accountability to those members. The arrangement is typically entered under favourable subsidised conditions that make it appear low-cost and low-risk. In practice, it combines the financial dependency of a SaaS model with the opacity of an internal service: member currencies have no portability guarantees, no visibility over the true cost structure of the infrastructure they depend on, and no formal mechanism for influencing its evolution. Switching costs are very high, and the dependency is structurally invisible precisely because the subsidy that funds the arrangement also suppresses the billing signals that would otherwise make cost and lock-in visible. We term this the intermediary subsidised capture model.

The most autonomous and most fragile arrangement is the fully internally developed solution, A8, in which the currency builds and operates its own proprietary platform without reliance on any external provider or pre-existing codebase. This arrangement delivers maximum governance capacity and maximum flexibility: all decisions about features, roadmap, integrations, and data remain entirely internal. The cost is full internal responsibility for development, maintenance, and continuity. Key-person de pendency is acute and entirely concentrated within the organisation itself. If the in ternal developer

departs, the system faces a crisis with no external ecosystem to draw on. This arrangement is viable where internal technical capacity is genuinely robust and where the organisation has the resources to sustain development over time.

5.1.1 Drivers of infrastructure selection

Platform selection across the sample is overwhelmingly pragmatic and rarely compar ative. No systematic benchmarking of available options was conducted by any of the currencies interviewed. Choices are shaped by a combination of factors: peer net work effects, whereby currencies adopt solutions already in use within their regional or thematic community; informal recommendation from practitioners within the field alongside active canvassing by solution providers; cost constraints and the availability of technically skilled volunteers at the moment of adoption; and chance, including per sonal relationships with technical teams that made a particular solution accessible at no cost (A3C). In some cases, solutions are developed internally by technically skilled founding members, an arrangement that concentrates operational knowledge around a single actor and may create structural incentives for technical centralisation that serve the developer's continued indispensability as much as the currency's operational needs. Geopolitical considerations have also emerged as a nascent driver, with some practition ers expressing preference for European sovereign solutions, including blockchain-based alternatives, in response to concerns about dependency on non-European infrastruc ture (A2P). Across cases, provider resilience and the availability of documentation weigh more heavily than licence model in practitioners' assessments of what makes a solution trustworthy (A6C, A7C). What is consistently absent is deliberate stra tegic evaluation: infrastructure selection happens without comparative assessment of governance implications, a gap whose consequences become visible only later in the trajectory.

5.1.2 Infrastructure arrangements in practice

The eight arrangement types identified in Tables X-a and X-b do not map onto autonomy outcomes in the way the OS/proprietary binary would predict. The empirical material consistently reveals that formal sovereignty, as expressed through licence type or stack ownership, diverges from practical autonomy, understood as the actual capacity to modify, redirect, or exit an infrastructure arrangement. This divergence is the central finding of this section. OS self-hosted deployments (A1) formally preserve the highest degree of sovereignty: the currency owns its server, controls its data, and retains fork rights over the

codebase. In practice, however, the complexity of the solution and its inter-dependencies makes management and maintenance the primary risk factor. Even where a currency holds full autonomy and ownership of its data on its own server, open-source solutions supported by third parties can prove more restrictive in terms of alternatives and lock-ins than their formal status implies (A1C). If an upstream open-source community fails to maintain the project, the currency may suffer at any time, introducing a dependency that is neither visible nor contractual (A3C). A proprietary solution with proper documentation and a long-term incumbent, by contrast, has built over years a larger network of expertise that allows for easier maintenance, a counter-intuitive finding that links directly to the question of organisational resilience (A7C). Proprietary also means much less one-person dependency, especially for a well-recognised and widely used solution, while open-source arrangements require local uptake both for practical implementation and IT resilience (A7C). The pragmatic dismissal of OS ideology as the primary selection criterion is explicit in several interviews: what matters is configurability and cost, not licence model, and provider resilience is the decisive infrastructure criterion (A6C). OSS is explicitly named as irrelevant to this risk by the same interviewee (A6C). Member-governed network arrangements (A3) occupy a formally high-sovereignty position, with currencies holding voting rights over infrastructure decisions. In practice, this formal position is constrained by technical asymmetry: voting rights exist but development decisions concentrate around whoever holds technical expertise. In a formally democratic OS network, structural conflicts of interest shift governance power toward the technically competent actor, who may simultaneously hold the role of developer, governance actor, and commercial service provider (A1C). One person may collapse and put an entire national federation at risk (A1C). OS self-managed arrangements with low-complexity infrastructure show no evidence of technical power concentration and report that digitalisation has not shifted internal power dynamics, consistent with a low-skill-barrier deployment (A3C). In-house built solutions (A8) resolve the dependency question differently: full independence is achieved by explicitly distributing control to the member base rather than to technical managers or external funders, with the currency claiming to have achieved the scaling and autonomy balance that others identified as structurally unresolved (A9C). The cost is full internal responsibility — maximum flexibility but maximum responsibility too (A9C). OS SaaS arrangements (A4) occupy the middle position the original hypothesis anticipated, but for reasons more nuanced than code visibility alone. A lone-developer solution, meaning a platform used by

member currencies but maintained by a single developer at the provider level, illustrates this concretely: the provider delivered a SEPA mandate feature based on its own interpretation of the currency's needs rather than its expressed requirements, generating technical debt and governance friction that the board was left to contest after the fact (A2P). Code visibility did not translate into influence over development direction. Infrastructure choice may also be led by geopolitical considerations, with some practitioners expressing preference for European sovereign solutions including blockchain-based alternatives (A2P). In the open core commercial arrangement (A5), developing custom features on top of a proprietary legacy base ensures a stable foundation with dedicated custom capabilities and the possibility of script migration, a model that some practitioners find more important than open-source without technical capacities (A6C). The uncertainty interviewees express about the precise terms of their own licence is itself a governance finding: several practitioners describe no clear knowledge of what their arrangement formally permits (A8D, A3C). The proprietary aligned arrangement (A6) produces the most counter-intuitive finding. As collaboration builds over time, even a proprietary solution for a small-scale non-profit organisation can yield the same incentive alignments as a formally open arrangement, lowering path dependency through relationship rather than contract (A6C). Long-term proprietary relationships can generate co-governance and support co-development of features and functionalities (A6C). Free open-source is not free: labour costs, maintenance burdens, and upstream community dependency mean that OSS deployments may be more expensive in practice than well-documented proprietary alternatives (A5C, A9C). The OSS/proprietary binary is contingent on resource context, not principled position, and organisational resilience matters more than the OSS label per se (B11D, A6C).

5.1.3 Dependency, exit options, and lock-in

Lock-in is a more complex and contingent phenomenon than the OS/proprietary binary suggests. Switching costs depend less on licence model than on the depth of third-party integrations, the opacity of cost structures, and the governance relationship with the provider. Platforms designed as modular and independent accumulate implicit depend encies through integration work: each additional connection to a bank, an accounting system, or an external service becomes a maintenance liability that raises the cost of exit regardless of what the underlying licence permits (A8D). High functional lock-in can therefore be acknowledged even where no proprietary constraint formally exists, because

no alternative platform covers the full functional stack that has been built up over time, and exit would require rebuilding it entirely (A6C). The knowledge-is-power dynamic operates as a distinct and parallel form of lock-in. Technical competence translates into de facto governance authority in ways that are not captured by any licence category. This dynamic operates within OS contexts as readily as propriet ary ones: in a formally democratic OS network, structural conflicts of interest shift governance power toward the technically competent actor, who simultaneously holds the role of developer, governance actor, and commercial service provider (A1C). In Belgium, the absence of knowledge-sharing at the management level of the platform re inforced a sense of impossibility of exit among member currencies, not because leaving was technically impossible but because no one within the member organisation under stood what leaving would actually require (A8D). Democratic governance structures can counterbalance this asymmetry: the French member-governed model, with more than fifty percent voting rights held by member currencies, regular joint meetings, and deliberate technical empowerment of currency coordinators, functions as a documented counterbalancing mechanism (A2P). The most structurally severe lock-in documented in the sample is neither commercial nor technical in origin. Where a civil society um brella organisation, initially publicly funded to support CC development, operates a proprietary platform on behalf of member currencies, the resulting arrangement com bines the financial dependency of a SaaS model with the opacity of an internal service. Member currencies bear very high switching costs, describing the process as “like chan ging banks”, requiring a full migration plan, a hybrid coexistence period, and complete user re-enrolment, while retaining no visibility over the actual cost structure of the in frastructure they depend on. The true human cost of platform maintenance, estimated at €20,000 to €25,000 per year, remained effectively invisible: “comme je vois pas de facture, je challenge pas” (A8D). The subsidy that makes the arrangement affordable also makes its governance opaque. Member currencies are not locked in by a commercial provider pursuing profit, but by a solidarity economy actor whose incentive structure, precisely because it is not market-based, is harder to contest. Long-term proprietary relationships of a different character, however, can generate co-governance over time: where provider and currency share aligned interests, co-development of features and practical adjustment of the solution can lower path dependency through relationship rather than contract (A6C). Free open-source is not free: labour costs, maintenance burdens, and upstream community dependency mean that OSS deployments may be more expensive in practice than well-documented proprietary

alternatives (A5C, A9C). Technological pooling within a proprietary SaaS model can represent a rational trade off between cost-sharing and institutional independence (A5C). The counter-example that most directly resolves this tension is the in-house built solution, where full in dependence is achieved by explicitly distributing control to the member base rather than to technical managers or external funders (A9C). This arrangement eliminates provider dependency entirely and, in the case documented, claims to have achieved the scaling and autonomy balance that other interviewees identified as structurally un resolved (A5C). The cost is full internal responsibility for development, maintenance, and continuity, a trade-off that brings its own structural fragility, which the following section addresses.

5.1.4 Key-person dependency as a structural governance risk

Key-person dependency is not a digitalisation-specific problem and is not eliminated by any infrastructure arrangement. It is a structural feature of the complementary cur rency field that predates digital adoption and operates across multiple simultaneous levels, each with distinct characteristics and distinct mitigation pathways. This paper maps those levels as a contribution toward greater organisational resilience. At the most immediate level, dependency concentrates around the internal technical manager or volunteer who carries operational knowledge of the digital system. When this per son departs, the currency faces not merely a staffing gap but a potential total loss of institutional memory (A3C). This is distinct from, though often compounded by, the dependency on a paid technical employee whose continued employment becomes a condition of operational continuity. Both forms are widely self-acknowledged: across the sample, interviewees are self-aware of their own indispensability and of the need for succession planning or role duplication (A5C). The “hero” dynamic, in which the motivation of a founding volunteer animates an entire organisation, means that when enthusiasm collapses, the volunteer base can follow, making group dynamic and vo lunteer recruitment a bigger driver of failure than technical dependency per se (A8D, A5C). At the provider level, dependency takes two analytically distinct forms. The first is the question of who can maintain the solution: keeping it operational, applying updates, managing routine configurations. Where the solution is widely deployed and a professional ecosystem of trained practitioners has formed around it, this risk is dis tributed and manageable. A widely used solution, even a proprietary one, can be more resilient on this dimension than a niche open-source deployment, precisely because the market of competent maintainers is larger (A7C). The second and more acute

form is the question of who can make the solution evolve: adding features, modifying beha viour, responding to the currency's changing governance needs. This concentrates risk sharply, particularly where a single developer holds both the technical authority and the commercial relationship with the currency (A1C). Even in a formally democratic OS network, structural conflicts of interest shift governance power toward this actor, bringing key-person dependency all along the value chain (A1C). A third level arises from custom development: bespoke APIs, additional scripts, or integrations built on top of a base solution. These create a double dependency, on the person who built them and on the upstream solution against which they were built. Resilience here is a direct function of the breadth of the developer ecosystem surrounding that upstream solution. A solution with a large, documented, and professionally active community, regardless of its licence model, reduces this risk in ways that a niche open-source pro ject with few active contributors does not (A7C, A6C). Finally, dependency operates at the infrastructure level independently of the payment solution layer. The various integrations and development choices that accumulate over time, bank connectivity, accounting systems, membership management tools, create a web of dependencies that is distinct from any single solution and often invisible until a migration is attempted. Each integration is a maintenance liability (A8D), and the cost of unwinding them com pounds with time. Subsidy dependency adds a further dimension: where infrastructure is funded by an umbrella organisation or public grant, the dependency can evolve into an NGO-aggregator dependency that is harder to contest than a commercial one pre cisely because its incentive structure is non-market (A8D). OSS only works if technical capacity exists to deploy and maintain it: a developer is the enabling condition, and without one, governance is formally participatory but substantively constrained by technical expertise asymmetry (B10C).

Table Y — Key-person dependency types identified across the sample

Dependency type	Description	Interview ref
Internal technical manager	Sole carrier of operational knowledge within the currency; departure = institutional memory loss	A1C, A3C



Dependency type	Description	Interview ref
Paid technical employee	Continued employment as condition of operational continuity	A5C, A6C, A9C
Founding volunteer	"Hero" dynamic; motivation collapse triggers broader organisational fragility	A8D, A5C
Provider with maintenance capacity	Who can keep the solution running; risk distributed if wide professional ecosystem exists	A7C
Provider with evolution capacity	Who can make the solution evolve; concentrates sharply in lone-developer arrangements	A1C, A4
Custom development replaceability	Bespoke APIs or scripts create double dependency on developer and upstream solution	A8D, A9C
Upstream OS community	Risk fed into the open-source project maintaining the core solution	A3C, B11D
Infrastructure integration web	Accumulated integrations (bank, accounting, membership) create invisible switching costs	A8D
Subsidy by intermediary	Funding dependency evolving into structural dependency	A8D, A5C

5.2 Governance, Professionalisation, and the Human Costs of Digitalisation

Digitalisation reshapes internal governance in ways that are simultaneously enabling and destabilising. It is a necessary condition for professionalisation and for the scal ing of operational capacity, and a transformative factor for the range of services a currency can render, the development pathways it can pursue, and the sustainability of its business model. It is also a catalyst that amplifies what is already present in the organisation: the strengths and the weaknesses alike. The degree to which di gitalisation delivers on its potential depends less on the infrastructure arrangement chosen than on three governance preconditions: clear internal decision-making pro cesses, properly documented operational procedures, and a deliberate transition plan that acknowledges what digitalisation does to the relationships with volunteers and merchant businesses. Where these preconditions are absent, digitalisation introduces new operational burdens that erode the volunteer culture and civic character on which most complementary currencies depend, alienates non-digital participants, and forces smaller systems into a structural trap — they cannot scale without digital, and they cannot sustain digital without the scale that would make it financially viable.

5.2.1 New operational demands and skill requirements

Digitalisation introduces new skill requirements that extend well beyond familiarity with the payment application itself. At the most basic level of deployment, a simple payment tool requires little additional competency beyond a willingness to learn and a general acquaintance with digital platforms (A1C). The threshold rises sharply, how ever, as the functional scope of the digital infrastructure expands. Bank connectivity, SEPA file conversion, accounting integration, and membership management each intro duce their own operational logic, and the coordinator who manages them must develop a form of general technology literacy that is not about writing code but about un derstanding what is happening across a connected system. The addition of an ERP tool emerges as the single most significant skill threshold in the sample, mentioned across multiple interviews as the tipping point for operational change rather than the digital currency itself (A2P). The task profile shifts radically: where coordinators once counted notes and managed paper stocks, they now interpret network data, assess cir culation patterns, and coordinate across digital workflows (A2P). This is the same role measured in the same full-time equivalent, but it is a different job. Technology liter acy thus becomes an organisational prerequisite, not merely a

technical skill: without someone capable of thinking in technical terms, the organisation cannot identify what solutions are possible, let alone implement them (A6C, A7C, A8D).

5.2.2 Benefits of digitalisation

Digitalisation is, across the sample, a consistent driver of increased circulation volumes and expanded operational capacity. The gains are not marginal: currencies report transaction volume multipliers ranging from modest to fivefold following digital adop tion, though these figures must be read against the timing of adoption, as early digit alisation from a small base produces higher multipliers than later transitions from an established paper system (A2P). Beyond volume, digitalisation enables entirely new service categories: B2B transactions, which are practically impossible to manage at scale on paper, become accessible once a digital layer is in place (A2P, A1C). Business development consulting, municipal data reporting, cashback mechanisms, and demur rage tools all become operationally feasible through digital infrastructure (A2P, A9C, B11D). The efficiency dimension is also documented: one currency reported saving 0.75 FTE through process automation alone, a critical gain at a moment of budget reduction (A1C). These gains are, however, deeply dependent on training, process documentation, and the technological readiness of the coordinator team. The gains do not materialise automatically from deployment; they require the human and organisational infrastructure to realise them. Digitalisation also functions as a catalyst, and this is perhaps its most analytically significant property. It amplifies what is already present in the organisation. Where governance capacity, volunteer energy, and operational processes are solid, digitalisation accelerates growth and unlocks new possibilities. Where they are fragile, it accelerates the fragility. Volume growth outpacing governance capacity, as documented in one near-collapse case, illustrates the downside of the same dynamic that produces success elsewhere (A2P). Two currencies underwent digitalisation and directly collapsed when the digital promise failed to deliver and residual motivation disappeared with it (A1C, A2P). The practitioner formulation of this dynamic is pre cise: “Lancer une monnaie électronique quand la monnaie va mal, c’est comme faire un bébé quand un couple va mal” (A2P) [launching a digital currency when the currency is struggling is like having a baby when a couple is in trouble]. Digitalisation does not save a currency; it reveals it.

5.2.3 The civic cost of formalisation

The organisational transformation that digitalisation drives carries a civic cost that is documented across multiple cases. Process formalisation, the introduction of struc tured workflows, reporting requirements, and digital administration procedures, can demotivate volunteers and drain the civic energy on which most complementary cur rencies depend (A1C). Clear cases exist in which digitalisation and its associated loss of informal autonomy correlate directly with the departure of founding practitioners and the alienation of volunteers who joined a civic project rather than an administrative one (A8D). This may be curbed by better preparation, clearer objective-setting, and deliberate alignment of expectations before the transition begins (A1C). The dynamic is not uniformly negative. At one currency, digitalisation coincided with a broadening of governance participation beyond the founding militant core. As the operational profile became more professional, decision-making attracted profiles less rooted in act ivist culture, a diversification that expanded the governance base while simultaneously diluting the civic character that had originally animated the initiative. Digitalisation here functioned less as a technical upgrade than as an organisational threshold: cross ing it reshuffled who felt competent, and therefore who felt entitled, to participate in governance (A2P). Digitalisation and organisational professionalisation co-occurred and are analytically entangled. New hybrid governance models have emerged in re sponse. One documented model preserves democratic participation at the periphery, with volunteers contributing ideas and energy at the edges of the organisation, while concentrating core governance decisions within the professional team (A6C). This is a pragmatic response to what another interviewee identified as the sociocratic time drain of fully distributed decision-making. Two distinct paths appear across the sample: an incentive-driven model oriented toward scale and professional engagement, and a values based model that accepts smaller scale in exchange for higher member commitment and civic coherence. This concurs with findings from Diniz (2018) that points to “the most relevant issues found are the risk to community feelings related to the virtuality dimen sion and the introduction of new actors that come along with digital technologies and that can compromise the shared governance spirit of most community organizations” (Eduardo H. Diniz et al., 2018).

5.2.4 Power dynamics: technical knowledge as governance influence

Technical competence translates into governance influence in ways that are not cap tured by formal governance structures. The most direct formulation comes from within the sample itself: in a flat governance structure, the technically competent adminis trator who self-assigns a CTO role carries the entire digital infrastructure, making technical authority and governance authority effectively coextensive (A8D). This is not always a product of bad faith; it is often a structural inevitability in organisations where technical expertise is scarce. Those who do, decide — a do-ocracy dynamic documented from the earliest interviews in the sample (A1C). The empirical material qualifies this finding, however. Technical power concentration is less systematically abused than the literature might anticipate. In several cases, technical expertise bias is acknowledged but accepted as a reasonable trade-off given the operational demands of digital coordination (A5C). Distributed technical competence functions as an anti technocracy mechanism where it exists: sharing knowledge, doubling roles, and invest ing in the technical literacy of non-technical governance participants all reduce the concentration risk (A2P, A5C). The awareness of institutional capture, the recognition that digitalisation produces power asymmetries as a natural outcome, is itself a gov ernance resource: where practitioners name the dynamic, they are better positioned to counterbalance it (A8D).

5.2.5 Training, documentation, and process design as critical success factors

Technical deployment alone is insufficient. A digital system can be deployed in half a day; without the human and organisational infrastructure to support it, it fails. The most consistent finding across the sample on this point is that documentation and training are the decisive factors, not the software (A1C, A2P). The gains from digitalisation are entirely dependent on the technological readiness of coordinators and the quality of process documentation that guides volunteers and staff through operational workflows. Where this investment is made, efficiency gains compound and the system becomes more resilient over time. Where it is absent, the digital layer becomes a source of confusion, friction, and eventual collapse. Simple payment mechanisms can be run at very little cost and with minimal skill requirements, and this is sufficient for a currency to operate successfully at small scale (A3C). The ceiling, however, is structural: without professionalisation and documented processes, a small scale currency is likely to remain small-scale and faces eventual closure when founding volunteers depart. The addition of further services, ERP

integration, bank connectivity, reporting tools, raises the skill bar significantly and requires proportionally greater investment in training and documentation. This investment is not optional: it is the governance precondition without which the potential of the digital infrastructure cannot be realised.

5.2.6 Business models and financial sustainability as a governance question

Digitalisation is not inherently costly, and many currencies have deployed functional digital solutions at very limited cost. Its relationship to financial sustainability is, however, structural and cuts in multiple directions. On the enabling side, digitalisa tion unlocks revenue streams and member segments that are inaccessible on paper. B2B suppliers with no consumer interface become reachable (A2P, A1C). Larger pro fessional members who expect banking-grade digital features, batch payments, SEPA direct debit, and data reporting, can be attracted and retained, and their higher mem bership contributions improve financial sustainability directly (A2P). Digitalisation also overcomes the credibility barrier with merchant partners: the monopoly money stigma dissolves when a professional digital interface is presented (A2P). Municipal partnerships, which represent a significant scaling opportunity, are facilitated by the data visibility and spending traceability that only digital systems provide (A2P, A6C, A8D, A9C). On the constraining side, digitalisation introduces a fixed-cost trap that is particularly acute for smaller systems. The infrastructure requires scale to become financially self-sustaining, but scale requires the infrastructure (A7C, A8D). One-shot public funding that covers the cost of initial deployment without building a sustain able business model leaves currencies holding an expensive digital system at the end of the grant period without the revenue base to maintain it. Several cases illustrate this dynamic: the absence of a business model at the point of digitalisation produced dependency on continued subsidy, which in turn foreclosed the operational autonomy needed to develop one. Merchant onboarding requires communicating network value, not technical features, and without a clear value proposition the digital investment cannot generate the adoption it needs to justify itself (A7C). The cooperative model and deliberate professionalisation are identified as markers of long-term viability, not because they guarantee success but because they create the organisational complexity required to navigate the fixed-cost trap (A6C). Discount mechanisms, demurrage, cash back, and behavioural incentives for habit formation all contribute to a viable business model, but their

implementation requires technical integration that itself depends on the infrastructure arrangement chosen (A9C, B11D).

5.3 Trajectories: Adoption, Retreat, and Collapse

The digital trajectories of complementary currencies in Europe are not the product of deliberate strategy. They emerge from the accumulation of early choices, each one narrowing the space of options available at the next decision point. Infrastructure selection made under conditions of limited information, peer influence, or opportunism creates dependencies that compound over time: integrations deepen, switching costs rise, and the governance implications of the original choice become visible only when change is attempted. Path dependency in CC digitalisation is therefore not primarily a technical phenomenon but a governance one.

5.3.1 Cases of Adoption, Retreat, and Collapse

Across the sample, four broad patterns emerge, though they resist clean classification. Systems exhibit distinct combinations of initial conditions, critical junctures, and out comes that resist reduction to a single explanatory variable. The most documented pattern is inertia: as long as the initial solution holds, there is no compelling reason to migrate. Even technically aware providers confirm that migration costs routinely out weigh the gains from new features, particularly when the steep learning curve associated with platform change is factored in (A3C, A1C). Proprietary-legacy solutions function as a safe fallback: for one currency, the complexity of successive failed infrastructure partnerships shaped a current stance of deliberate simplicity-seeking, returning to a well-documented legacy solution after years of experimentation (A7C). Inertia is not passivity; it is a rational response to high switching costs given limited resources. Its governance consequence is that path dependency accumulates silently, and the fore closure of alternatives only becomes visible when a migration is finally attempted. A second pattern is scaling via professionalisation, which in several cases followed a near collapse moment. Where volume growth outpaced governance capacity, currencies faced a critical juncture: professionalise or collapse. Those that professionalised suc cessfully report that digitalisation became the enabling condition for municipal partner ship, B2B development, and institutional legitimacy (A2P, A5C, A6C). Digitalisation enabled the scale and multi-actor coordination that makes municipal-level engagement operationally possible (A6C). In one documented case, digital spending traceability data built the quantifiable argument that facilitated a student-aid programme

with a municipal authority (A2P, A5C). This trajectory is not linear: it passes through a governance crisis before stabilising. A third pattern is subsidised capture: a path in which early adoption under favourable subsidised conditions masks the true cost and governance implications of infrastructure dependency. By the time the subsidy question becomes salient, switching costs have become prohibitive and the currency's institutional autonomy has been quietly constrained. This trajectory is particularly insidious because it does not announce itself as dependency: the arrangement feels like support. It becomes visible only retrospectively, when conditions change or when a technically literate actor begins to ask questions that the absence of invoices had pre viously made unnecessary. Capacity constraints shape which open-source options are realistically available to currencies in this situation: not all OSS is accessible equally, and the absence of internal technical capacity means that the theoretical freedom to migrate remains operationally meaningless (A7C). A fourth pattern is collapse under operational weight, which occurs when the additional workload from digitalisation is unforeseen and the organisational capacity to absorb it does not exist. Two currencies underwent digitalisation and collapsed directly when the digital promise failed to deliver and residual motivation disappeared with it (A1C, A2P). In one case, digitalisation accentuated pre-existing internal divisions; in another, the digital promise functioned as a fragile motivational prop whose failure triggered merger with another initiative. A fifth pattern, partially distinct, is stagnation under proprietary SaaS: where a cur rency is neither collapsing nor scaling but is held in place by a combination of subsidy dependency, opaque cost structures, and the absence of a viable business model that would enable genuine operational autonomy (A8D). Across all patterns, one structural condition recurs: the absence of a clear development path when it comes to legal com pliance acts as a glass ceiling on ambition. Currencies that wish to scale beyond the limited network exemption face regulatory uncertainty that discourages digital exper imentation and pushes toward conservative, legacy-compatible infrastructure choices. This is not because the regulatory framework is hostile, but because its application is insufficiently clear to support confident planning (A7C, A9C).

5.3.2 Legal and regulatory pressure as a trajectory driver

Regulatory concerns play a more limited role in shaping CC digitalisation trajectories than the literature might anticipate. Across the sample, most currencies operating at small scale are effectively unconcerned with regulatory compliance: the limited network exemption

provides sufficient cover, and the threshold at which additional obligations apply remains safely distant from their operational scale. Main concerns where they exist are RGPD and AML-CFT obligations, and the regulatory landscape on these points is considered sufficiently clear (A2P). Only the largest systems, or those with explicit ambitions for municipal integration, begin to engage seriously with regulatory questions. The French legislative context, shaped by the 2014 law on the social and solidarity economy, represents one documented case of regulatory pressure shaping tra jectory. More significantly, digitalisation itself introduces regulatory actors into the governance environment who were previously absent: in one case, the digital trans ition attracted lawyers, university researchers, and financial sector surveillance bodies into the currency's orbit, creating new informal pressure channels alongside formal governance structures (A7C). Regulatory actors appear in the actor network precisely because of the digital transition, not independently of it. For future development, the lack of clear regulatory pathways at the European level acts as a structural constraint on scaling ambitions. MiCA could concern CC systems experimenting with blockchain based instruments, and the question of EM licence passporting as an interoperability mechanism remains unresolved at the policy level (A9C). This sub-section deliberately preserves these open questions as a horizon for future policy research rather than resolv ing them prematurely.

5.3.3 Path dependency: when early choices constrain later options

The empirical material does not yield clean cases of regret: when asked whether they would have chosen differently, most interviewees acknowledge that every solution in volves trade-offs and that their current situation reflects accumulated choices rather than a single identifiable mistake. Regrets, where they exist, are more about process management and transition preparation than about the infrastructure choice per se. What the material does yield is evidence of constraint: situations in which the cost of change has become prohibitive not because the initial choice was wrong but be cause integrations, customisations, and organisational adaptations have accumulated around it to the point where the arrangement is effectively irreversible. One currency describes its open-source deployment as paradoxically creating stronger lock-in than a proprietary alternative would have, because the absence of governance rules around the OS project meant that no migration path was ever documented or planned (A3C). Intermediary capture, as documented in the Belgian cases, leads to the most acute form of path dependency: not only are switching costs

prohibitive, but the absence of itemised cost information means that the dependency itself is invisible to those sub ject to it (A8D). Provider resilience and funding continuity matter more than licence type in determining whether a trajectory remains open or narrows. Where a provider organisation is financially stable and technically active, the currency retains practical options even within a proprietary arrangement. Where a provider is a lone developer, a small team, or a subsidy-dependent civil society organisation, the currency's traject ory is exposed to risks that have nothing to do with its own governance choices (A5C, A9C).

5.3.4 What support is needed

When asked what would facilitate CC digital development over the next three to five years, practitioners across the sample converge on a pragmatic answer: they do not primarily seek regulatory guidance, technical infrastructure, or European coordination. They want sustainable business models and better processes, combined with stronger relationships with municipal authorities. Digitalisation data, spending traceability, circulation metrics, impact reporting, is identified as the primary lever for municipal engagement: it provides the quantifiable argument that legitimises the currency as a policy instrument rather than a marginal civic experiment (A2P, A5C, A6C). Two specific support needs recur: a model for federated infrastructure cost-sharing that would reduce the fixed-cost burden on individual currencies, and a shared technology intelligence network that would allow practitioners to compare solutions, document experiences, and avoid repeating the same costly mistakes in isolation (A8D). Neither of these requires regulatory intervention; both require coordination infrastructure that the field currently lacks.

6 Discussion

6.1 Synthesis: From Hypotheses to Findings

The digital space is another space — another arena in which democratic practice must be considered, contested, and actively designed. Digital infrastructure can be enclosed or managed as a commons, and this has very little to do with the open source/proprietary nexus per se. A proper digital commons for complementary cur rency infrastructure would share the defining properties of any commons: widespread information dissemination, the genuine ability of participants to contribute to its devel opment and governance, and the displacement of gatekeepers in ways that build more resilient and accountable systems.

A second finding concerns the meaning of working together. Collective infrastructure arrangements have varied meanings depending on the actual governance relationships they encode. Currencies can share infrastructure in arrangements that are deeply unequal — where one actor holds all technical and financial leverage while others bear the costs without agency — or in arrangements that are genuinely equalitarian, where sovereignty is distributed and decision-making is participatory. What matters most is not the formal structure of the arrangement but the strength, legitimacy, and actual agency of participants within it.

The empirical material confirms that no single architecture fits a utopian framing of collective sovereignty. Yet common infrastructures that maintain the practical sover eignty of member currencies have been shown to exist and prosper in the European context. Proprietary models led by non-profit organisations have demonstrated flexib ility, adaptability to the evolving needs of currencies, and long-term resilience where organisational alignment is maintained. Blockchain has entered the field as a candid ate for decentralised infrastructure but has yet to demonstrate its practical value for community currencies at operating scale.

A cross-case analysis of the empirical material reveals a fragmented and unevenly dis tributed digitalisation landscape across the European CC sector. By confronting our initial working hypotheses with practitioner narratives, this paper establishes four ana lytical claims: (1) The European DCC landscape is structurally scattered and non linear. The transition from paper-based to digital architectures is driven by localised pragmatism rather than unified systemic directives. Digitalisation consistently triggers transactional volume expansions, but these gains remain bounded by local merchant infrastructure density and organisational capacity. (2) The OS/proprietary binary is not the primary arbiter of institutional autonomy. The true determinant of practical sovereignty is infrastructure maintainability over time — the availability of human and technical resources to sustain, evolve, and if necessary migrate the solution. Open source deployments only preserve genuine self-governance if supported by a mature de veloper ecosystem and exhaustive documentation; absent this, they can generate more acute lock-in than well-documented proprietary alternatives. (3) Digitalisation forces a profound, often alienating, shift in internal roles and power dynamics. The opera tional burden shifts from physical currency logistics to digital system administration, raising technical barriers to entry and concentrating informal

governance authority. (4) Subsidised capture constitutes a distinct and particularly insidious development path, wherein early dependency on a well-meaning civil society intermediary quietly constrains a currency's long-term operational flexibility and institutional autonomy.

6.2 Theoretical Contribution

The core theoretical contribution of this paper lies in articulating the scaling capacity versus institutional autonomy trade-off as the central governance challenge of CC di gitalisation. Our results extend and refine the four-dimensional taxonomy proposed by Diniz et al. (2018) by adding three relational, non-technical dimensions: institutional autonomy, professionalisation trajectories, and systemic path dependency. We further contribute the first analytical mapping of digital infrastructure arrangements in the European CC field, providing a typology that moves beyond the licensing binary to characterise the full governance profile of each arrangement type. While Silva de Faria et al. (2022) highlighted a structural tension where digitisation represents "the same idea implemented in different ways," our work demonstrates that the digital layer com pletely shifts the underlying governance equilibrium. We validate Ruddick's critique that modern digital platforms tend to recreate dependencies on centralised gatekeep ers; however, we uncover that in the European context, this gatekeeper is rarely a predatory commercial entity, but rather a civil society intermediary that achieves insti tutional capture through well-meaning, subsidised software administration. This paper challenges Toti's (2024) optimistic reliance on participatory structures to mitigate tech nological risks. We show that formal participation rights, including voting rights in member-governed networks, are systematically constrained by technical asymmetry: those who hold the code hold the power, regardless of the formal governance struc ture. By mapping these dynamics across a typology of infrastructure arrangements, this paper provides alternative economics with a grounded framework for understand ing how technical infrastructure choice directly shapes the conditions for institutional autonomy.

6.3 Implications for CC Design and Practice

For currency designers and grassroots practitioners, this study yields several hard truths that challenge common activist assumptions. Infrastructure selection must be treated as a binding governance decision made at launch, rather than an interchange able technical operational step. The initial choices of the overall stack must be well informed: the consequences of digitalisation must be well understood, the willingness and ability to

maintain agency over citizen-led solutions must be recognised, and the civic cost that may accrue from formalisation must be anticipated and managed. Prac titioners must look past the ideological appeal of open-source licences and rigorously interrogate long-term exit options, data portability, and the practical resilience of the provider relationship. No systematic benchmarking of infrastructure options has ever been conducted in the CC field: platform selection happens without comparative eval uation of governance implications, and this gap is itself a finding with direct practical consequences. Software is fundamentally a tool, not an ideological end in itself. Because key-person dependency remains a critical structural risk within small-scale volunteer initiatives, highly streamlined, automated SaaS solutions are often far more resilient than custom-coded platforms maintained by a single developer. Bespoke software ar chitectures routinely lead to developer burnout and total institutional memory loss during leadership handovers. A practical approach combining accountable leadership, documented processes, and a sustainable business model are non-negotiable features of a prosperous system. Shifting from organic, face-to-face community exchanges to rigid digital ERP workflows often alienates non-digital participants and erodes the volun teer culture that animates alternative economies: comprehensive training and process documentation must be treated as non-negotiable governance preconditions, and sus tainable business models must be designed directly into the infrastructure from the outset. Resilience, in the end, is about knowledge availability and organisational capa city. A functioning business model trumps licence ideology. Ownership and genuine agency over the digital infrastructure appear as strong drivers of growth and volun teer motivation. Subsidy-captured solutions that deny currencies agency over their own tools reduce not only their sovereignty but their capacity to develop viable busi ness models. Feenberg's normative conclusion applies directly: "only the democratiz ation of technology can help" (Andrew Feenberg, n.d., p. 6). The spread of technical knowledge alone is insufficient; for that knowledge to be taken seriously, the range of interests represented in governance must be enlarged to include those who bear the consequences of technical decisions. For complementary currencies, this means that IT literacy and genuine sovereignty over digital infrastructure are not merely operational desiderata but the conditions for democratic governance of community monetary sys tems. Grassroots initiatives that cede operational autonomy to technical gatekeepers, however well-meaning, reproduce at the community scale the same power asymmetries that monetary innovation was designed to challenge.

6.4 Implications for Policy

The findings carry clear implications for EU and national regulators and funders. Com plementary currencies serving social needs and representing small interpersonal or pro fessional business arrangements face disproportionate compliance burdens relative to their actual operations and risks. Two pathways seem worthwhile for policymakers to consider. The first is a regulatory sandbox model: a white card to test and develop, offering minimum, sound, and easy-to-integrate compliance rules that allow peaceful growth and expansion of these systems and the local economic benefits they generate. Regulatory sandbox design would favour report-based oversight without prescriptive compliance burden, collaborative regulatory design rather than top-down frameworks, and clear pathways that avoid regulatory lag (A6C, A9C). The second is a path toward greater regulatory clarity: the current uncertainty quenches potential development and partnership, including with public authorities. Even though this uncertainty has borne limited impact on today's systems, tomorrow's currencies that grow past certain thresholds should not collapse under compliance weight because of overdue concerns disproportionate to actual field operations. Municipal partnerships represent a signific ant scaling opportunity already documented in the sample, and regulatory frameworks that facilitate rather than obstruct these partnerships would yield the greatest prac tical benefit. Funding design must ensure sustainability beyond the project period: one-shot grants that do not build toward a business model produce the subsidised cap ture dynamics this paper documents. Legal tender status via EM licence passporting, as suggested by one interviewee, represents an elegant interoperability solution that merits further policy attention (A9C).

6.5 Limitations

This study is limited in scope to eleven practitioners across seven European countries, all geographically concentrated in Western Europe. The sample is biased toward active and digitally engaged systems: currencies that collapsed, retreated from digitalisation, or never adopted it are underrepresented, as is the eastern European CC landscape. Findings are limited to fiat-backed local currencies and interpersonal mutual credit sys tems; time banks, crypto-based systems, and blockchain-based currencies are excluded. The sample operates within an intertwined ecosystem: many interviewees know each other and share platforms, which may limit the diversity of perspectives captured. CC lifecycles have autonomous dynamics, including cyclical waves and cultural catalysts like the film

'Demain', that are independent of digitalisation and that this paper can not fully disentangle from the governance dynamics it analyses. One recording failed and was reconstructed from notes, introducing a potential source of inaccuracy for that case.

6.6 Future Research

Given that many European digital currency platforms are only now approaching a decade of maturity, longitudinal tracking of infrastructure migrations presents a vital horizon for future research. Subsequent scholarship should prioritize the formulation of precise, governance-preserving technical design principles that actively prevent struc tural key-person or institutional lock-ins. Comparative socio-technical evaluations ex tending this analytical framework to decentralised mutual credit models and non-fiat time banks would widen understanding of digital alternative economics. The regulat ory landscape warrants dedicated mapping across EU member states, with particular attention to the implications of MiCA and EM licence passporting for CC scaling. Fi nally, as systemic pressures and software updates force old deployments to modernize, researching these infrastructural adjustments will serve as the ultimate stress test for evaluating the long-term institutional resilience of citizen-driven monetary systems.

7 Conclusion

Digital infrastructure, in the complementary currency field as in the broader digital economy, is not neutral. The choices made at the moment of adoption, the governance arrangements through which solutions are accessed and maintained, and the human and organisational conditions surrounding the transition all shape whether digitalisation serves the values a currency was created to embody or gradually erodes the autonomy needed to pursue them.

Path dependency in CC digitalisation is the progressive narrowing of institutional autonomy through decisions that did not present themselves as governance decisions at the time they were made. A currency that selects a payment solution based on peer recommendation, cost availability, or chance is not making a purely technical choice: it is setting the trajectory of its institutional autonomy for years to come. The integrations that accumulate, the switching costs that compound, and the knowledge asymmetries that solidify around whoever maintains the system all narrow the space of futures available to the organisation.

This paper has shown that the central governance challenge of CC digitalisation is not technology choice per se. It is the capacity of community-based organisations to retain

practical control over their monetary infrastructure as they scale. That capacity depends on the governance architecture of the arrangement, not the licence of the software. It depends on distributed knowledge and documented processes, not on the ideological commitment to open source. It depends on a sustainable business model, not on the availability of a subsidy. And it depends on the active, informed agency of the practitioners who design, manage, and coordinate these systems.

The digital space is another space where democratic practice must be considered and actively designed. Digital infrastructure can be managed as a commons, but only if the conditions for genuine commoning are in place: widespread information, real participation rights, and the displacement of gatekeepers. Where those conditions are absent, the digital layer becomes another mechanism through which power concentrates, dependency deepens, and the civic aspirations of complementary currency systems are quietly constrained.

8 Disclaimer on use of AI

Thematic coding was conducted by the researcher, assisted by an AI language model (Claude, Anthropic) for preliminary code identification and transcript formatting. All final tagging and validation decisions were made by the researcher.

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A LOCAL CURRENCY SUPPORTED BY A MUNICIPAL GOVERNMENT: CONTRIBUTIONS TO TERRITORIAL DEVELOPMENT AT THE CASE OF MARICÁ (R.J., BRAZIL)

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Abstract

Well known in France and in Brazil as artifacts built by associations whose relations with local governments are often tenuous (Blanc et al., 2023 ; Rigo et al., 2024), convertible local currencies (CLCs) field has presented a notable development: the implementation of cash transfer policies and basic income programs provided in CLCs, in a dozen cases in Brazil (Martins de Oliveira et al., 2022). The first historical case has been the Mumbuca currency since 2013, in the city of Maricá, located in western suburbs of Rio de Janeiro.

Given this context, a relevant question is related to the use of CLCs for cash transfer programs as a strategy to promote territorial development (Martins de Oliveira et al., 2022). Inspired by Torre (2019), Blanc et al. (2025) proposed a framework to analyze under what conditions CLC could support territorial development in the French context. For Torre (2025), the drivers of territorial development are production and territorial governance, both being

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underpinned by combinations of geographical and organized proximity. Blanc et al. (2025) showed that in the majority of cases French CLCs were not able to generate territorial development paths, due to the lack of efficient network building with territorial partners and the lack of impulse, if not support, from local governments (Blanc et al. 2025).

Blanc et al (2025) demonstrated that local authorities in France have little involvement in CLCs. In the French case, the relationship of CLCs to local authorities are also generally too limited to make them effective partners of territorial dynamics, which prevents CLCs from effectively contributing to territorial development. Despite the existence of these obstacles or limitations, it can be assumed that CLCs might support a territorial development strategy.

This paper investigates the dynamics of territorial development prompted by the CLC Mumbuca in Maricá. The case is indeed very different at first glance: a municipality-led scheme of more than 10 years marked by and acceleration of the program during the covid period, etc. We intend thus to analyze the consequences for territorial development paths of the Mumbuca case, from a mixed team of Brazilian and French scholars, and on the basis of a dozen interviews conducted mostly in Maricá.

The specific question guiding the paper is: in the CLC projects led or co-led by the local government, how does the presence of the latter affect the territorialized monetary infrastructure and territorial intermediation? Following Blanc et al. (2025), it will be analyzed how local governments affect rules, organizations and technologies. As for territorial intermediation, Blanc et al. (2025) depart from Bourdin et al. (2020) in order to establish functions that may be fulfilled by actors to contribute to territorial development. The present paper completes this framework, adding a sixth role, namely funding, to the five that are included in Bourdin and al. (2020): matchmaking, orchestrating, facilitating, mediating and innovating. Therefore, it will be analyzed how local government particularly affects the funding role, as well as the aspects of governance and territorialized monetary infrastructure, and consequently generate paths of territorial development.

Keywords – Municipal currency, basic income, institutionalization, Brazil, Mumbuca

1. Introduction: Recent Challenges Facing Banco Mumbuca's Sociotechnical Network

This paper represents a step forward in the research effort on the (Martins de Oliveira et al., 2022). Inspired by Torre (2019), Blanc et al. (2025) proposed a framework to analyze under what conditions CLC could support territorial development in the French context (figure 01).

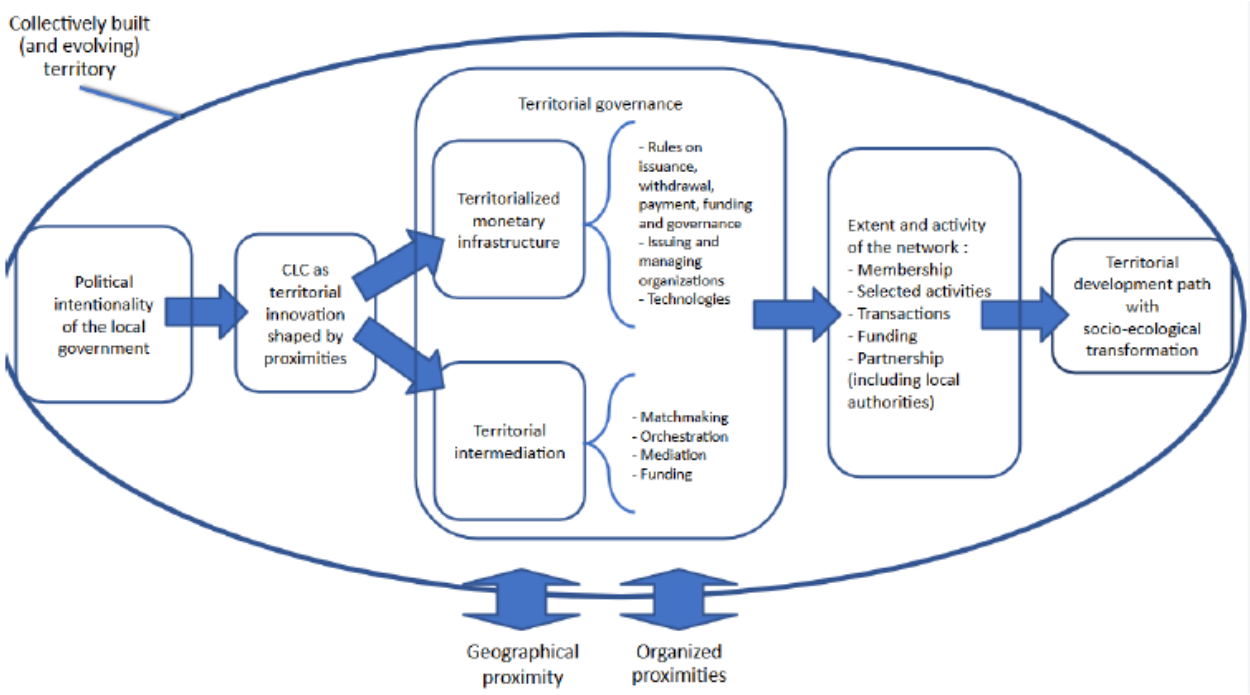


Figure 01. Blanc et al. (2025) framework

Here we investigate recent years episodes in the dynamics of territorial development prompted by the CLC Mumbuca in Maricá. The case is a municipality-led scheme of more than 10 years marked by an acceleration of the program during the covid period. We intend thus to analyze the consequences for territorial development paths of the Mumbuca case, from a mixed team of Brazilian and French scholars, and on the basis of interviews conducted with representatives of Banco Mumbuca (BCM), local government and Instituto E-Dinheiro Brasil. The specific question guiding the paper is: in the CLC projects led or co-led by the local government, how does the presence of the latter affect the territorialized monetary infrastructure and territorial intermediation?

Particularly in this paper, we will focus on relating our impressions from the interviews to some of the concepts presented in the framework by Blanc et al. (2025), namely, territorial

governance, territorialized monetary infrastructure and territorial intermediation - specially concerning the funding aspect.

In the context of Brazilian CLCs, what we might call the sociotechnical arrangement (Barinaga, 2025) of the Mumbuca currency stands out for several reasons, such as its scale, the actors involved, and the relationships among these actors.

The originality of the arrangement, which was established between 2017 and 2025, stems primarily from cash transfer programs for the local population. To make these payments, the contracted institution was the Instituto E-Dinheiro Brasil (IEB), affiliated with the Brazilian Network of Community Banks (BNCB), whose digital platform (E-Dinheiro) was launched in Marica in 2017. Also in 2017, the Mumbuca Community Bank Association (Banco Mumbuca) was formally established, with its own CNPJ[6] and formally independent from both the city government and the IEB itself.

E-Dinheiro's entry into Maricá allows the 2% sales fee collected in Mumbucas to be returned to the territory, in line with the practice agreed upon in the BNCB. These fees were previously collected by the IEB and transferred to Banco Mumbuca. With this transfer, the bank gains relative financial autonomy, begins granting microcredit to the population (with lines of credit for the solidarity economy and for home renovations, for example), and acquires a building for its headquarters.

Inspired by the Maricá model, other municipalities (particularly in the state of Rio de Janeiro during the COVID-19 pandemic) implemented similar practices, though with significant differences. Some initiatives do not charge fees or do not use them for reinvestment in the community. Others also support solidarity economy initiatives in the community, but with important differences. Niterói is one of them: in its model, the fees are managed by a local solidarity economy council, composed of representatives from city hall and civil society. Without implementing microcredit or a legally independent community bank[7], the Niterói initiative began in 2021 and has been issuing public calls for proposals to support solidarity economic initiatives in the region (from 2023 on). Both models (Maricá and Niterói) are

[6] CNPJ stands for Cadastro Nacional de Pessoas Jurídicas in Brazil (National Register of Legal Entities).
[7] The city of Niterói has been home to the Banco Comunitário do Preventório since 2011, and its social currency, Prevê, was widely used (between 2011 and 2016). However, the bank does not have a partnership with the city government. The municipal currency, Arariboia, began operating in 2021 with no operational relation to Banco Preventório.

identified by Faria et al. (2026) as distinct yet closely related alternatives to the solidarity economy.

These differences proved to be fundamental in the disputes between the two municipalities and the Tribunal de Contas do Estado do Rio de Janeiro (TCE)[8], which are central to our analysis in this article. The TCE challenged the collection of these fees, arguing that they were levied on funds that were originally public. In Niterói, the TCE accepted the justification provided by the IEB and the local city government, that the fees were earmarked for the solidarity economy council, a body established by municipal law and subordinate to the city government. In the case of Marica, however, Banco Mumbuca ((BCM)) had no formal contract with either the local city government or the IEB. The alternative found in the local arrangement was to transfer the IEB fees to Banco Mumbuca through donations (according to a BCM representative). However, this solution was not well received by the TCE, and the IEB stopped collecting them in 2022.

The formal autonomy achieved through the Banco Mumbuca Association, as well as the financial autonomy made possible by the fees donated by E-Dinheiro, thus suffered a major setback in BCM's recent history. Without the monthly fees coming into its coffers, Banco Mumbuca halted the issuance of new loans. The microcredit program has been suspended. Disagreements over resolving the impasse with the TCE (which we will examine below) gradually compounded dissatisfaction with the platform and data sharing (according to a representative of Banco Mumbuca). In 2025, Washington Quaquá—the mayor who had implemented the currency experiment in Marica—returned to the local government. In September 2025, the City of Marica unilaterally terminated its contract with the Instituto E-Dinheiro Brasil and entered into an emergency contract with Banco Mumbuca. Banco Mumbuca, in turn, contracted a company to manage the new Mumbuca currency platform.

2. Four analytical perspectives and the different viewpoints on E-Dinheiro and Banco Mumbuca

Based on the analysis of the situation described above—including the challenges and recent changes faced by the Mumbuca currency network—we conducted interviews with

[8] It is a public institution which does not belong to any of the three traditional branches of government (Executive, Legislative, or Judicial), but acts as an autonomous body that assists the Legislative Branch in external oversight.

stakeholders involved with the IEB (two) , Banco Mumbuca (two), and the city government (one). As a result, we propose four empirical areas of interest for our research, namely: royalties and funding sources, local government, the digital platform, and microcredit. Next, we will describe the main issues observed in each of these areas, in light of the scenario described above and the interviews conducted. Subsequently, we will briefly relate these observations to Blanc's (2025) framework.

2.1 Royalties, cash transfers, and sources of funding and territorial development

All interviewees acknowledge Maricá's heavy reliance on oil royalties and the city government's political decision to use a portion of those funds for an cash transfer program in Convertible Local Currencies (CLC).

For a E-Dinheiro representative, the most immediate risk is political, as he believes that the current mayor (Quaquá) is promoting a "drastic" shift by reducing the number of beneficiaries and questioning the "Basic Income" concept, thereby jeopardizing the program's philosophy. One hypothesis to be investigated in this regard is the national political conflict between the center-left (represented by the Workers' Party) and the far right, which is highly critical of income transfer policies. The mayor's stance may indicate an attempt to respond to such criticism.

However, a Banco Mumbuca interviewee understands that the greatest risk lies in the finite nature of royalties, and that mitigating these risks would require a long-term strategy from Banco Mumbuca. This would come from various initiatives, such as managing the municipal payroll and developing its own platform to replace E-Dinheiro, which we will discuss later. She[9] explains that the circulation of the currency and the 2% fee generated revenue (R$ 600,000 per month), the interruption of which harmed microcredit and forced BCM to tighten its belt.

For his part, E-Dinheiro representative separates the digital platform from the suspension of the fees. He explains that the TCE-RJ challenged the collection of the 2% fee from merchants because the fee was not provided for in municipal law. This led to the suspension of the fee in 2023 and the TCE's retroactive demand for the return of millions of reais. This revenue was

[9] In this article, we refer to the interviewees using the feminine gender form.

vital for microcredit, which would depend on the mayor's promise to inject R$90 to 100 million into the bank for this purpose.

2.2 Local Government and Territorial Development

According to a E-Dinheiro interviewee, the municipal government, in practice, ends up promoting a centralized political control, like an "emperor" who dictates the rules and is responsible for defining the philosophy and controlling Banco Mumbuca. In his view, the municipal government has chosen not to resolve regulatory conflicts (for example, regulating the issue of fees). In this sense, there are indications of relative "political capture". BCM is said to be "extremely politicized" and controlled by the dominant political group within the local government, aligned with political objectives such as the mayor's national profile. The risk here is the loss of the concept of a solidarity economy in favor of electoral objectives.

Banco Mumbuca's perspective is different. The local government is viewed as a key partner and the BCM's primary funder. In addition to being responsible for founding the bank (within the Secretariat for Human Rights), it also provides operational support by funding it through a partnership agreement (at the time of the interview, with E-Dinheiro), including the payment of staff salaries. The role of the local government was even part of their plans (at the time of the interview) to use the BCM as a "local savings bank," injecting funds into large-scale credit lines. Thus, there would be no "political capture," but rather a "very close political relationship" and an "umbilical" link between the BCM and the local city government, even though the BCM is an integral part of civil society.

2.3 Technological Platform and Territorial Development

A E-Dinheiro representative expresses concern that, with the replacement of the E-Dinheiro platform, the platform's operating model might change—shifting from a focus on local economic development, in line with the solidarity economy, to a model in which the pursuit of profit predominates. Ultimately, the currency would be transformed into a mere social benefit paid by a large corporation, which could eliminate the complexity of local circulation and undermine the credibility of the concept of social currency in Brazil.

A BCM interviewee states that there is no indication that Banco Mumbuca will become a profit-driven entity. However, she admits that the new "proprietary platform" incorporates

market-based features ("like a Nubank[10], but a 'good' Nubank") and allows for commercial expansion (Pix[11], bill payments) beyond Maricá, indicating a hybrid model. The impact of the platform change is viewed as positive, as it aims to enhance the ability to achieve social objectives.

In Banco Mumbuca perspective, the proprietary platform will encourage recirculation through cashback and equitable fee structures (differentiated rates for small and large merchants). This feature would aim to generate revenue and enable the Bank to resume its social initiatives and lending activities. The interviewee states that, for BCM, financial objectives are aligned with social ones through the pursuit of operational sustainability. The new platform would thus aim to "monetize its power and generate revenue for the bank" in order to retain employees and resume training, incubation, and sponsorship initiatives. Technological independence would offer the flexibility to create features that foster a solidarity-based economy (e.g., cashback).

A E-Dinheiro representative, in turn, states that, from the perspective of the E-Dinheiro platform, financial objectives (revenue) are aligned with social ones, since the IEB is a nonprofit organization. Its goal is to sustain the Brazilian Network of Community Banks and ensure that they preserve their civil society character. The potential conflict would stem from the local manager's new political vision.

2.4 Microcredit, Civil Society, and Territorial Development

Como indicado brevemente na seção anterior, o E-Dinheiro, o microcrédito e a autonomia formal do Banco Mumbuca chegam à rede de Marica quase que simultaneamente, em 2017. A definição e implementação das linhas de microcrédito conformaram um dos principais eixos de diálogo do Banco Mumbuca com a sociedade civil de Maricá, na medida em que o Banco promovia rodas de conversa com a população para explicar o processo de empréstimo e para ouvir demandas por microcrédito.

As briefly mentioned in the previous section, E-Dinheiro, microcredit, and Banco Mumbuca's formal autonomy arrived in the Maricá network almost simultaneously in 2017. The design and implementation of microcredit programs formed one of the main pillars of Banco Mumbuca's dialogue with Maricá's civil society, as the bank organized community

[10] Nubank is a brazilian fintech.
[11] Pix is a brazilian public payment platform.

meetings with residents to explain the lending process and to hear requests for microcredit - there are also other ways in which the bank interacts with society, such as fostering productive groups and supporting projects.

For a BCM representative, the bank itself actively functions as a civil society institution engaged in territorial development. BCM is also said to be highly effective in working with local collectives, residents' associations, market vendors, and the incubation of cooperatives. It uses its headquarters to serve the community and continues to promote social initiatives, although she acknowledges that its territorial reach is limited outside the main headquarters.

A E-Dinheiro representative holds the opposite view. According to her, there is a "total absence of independent civil society" in the Maricá project. Although the region has experienced economic development, it was the result of centralized action by the political group, not of an autonomous civil society. An independent governing council is lacking. In this view, E-Dinheiro would be an exception, as it has resisted co-optation—in the sense that the IEB is an organization linked to a social movement (the BNCB) and is, in fact, independent of the local government.

3. Initial considerations in dialogue with the theoretical framework

The four empirical areas presented above simultaneously cut across the three dimensions of the theoretical framework with which we began our research, namely—in brief—monetary infrastructure, territorial intermediation, and governance (BLANC et al., 2025).

Although the monetary infrastructure has proven robust in Maricá, it has faced significant recent challenges, culminating in the migration of the E-Dinheiro platform to a new (and uncertain) configuration. The Mumbuca case, on the one hand, shows that E-Dinheiro was fundamental to the expansion of the local currency, but on the other hand, it raises questions about whether the platform change will also entail institutional change. In other words, we are referring to the threat of "mission drift" toward a predominance of market logic at the expense of the principles of the solidarity economy.

Another perspective suggests that the platform change could foster greater technological autonomy and the possibility of product diversification. Although the Banco Mumbuca Association's desire for greater autonomy (including with regard to the technological

platform) and for a clearer (and contractually defined) role is entirely justifiable, as of this point in the research, it has not been possible to gather evidence that the platform will be "its own platform" (belonging to BCM)—in reality, it belongs to a company under contract with BCM.

The aforementioned issue also relates to the governance. BCM itself admitted that, despite disagreements with the IEB and the desire to improve the platform and gain more autonomy, the decision to unilaterally terminate the contract was made by City Hall ("we were caught by surprise"), which led to an emergency operation to facilitate the transition between platforms. This incident itself points to Banco Mumbuca's heavy dependence on the City Government's decisions.

Such political dependence carries risks: on the one hand, what we might call "political capture," and on the other, the reversibility of the process in possible change in local government leadership. In this sense, the perspectives presented by our interviewees can be seen as complementary: the state's capacity (resources and scale) resulting from the integration between Banco Mumbuca and City Hall is compounded by a relative political centralization (and capture), and the fragility of independent civil society.

From the perspective of territorial intermediation, we draw attention to the role of the funder (BLANC, 2025). In short, the situation in Maricá involves the use of royalties allocated to cash transfer programs paid in local currency (Mumbuca), generating local economic circulation and strengthening local commerce. In this regard, the views presented by the interviewees concerning the local government as a funder also seem complementary to us: both the threat of political risks (for example, decisions to reduce cash transfer programs) and the threat of the finite nature of royalty revenues seem quite plausible to us.

Additionally, from the perspective of the fees as promoters/funders of Banco Mumbuca's microcredit program (as a civil society association), we noted the risk that the legal controversy regarding the collection of fees—arising from the Tribunal de Contas do Estado (TCE) disagreement with the arrangement prior to the breakdown between the City Hall and E-Dinheiro—might remain unresolved. It is worth noting that, as of the writing of this paper, despite the change in digital platform, this dispute had not been resolved, nor had any other form of direct funding from the local government been initiated to restart the microcredit program in Maricá.

4. Concluding remarks

This paper is part of an effort to analyze the use of convertible local currencies (CLCs) for cash transfer programs as a strategy to promote territorial development. Here, we examined the case of the Mumbuca currency, and in particular its transformations over the past 10 years.

We did so based on interviews with key actors associated with Banco Mumbuca, the Instituto E-Dinheiro Brasil, and the Maricá municipal government. We used four analytical dimensions to initially organize our impressions of the interviews and the different perspectives expressed therein. They were all connected to territorial development: royalties, cash transfers, and sources of funding; local government; technological platform; and finally microcredit and civil society

Finally, we started to relate these dimensions and considerations to elements of the framework proposed by Blanc et al. (2025), namely, monetary infrastructure, territorial intermediation, and governance.

We believe that future research should conduct follow-up interviews and monitor developments such as: the implementation of the new platform; the resolution of the dispute over fees; the resumption of the microcredit program; and the relationships between Banco Mumbuca, the city government, and the new digital platform.

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THE INNOVATIVE DIMENSION OF THE SOLIDARITY ECONOMY: THE ARARIBÓIA SOCIAL CURRENCY IN NITERÓI, RIO DE JANEIRO

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Abstract

The research identified a normative innovation of great impact: the possibility of combining the Araribóia benefit with the Continuous Cash Benefit (BPC), established by Municipal Law No. 3,972/2024. This measure corrects a historical distortion in the Brazilian protection system, which traditionally counts the value of the BPC in the calculation of family income, hindering access for elderly people and people with disabilities to other benefits. Program data reveal that, as of April 2025, Niterói was the only municipality in Brazil with this inclusive provision. Quantitative findings demonstrate the program's reach: it covers 68.5% of families registered in CadÚnico in Niterói, benefiting approximately 31,000 families by the second semester of 2022. The socioeconomic profile indicates strong targeting of vulnerability: 74.5% of household heads are women (50.1% Black), with an average family income of R$296.22, concentrated territorially in the Northern Region of the municipality, the area with the lowest per capita income. The study concludes that the Araribóia Social Currency represents an innovative triple articulation: (1) in solidarity economy, through public funding calls; (2) in social assistance, via integration with federal policies such as

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the BPC; and (3) in territorial development, by stimulating local economic circuits. The experience offers a replicable model of self-sustainable municipal policy that overcomes the dichotomy between social compensation and economic development, positioning itself at the forefront of innovations in Brazilian federalism.

Keywords: *Basic income, inequality, social justice, municipal currencies, solidarity economy*

Resumo

A pesquisa identificou uma inovação normativa de grande impacto: a possibilidade de acumulação do benefício da Araribóia com o Benefício de Prestação Continuada (BPC), estabelecida pela Lei Municipal nº 3.972/2024. Esta medida corrige uma distorção histórica do sistema de proteção brasileiro, que tradicionalmente computa o valor do BPC no cálculo da renda familiar, prejudicando o acesso de idosos e pessoas com deficiência a outros benefícios. Os dados do programa revelam que, até abril de 2025, Niterói configurava-se como o único município do Brasil com esse dispositivo inclusivo. Os achados quantitativos demonstram a abrangência do programa: atinge 68,5% das famílias cadastradas no CadÚnico em Niterói, beneficiando aproximadamente 31 mil famílias já no segundo semestre de 2022. O perfil socioeconômico indica forte focalização na vulnerabilidade: 74,5% dos responsáveis familiares são mulheres (50,1% negras), com renda média familiar de R$296,22, concentrando-se territorialmente na Região Norte do município, área de menor renda per capita. O estudo conclui que a Moeda Social Araribóia configura uma tríplice articulação inovadora: (1) na economia solidária, através dos editais de fomento; (2) na assistência social, mediante integração com políticas federais como o BPC; e (3) no desenvolvimento territorial, por meio do estímulo a circuitos econômicos locais. A experiência oferece um modelo replicável de política municipal autossustentável que supera a dicotomia entre compensação social e desenvolvimento econômico, posicionando-se na vanguarda das inovações no federalismo brasileiro.

Palavras-chave: *renda básica, desigualdade, justiça social, moedas municipais, economia solidária*

Introduction

The trajectory of social policies in Brazil after 1988 provides a privileged lens through which to examine the transformations in the role of the State and federative entities in addressing social inequalities. The 1988 Federal Constitution, by establishing a new federative pact, promoted significant political-administrative decentralization, assigning municipalities specific responsibilities in the social sphere and creating mechanisms of popular participation that reshaped relations between State and society (Brasil, 1988). This process, however, unfolded unevenly: while some municipalities developed institutional capacity to design innovative policies, others remained dependent on federal and state transfers, highlighting the asymmetries of Brazilian federalism (Arretche, 2010).

In the field of income transfer policies, a gradual municipalization of programs complementary to Bolsa Família has been observed, particularly since the 2000s. Niterói, a municipality in the metropolitan region of Rio de Janeiro, stands out for implementing, since 2013, a municipal income transfer program that preceded and laid the groundwork for the creation of the Araribóia Social Currency in 2021 (Fernandes et al., 2023), the focus of this study. This trajectory reflects both the municipality's fiscal capacity, among the highest per capita revenues in the state of Rio de Janeiro, and its tradition of innovation in social policy, exemplified by initiatives such as Lab.Nit, a public innovation laboratory aimed at rethinking policy design through enhanced citizen participation (Teixeira, 2023).

Following this pattern of innovation, the distinctive feature of the policy under analysis lies in the articulation between the Araribóia Social Currency and solidarity economy initiatives. In this point, it is important to establish what we understand as innovation. As Hartley (2005) argues, innovation in the public sector is characterized by the creation of novel practices, processes, or institutional arrangements that generate public value and respond to complex social challenges. In a nutshell, public innovation is not simply the introduction of new administrative routines or incremental adjustments to existing programs. It involves rethinking the role of the State and its relationship with citizens, often through participatory governance, new forms of service delivery, or hybrid institutional designs that transcend traditional bureaucratic models.

Innovation must also be understood in relational terms: innovation for whom and to what end. Mulgan and Albury (2003) emphasize that genuine innovation occurs when public

action produces measurable improvements in outcomes for citizens, particularly marginalized groups, rather than merely enhancing internal efficiency. In this sense, innovation is distinguished from administrative adaptation by its capacity to alter the logic of policy intervention—shifting from compensatory measures to strategies that integrate redistribution, empowerment, and local development.

Criteria that distinguish innovation from mere adaptation include: (i) novelty in design or governance arrangements; (ii) capacity to generate social inclusion and equity beyond existing frameworks; and (iii) sustainability through institutionalization rather than temporary fixes (Osborne & Brown, 2011). Thus, innovation in public policy is defined not only by originality but by its transformative impact on the relationship between State, society, and territory, creating new pathways for collective well-being.

Within the scope of social assistance, the Araribóia Social Currency is notable for adopting a more inclusive approach by allowing accumulation with the BPC, as established by Municipal Law No. 3.972/2024. This normative innovation addresses a gap in Brazil's protection system, which traditionally counts the BPC in family income calculations, thereby restricting access to other benefits for elderly and disabled individuals who were unable to contribute during their lifetimes. In this way, the municipal policy seeks to mitigate overlapping vulnerabilities, aligning with the national assistance system in poverty reduction.

Against this backdrop, the Araribóia Social Currency consolidates itself as a concrete expression of Niterói's capacity for public policy innovation, engaging with a broader movement of re-signifying social policies in Brazil after the 2015 crisis. As Lavinas (2017) argues, this period was marked by a shift in social protection strategies, with growing emphasis on mechanisms that combine monetary transfers with the stimulation of local economic activity. In this sense, Niterói's experience represents an attempt to overcome the dichotomy between compensatory policies and economic development, integrating solidarity economy, food security, and productive inclusion into a single instrument (Singer, 2002; Ipea, 2017).

The present article aims to trace the trajectory of the Araribóia Social Currency in Niterói, from its inception to its operationalization, as expressed in its normative framework (Municipal Law No. 3621, July 30, 2021), to understand its institutional design and its connections with the solidarity economy agenda. The relevance of this study lies in the

debate on municipal innovation capacity within Brazilian federalism, a theme that gained renewed attention after the Covid-19 pandemic (Souza, 2020). Furthermore, it offers an analysis of a little-studied instrument (municipal social currencies) whose understanding is essential for evaluating alternatives to traditional income transfer policies.

Methodologically, the research combines documentary analysis (Law No. 3.473/2020, Law No. 3.621/2021, and Law No. 3.972/2024) with a literature review on solidarity economy and municipal social policies. Search strategies included platforms such as SciELO, Ipea Repository, and Google Scholar, using descriptors such as "solidarity economy," "social currency," and "Niterói." Beyond the introduction, the article is organized into three sections: the first section focuses on the program itself, addressing its legal framework (Municipal Law No. 3.473/2020 and Law No. 3621/2021) and operational aspects. The second section presents an analysis based on secondary studies, situating Niterói's experience within the broader debate on innovation and solidarity economy. Finally, the concluding remarks synthesize the arguments developed throughout the article, based on the data gathered and analyzed through the proposed methodology.

The central hypothesis advanced here is that the Araribóia Social Currency represents progress in the municipalization of redistributive policies, insofar as it institutionalizes an innovative instrument that combats poverty without conditionalities, linking economic and social development with a territorial focus. The analysis of this case thus offers insights into the limits and possibilities of municipal action in poverty reduction and the promotion of solidarity economy.

From Niterói's Emergency Social Policies to the Araribóia Program

This section presents a brief overview of Niterói's income transfer policies, reconstructing the evolution and context that led to the creation of the Araribóia Social Currency. In response to the social and health emergency caused by Covid-19, which heightened the vulnerability of many families, the municipality implemented in 2020 two complementary income transfer programs: *Temporary Basic Income* and *Active Search*. Although designed as emergency measures, these initiatives laid the groundwork for the subsequent Araribóia Social Currency Program, as they targeted populations similar to those later included in the policy (Niterói, 2021).

Conceived to mitigate the impacts of the pandemic, these programs provided financial support to low-income families and micro-entrepreneurs, operating in parallel with the federal *Emergency Aid* program (Niterói, 2021). Established by Municipal Law No. 3.480 of March 31, 2020, the *Temporary Basic Income* program represented an immediate response to the social crisis. According to the *Final Report of the Executive Evaluation of the Araribóia Social Currency Program* (2024), the benefit was directed to families registered in *CadÚnico* and classified as socially vulnerable. Implementation occurred through prepaid cards restricted to essential establishments (markets and pharmacies). This experience informed the later design of the Araribóia program, particularly regarding targeting mechanisms and benefit operations (Britto; Bridi; Fernandes; Waltenberg, 2024).

Complementing the *Temporary Basic Income*, the municipality created the *Active Search* program through Municipal Law No. 3.485/2020, enacted on April 9, 2020. This initiative specifically targeted informal workers whose activities were severely affected by pandemic restrictions, covering a wide range of vulnerable occupations such as street

vendors, artisans, and solidarity economy workers. Eligibility criteria were structured around two main axes: workers were required either to have their registration updated with the relevant municipal departments or to operate under formal authorization from the municipality; for activities not meeting these conditions, proof of residence in Niterói was required. Both programs (*Temporary Basic Income* and *Active Search*) remained in effect from April 2020 to December 2021.

The design of these emergency policies, their eligibility criteria, targeting strategies, and verification mechanisms, provided the material foundation for the subsequent implementation of the Araribóia Social Currency. Moreover, as highlighted by IPEA (2021), these initiatives demonstrated the municipality's capacity to develop agile and tailored responses to diverse profiles of socioeconomic vulnerability.

At the legislative level, Niterói established the *Municipal Policy for Popular Solidarity Economy*, which laid the foundation for Law No. 3.621 of July 30, 2021. This law created the *Municipal Program for Solidarity Economy, Poverty Reduction, and Socioeconomic Development*. The legal framework for solidarity economy emerged as one of the outcomes of *Niterói Que Queremos – NQQ (2013–2033)*, a strategic plan developed during the 2013 administration of then-mayor Rodrigo Neves (PDT-RJ), approved in January 2020 through Law No. 3.473. The *Municipal Policy for Popular Solidarity Economy* aims to integrate

broader strategies of social and solidarity-based development in a fair and sustainable manner.

Within this context, on June 17, 2021, the first step toward the creation of the Araribóia Social Currency was taken. Among its justifications was the strategy of establishing a social currency to stimulate endogenous markets, valorize local production, and align with the principles of solidarity economy advocated by Singer (2002) and Gaiger (2004).

Legal and Operational Framework of the Program

The case of the Araribóia Social Currency has attracted attention in secondary studies as an example of how municipal innovation can reshape redistributive policies. Scholars highlight that its formulation resulted from a favorable institutional arrangement, combining fiscal capacity, the emergency context of the pandemic, and Niterói's tradition of social innovation. As Arretche (2010) suggests, this process illustrates an expansion of municipal autonomy within Brazilian federalism, where local governments assume a leading role in designing social protection policies rather than merely executing federal programs.

The institutional design of the Araribóia Social Currency Program is anchored in a set of municipal laws that progressively structured its implementation. Municipal Law No. 3.473/2020 established the *Municipal Policy for Popular Solidarity Economy*, while Law No. 3.621/2021 created the *Municipal Program for Solidarity Economy, Poverty Reduction, and Socioeconomic Development*. Later, Law No. 3.694/2022 consolidated the program's legal framework, ensuring continuity and expansion (Britto; Bridi; Fernandes; Waltenberg, 2024).

The program is guided by four basic principles: (i) the use of *CadÚnico* as the basis for defining beneficiaries; (ii) provision of a complementary benefit to those already receiving federal or state transfers; (iii) openness to future incorporation of other benefits; and (iv) parity of the Araribóia with the Brazilian real (Fernandes et al., 2023). Initially set at 90 araribóias, the benefit was increased to 250 in February 2022, with additional increments per family member up to six beneficiaries. A 5% adjustment in April 2024 further updated the values, ranging from R$308 for single-member households to R$868 for families of six.

Eligibility criteria, defined by Law No. 3.621/2021, require active registration in *CadÚnico*, proof of residence in Niterói, and classification within poverty (up to R$436 per capita) or extreme poverty (up to R$218 per capita). Continued participation depends on maintaining

these conditions, with suspension foreseen in cases of income improvement, relocation, inconsistencies, or fraud. This ensures that benefits are directed to families in greatest need.

Operationally, the program reflects a hybrid governance model. Management is centralized in the Municipal Secretariat of Social Assistance and Solidarity Economy, while implementation is carried out by the Araribóia Community Bank and the E Dinheiro Institute. This networked governance structure combines state oversight, civil society participation, and technological infrastructure. By restricting circulation to Niterói and maintaining parity with the real, the program strengthens targeting and sustainability, though it also raises challenges of autonomy and transparency.

The institutionalization of solidarity economy through municipal programs such as Araribóia raises both opportunities and tensions. Gaiger (2004) highlights its transformative potential when rooted in collective organization and autonomy yet warns that state-led institutionalization can dilute its emancipatory character. Lavinas (2017), in turn, critiques the risk of reducing solidarity economy to compensatory transfers, arguing that without structural change it may reinforce dependency rather than empowerment.

Laville (2010) adds that solidarity economy must be understood as a plural economy, where market, state, and community logics coexist, but also compete. From this perspective, the local financialization of solidarity circuits, through social currencies and community banks, creates new spaces for redistribution but also exposes them to risks of cooptation, bureaucratization, and dependence on political cycles. Thus, innovation in this field is characterized by the ability to preserve autonomy and ensure sustainability, beyond the creation of new instruments.

In sum, the legal and operational framework of the Araribóia Social Currency demonstrates how municipal innovation can institutionalize redistributive policies that integrate income transfer, digital inclusion, and local economic development. Niterói's experience highlights the potential of municipalities to move beyond emergency response.

Innovation and Social Currency

The Araribóia Social Currency did not emerge in a political or conceptual vacuum. Its design reflects a broader historical trajectory of Brazilian social policies and the maturation of

alternative approaches to traditional economic development. The experience in Niterói can be understood through three interconnected dimensions: solidarity economy, basic income, and municipal social currencies.

Solidarity emphasizes collective organization and community protagonism, privileging social needs over individual profit accumulation (Singer, 2001; Ipea, 2020).

Basic income, in contrast, refers to a universal, unconditional, and regular monetary transfer aimed at guaranteeing a subsistence floor for all individuals, regardless of labor market participation (Lavinas, 2017). While both share the goal of promoting social justice, they differ in their operational logic: solidarity economy transforms production relations through self-management, whereas basic income operates via direct transfers financed by the State.

Social currencies represent the convergence of these agendas. Community currencies typically arise from grassroots initiatives to strengthen local exchanges and prevent resource leakage (Blanc, 2011; Freire, 2011). Municipal social currencies, such as Araribóia, differ by being formal public policies institutionalized by local governments. Unlike pioneering community experiences such as Banco Palmas, Araribóia is a permanent income transfer program executed by the municipality of Niterói through its Secretariat of Social Assistance and Solidarity Economy (Fernandes et al., 2023). This institutionalization highlights the role of the local State as a promoter and financier of solidarity economic circuits.

Innovation is evident in several aspects. First, the program integrates redistributive transfers with territorial development by restricting circulation to local businesses, thereby reinforcing endogenous economic dynamics. Second, it introduces a normative breakthrough by allowing accumulation with the BPC, expanding protection for elderly and disabled individuals. It makes Niterói the only municipality in Brazil (until April 2026) to allow accumulation without conditionalities. This measure corrected a historical distortion in Brazil's welfare system, where the BPC was counted in family income calculations, often excluding households from Bolsa Família. By recognizing that the BPC alone is insufficient to sustain entire families, the program expanded protection for individuals in vulnerable contexts.

Third, its financing model (based on a 2% administrative fee on transactions) creates a self-sustaining mechanism that reinvests resources into solidarity enterprises through annual funding calls of R$2 million. This hybrid architecture combines state regulation, community participation, and technological infrastructure. The program is managed by the municipal secretariat, operationalized by the Araribóia Community Bank and the E-Dinheiro Institute, and embedded in a governance network that balances redistribution, digital inclusion, and local development.

As highlighted in recent studies, the Araribóia Social Currency represents a "triple articulation": (1) solidarity economy, through public funding calls; (2) social assistance, via integration with federal policies such as the BPC; and (3) territorial development, by stimulating local economic circuits and generating employment and income. Besides, by early 2022, the Social Currency reached 31,000 families, injecting around R$ 135 million annually into the local economy. In 2023, the program expanded to 37,000 families, with an annual budget of R$ 200 million and a recorded circulation volume of R$ 257 million in local businesses. By 2025, the program had grown further to 45,000 families, with an annual budget surpassing R$ 240 million. These figures, drawn from official municipal sources and local press, demonstrate the program's innovative capacity: it is not only a social transfer policy but also a territorial development tool, channeling resources directly into local commerce and reinforcing solidarity economy circuits. The scale of beneficiaries, the sustained budgetary allocation, and the measurable circulation volume distinguish Araribóia from mere administrative adaptations, positioning it as a replicable model of municipal innovation in Brazil (Niteroi, 2025).

The emergency programs implemented in Niterói during the Covid-19, crisis Temporary Basic Income and Active Search, can be interpreted not only as reactive measures but as institutional experiments that opened space for innovation. As Kingdon (1995) suggests, crises often function as "windows of opportunity" for policy change, allowing municipalities to test new instruments that may later become permanent. In this sense, the transition from temporary aid to the Araribóia Social Currency illustrates a trajectory of incremental innovation, where short-term responses were transformed into structural mechanisms of redistribution.

Yet, to characterize these measures as innovation rather than mere administrative adaptation, it is necessary to establish analytical criteria. Hartley (2005)

argues that public innovation is defined by novelty, effectiveness, and the creation of public value, while Mulgan and Albury (2003) emphasize its capacity to improve outcomes for citizens, particularly vulnerable groups. Applying these perspectives, Niterói's initiatives stand out because they did not simply replicate federal transfers but reconfigured them through local governance, digital inclusion, and solidarity economy principles.

The criteria of novelty (a municipal social currency), inclusiveness (integration with BPC), and sustainability (financing through transaction fees) distinguish innovation from routine adaptation. Furthermore, the dialogue between authors such as Singer (2001), who highlights the transformative potential of solidarity economy, and Lavinas (2017), who critiques the limitations of compensatory transfers, reveals the hybrid nature of Araribóia. The program synthesizes redistributive logic with developmental strategies, positioning itself at the intersection of social protection and territorial development. In short, Araribóia is not merely a transfer program. It is an institutional innovation that synthesizes different models, acting simultaneously as a redistributive instrument, a mechanism for strengthening solidarity economy, and a tool for territorial development. This originality, along with its challenges, positions Niterói at the forefront of municipal innovation in Brazilian federalism.

Final Considerations

This article analyzed the Araribóia Social Currency as an innovative public policy within the framework of Brazilian federalism, examining its institutional design and mechanisms of articulation between income transfer, solidarity economy, and local development. The study demonstrated that the program represents a significant innovation in the municipalization of social policies by overcoming the traditional dichotomy between compensatory measures and economic development strategies.

Debates on solidarity economy and social currencies have increasingly gained public relevance in Brazil. The recent approval of Bill No. 4476/2023 by the Finance and Taxation Committee of the House of Representatives, which establishes a regulatory framework for social currencies, marks an important step toward the recognition and expansion of initiatives such as the Araribóia. Developed with the participation of the Ministry of Labor and Employment through the Senaes, this framework provides legal security by defining

clear rules for issuance, transactions, and certification of community banks, which must be registered in the Cadsol (National Registry of Solidarity Economy Enterprises).

Within this national context of institutionalization, Niterói's solidarity economy funding calls gain renewed significance, demonstrating alignment between local innovation and the construction of a favorable regulatory environment for strengthening solidarity economic circuits. Among the Brazilian municipalities that have implemented social currencies, Niterói stands out for its unique institutionalization of regular funding calls, with an annual budget allocation of approximately R$2 million, largely financed by the Araribóia Social Fund through a 2% administrative fee on transactions. This arrangement ensures not only financial sustainability but also systematic reinvestment in local solidarity enterprises.

Another substantive innovation lies in the program's federative articulation, particularly the legal provision allowing accumulation of the Araribóia benefit with the BPC. This measure corrects a structural distortion in Brazil's welfare system, which traditionally counted the BPC in family income calculations, thereby excluding vulnerable elderly and disabled individuals from other benefits. By adopting a more inclusive perspective, the municipal policy mitigates overlapping vulnerabilities and advances the construction of a more integrated social protection system.

The Araribóia experience thus reveals a threefold innovation: (1) in solidarity economy, through funding calls that operationalize national principles at the local level; (2) in social assistance, by integrating with federal policies such as the BPC and expanding protection for vulnerable groups; and (3) in territorial development, by stimulating local economic circuits and generating employment and income.

Although challenges remain, particularly regarding governance and digital inclusion, the Araribóia Social Currency consolidates itself as a paradigmatic reference for municipal innovation in public policy. Its ability to integrate solidarity economy, social protection, and local development, sustained by a financially self-sufficient model, offers valuable insights for replicating similar experiences in other Brazilian municipalities.

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EXPLORING THE POTENTIAL OF BLOCKCHAIN TECHNOLOGY FOR COMMUNITY CURRENCIES: THE CASE OF OURVILLAGE IN CAMEROON

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Abstract

Though blockchain-based community currencies enjoy increasing popularity, they are still an underexplored topic, which is reflected in the very limited amount of academic literature devoted to it specific features. This paper examines the potential of blockchain technology for the implementation of community currencies in general and in the "OurVillage" project in Cameroon in particular. The specific features of decentralisation, transparency and immutability and thus data security due to its ledger and consensus mechanism make the Blockchain technology particularly appropriate for the application within community currency systems. We show that blockchain-based community currencies offer various potentials, inter alia its integrity, its inclusiveness, its lower transaction costs, and its simultaneous immutability and flexibility in order to prevent technological obsolescence. We identify blind spots in literature on blockchain-based community currencies such as long-term sustainability considerations or strong conceptual issues related to the design and its specific features, principles and rules which influence voice, participation, distribution of benefits and the empowerment of community members and civil society. We also indicate challenges of blockchain-based community currencies arising from the specific technology and its regulation, e.g. interoperability with other networks, scalability,

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exposure of sensitive information to the network and definition of data-sharing protocols, but also the necessary regulatory compliance and the creation of a risk management strategy. Finally, the user-friendliness in form of handling and user interface of the community currency are major drivers for the inclusion of a diverse user base comprising also households with only limited technological proficiency.

Keywords: Blockchain, crypto currencies, digital community currencies, scalability, interoperability, risk management strategy, sustainability, empowerment, Cameroon

JEL codes: B59, E41, E42, E51, G28, F 63, P44

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Table A3 Selected blockchain-based community currencies

1 Introduction

A community currency is a type of currency used only within a particular community or locality and is designed to support local trade, induce economic activities, create new opportunities for local businesses, thus enhances economic development and strengthens linkages and interactions between members of the community. Community currencies are typically created and managed by members of the respective community, rather than by central banks or other traditional financial institutions (Community currencies can take many different forms; in the past it had been mainly physical tokens and local paper currencies allowing members of the community to trade goods and services between each other and within the community. More recently, we see a shift towards digital community currencies, either as a complement or as a complete substitute of physical forms. In particularly, with the advent of blockchain technology, there has been a growing interest in leveraging its unique features to enhance the functionality and effectiveness of digital community currency systems (Parikshit and al 2022).



However, the implementation of such digital community currencies has often been hampered by technical, logistical, and regulatory challenges. A major challenge is the provision of a secure digital network through which digital payments can be operated alike digital banking activities. The network has to be resilient to hacking and other security and fraud related activities, which requires substantial initial investment costs as well as operating costs and profound monitoring. Moreover, such a digital network has to show regulatory compliance similar to other payments systems.

Blockchain technology, with its decentralized and by design secure nature, seems to offer a promising solution to many of these challenges. A blockchain refers to a chain of blocks, digital containers on which various types of information are stored: transactions, contracts, property titles, artworks, and more. This ledger is decentralized, meaning it is not hosted by a single server but by a portion of the users. The information contained in the blocks is protected by several innovative cryptographic processes, making it impossible to modify them afterwards.

By using blockchain-based platforms, community currencies can be created, managed, and exchanged in a transparent and up to now secure manner. Fintech innovations such as mobile payments and digital wallets facilitate the range of dissemination and usage of blockchain-based community currencies as the network within which the blockchain-based community currencies operate are mobile phone networks of telecommunication providers which are regulated, monitored and supervised anyway.

This working paper aims to provide a thorough analysis of technical requirements of digital community currencies. Our objective is to expand the existing knowledge base surrounding digital community currencies and blockchain technology, offering significant insights and recommendations to practitioners, policymakers, and community organizers aiming to implement or enhance digital community currency systems in their specific regions. Specifically, our focus lies in exploring the potential utilization of blockchain technology in community currencies.

Our major motivation for this paper is to analyse the phasing-in and adoption of blockchain technology in the context of the community currency system, in particularly to decipher the particularities arising from the technology that need to be addressed to harness the full potential of blockchain-based community currencies. Hence, our overall contribution to

literature is to identify key factors that contribute to success or failure of blockchain-based community currency systems.

In detail our contribution to literature on community currencies is first to clarify what are the specific potentials and requirements of blockchain-based community currencies. Some of the discussed aspects are specific to blockchain-based community currencies as e.g. such as the technical consensus mechanism or energy consumption, while others also apply to digital currencies as such as for instance issues of governance, ownership and participation.

Second, we offer a critical overview on the limited literature about blockchain-based community currencies. Though blockchain-based community currencies enjoy increasing popularity, they are still an underexplored topic, which is reflected in the very limited amount of academic literature devoted to it specific features. In contrast, most of the (digital) community currency literature deals with various non-blockchain-based forms of locally adopted (digital and tokenised) currencies or means of payments, including so-called complementary currencies or social currencies.

Third, we identify gaps and blind spots in literature on the functioning and understanding of blockchain-based community currencies such as long-term sustainability considerations in all three dimensions of sustainability or strong conceptual issues related to the design and its specific features, principles and rules which influence voice, participation, distribution of benefits and the empowerment of community members and civil society.

Fourth, we discuss benefits of blockchain-based community currency systems, highlighting their potential to stimulate local economic activity, foster community engagement, and empower marginalized populations, but also their technological challenges.

Fifth, we offer insights into one specific blockchain-based community currency project in rural Cameroon; a group of communities introduced local blockchain-based community currencies in their respective villages Bameka, Batoufam and Fondjomekwet in the *Région de l'Ouest* in Cameroon. These communities have implemented a blockchain-based community currency system to address economic challenges and promote sustainable development in their local areas. We present the OurVillage project and share the experience with the blockchain-based community currencies, testing its potential in a real-world scenario and detecting some short-comings.

The remainder of this paper is structured as follows: Section 2 provides stylised facts about blockchain technology relevant for community currencies such as decentralisation, transparency or immutability due to its ledger and consensus mechanism. In Section 3, we offer a structured review of literature related to blockchain-based community currencies. Moreover, we provide a discussion on blind spots of the existing literature, however touching on essential issues for the viability of digital community currencies. Completing Section 3, we analyse and discuss technical challenges in particularly in the implementation of blockchain-based community currencies.

In Section 4, we present a detailed description of the digital community system OurVillage in Cameroon, including its objectives in terms of its social and economic impacts, discuss the technological challenges surrounding the implementation and finally we share some insights from the project OurVillage. The paper concludes with a brief summary of key findings and implications for policy.

2 Some stylised facts about blockchain technology

Blockchain technology is a decentralized and distributed ledger system that records transactions in a transparent and immutable manner. It relies on cryptographic algorithms to secure data and ensures that all participants have a consistent view of the shared ledger. This technology has gained attention for its potential to enhance the functionality and security of digital community currency systems.

The technology has emerged as a transformative innovation with a deep impact on various industries and sectors. Initially introduced as the underlying technology for Bitcoin, a decentralized cryptocurrency, blockchain has evolved to become a versatile and powerful tool for secure, transparent, and decentralized record-keeping.

The concept of blockchain originated in 2008 with the publication of the Bitcoin whitepaper by the pseudonymous person or group known as Satoshi Nakamoto. The whitepaper[3] introduced the concept of a peer-to-peer electronic cash system based on a decentralized ledger called blockchain. Over time, blockchain technology has evolved, different types as briefly exposed in table 1 and more comprehensively shown in table A1 in the annex, new iterations and variations have emerged.

[3] Nakamoto (2008), Bitcoin: A Peer-to-Peer Electronic Cash System Satoshi. Bitcoin.org

Table 1 Selected blockchain types

Type	Description	Examples
Public Blockchain	No one runs the network, anyone can participate by reading, writing, or auditing the blockchain	Bitcoin, Litecoin, Ethereum, Ripple, etc.
Private Blockchain	The private property of an individual or organization, where an entity directs the writing/reading or the rights of access to the write/read	Bankchain, Corda, Hyperledger Fabric, Multichain, etc.
Federated Blockchain / Consortium	Several people run the network. A group of companies or individuals representing make joint decisions for the benefit of the network	R3 Corda, Energy Web Foundation (EWF), Quorum, RippleNet, etc.

Source: own presentation

The second-generation blockchain platforms, such as Ethereum, introduced the concept of smart contracts, enabling the execution of programmable agreements and decentralized applications. This advancement expanded the scope of blockchain technology beyond simple transactions, opening doors to various decentralized use cases.

Furthermore, the evolution of blockchain technology led to the development of third-generation platforms, such as Cardano platform in September 2017 and Polkadot platforms in May 2020 which aimed to address scalability, interoperability, and sustainability challenges faced by earlier iterations. These platforms introduced novel consensus mechanisms as shown in table 2, layering solutions, and governance models, enhancing the overall efficiency, security, and flexibility of blockchain systems.

Blockchain is characterized by several key features that differentiate it from traditional centralized systems. Firstly, it is decentralized, meaning that the data and control of the network are distributed across multiple nodes, reducing reliance on a central authority. This decentralized nature enhances transparency, eliminates single points of failure, and promotes trust among participants.

Secondly, blockchain technology utilizes cryptographic techniques to secure data integrity and provide verifiability. Each block in the chain is linked through cryptographic hashes, ensuring immutability and tamper resistance. This feature ensures that once a transaction or record is added to the blockchain, it cannot be altered without consensus from the network participants.

Table 2 Consensus mechanisms

	Key Characteristics	Advantages	Disadvantages
Proof of Work	Miners compete to solve complex mathematical puzzles to validate transactions and create new blocks	Highly secure and decentralized; rewards are distributed fairly based on computational power	Requires significant computational power, which can lead to high energy consumption and slow transaction speeds
Proof of Stake	Validators stake a certain amount of cryptocurrency to validate transactions and create new blocks	More energy-efficient than PoW; rewards are distributed fairly based on staked tokens	Can lead to centralization if a few validators hold a large share of tokens; does not incentivize validators to act in the best interest of the network if they have little at stake
Proof of Authority	Validators are approved based on their reputation or authority in the network	More efficient and scalable than PoW or PoS; does not require significant computational power or staked tokens	Can be more centralized; power to create new blocks is concentrated in the hands of a few validators

Source: own presentation

Another essential aspect of blockchain technology is its transparency. While the details of transactions are publicly accessible, the identity of participants can be pseudonymous or anonymous, depending on the level of privacy provided by the specific blockchain implementation. This transparency enables auditability and accountability within the network.

Blockchain technology has the potential to disrupt various sectors and industries, in particularly money and finance. In digital payment systems, it offers the potential for faster, more secure, and cost-effective cross-border transactions, as well as enabling new models of decentralized finance (DeFi) and tokenization of assets. Blockchain technology has evolved significantly since its inception, moving beyond its initial application in crypto assets. Its decentralized, transparent, and secure nature presents immense opportunities for innovation across various sectors and reaching out towards formerly excluded individuals and communities.

3 Community currencies and blockchain technology

3.1 Literature review on blockchain-based community currencies

While the emergence of community currencies in modern times goes back almost one century to the dismal years of the Great Depression (Scalfoni Rigo, 2020), digital community currencies have become more popular only within the last decade after financial markets have undergone tremendous transformation. The creation of innovative financial instruments as for instance mobile money or crowd funding platforms have expanded outreach of financial services to formerly financially excluded households and companies. The subsequent expertise gained with these digital financial services have been applied to existing, still physical community currencies. Given the rise in mobile phone coverage both in the Global North and the Global South, some community currencies also introduced a digital version to complement at first the physical tokens and later to substitute them completely.[4] Recently, some newly created community currencies have opted to go digital from the very beginning. However, using blockchain technology is only one option in the digitalisation of community currencies; the introduction of e-Wallets constitutes another one. Accordingly, the academic exploration of digital community currency systems in general, and in particular their integration with blockchain technology is to the best of our knowledge very limited, though the topic has gained significant attention among policymakers and practitioners.

Blockchain technology has emerged as a groundbreaking tool, inter alia disrupting traditional financial systems, and enabling the creation of decentralized and transparent networks (Du et al., 2019;). At its core, a blockchain consists of a chain of data blocks, each containing transaction records, cryptographic hashes, and timestamps, ensuring data integrity and immutability.

Literature emphasises the potential capacity of blockchain for community currencies based on its technological particularities. In table 3 we present some of the more recent papers on the merits of using blockchain technology in the provision of digital community currencies. These potentials entail inter alia its integrity due to transparency and traceability, its individual and collective inclusiveness due to the decentralisation and traceability of

[4] See also appendix table A2 and A3 for selected examples.

transactions, its lower transaction cost due to the elimination of intermediaries, and finally its simultaneous immutability and flexibility in order to prevent technological obsolescence.

Table 3 Selected papers on community currencies using blockchain

Author(s)	Main Conclusions	Region of Study
Diniz et al (2019)	Develops a taxonomy of digital community currency platforms (Local, Proprietary, Commons, Cyber) based on governance and architecture; blockchain is one of several enabling technologies.	Global (22 platforms studied)
Koens & Poll (2018)	Proposes a general decision framework for whether blockchain (versus alternative technologies) is the appropriate choice for a given use case, cautioning against blockchain-by-default adoption.	General / conceptual (30 decision schemes reviewed)
Kuk et al. (2024)	Complementary currencies help sustain micro-entrepreneurs in informal settlements by lowering barriers to local trade and building social capital.	Kenya (informal settlements)
Dissaux (2023)	Examines geographies of monetary exclusion in informal settlements and how community currencies can extend financial inclusion where formal banking is absent.	Kenya (informal settlements)
Mattsson, Criscione & Ruddick (2022)	Presents the transaction dataset of the Sarafu community inclusion currency during 2020–2021, showing sustained peer-to-peer local commerce on a blockchain-based system.	Kenya

Source: own presentation

In detail, the use of blockchain in community currencies offers several advantages due to the specific technology in contrast to digital, though non-blockchain based community currencies. First, Blockchain's immutability and transparency ensure the integrity of transactions and prevent fraudulent activities[5] (Du et al., 2019), thereby enhancing trust and confidence within the community. All participants of a community currency are able to view and verify transactions and the transactions, once recorded, cannot be altered or tampered with. This real-time transaction verification and consensus mechanism together with its various other security features such as the utilization of cryptographic safeguards in form of cryptographic hashing and secure key management (Du et al., 2019,) contribute to the integrity of the community currency system as such. Similarly, Ussher et al. (2023), studying the Sarafu community currency in Kenya, stress the integrity of blockchain-recorded

[5] Nakamoto (2008), Bitcoin: A Peer-to-Peer Electronic Cash System Satoshi, Bitcoin.org

transactions and show that this facilitates governance of the system and thereby enhances trust.

Second, the decentralized nature of blockchain enables community members to participate in the governance and decision-making processes, fostering a sense of ownership and hence inclusivity (Lietaer & Dunne, 2013). Moreover, blockchain's traceability allows for the tracking of transactions, enabling community representatives to gain insights into economic flows and patterns, thereby informing local economic policies (Lietaer & Dunne, 2013). Additionally, blockchain's transparency allows for community members to monitor the circulation of community currencies, promoting accountability and trust (Du et al., 2019).

Third, other studies have focused on understanding the potential of blockchain technology in enhancing the functionality and effectiveness of digital community currency systems. Tapscott and Tapscott (2016) highlight reduced transaction costs, alongside increased transparency and enhanced security of transactions, as major benefits that could encourage increased adoption of a blockchain-based community currency.

By decentralizing the ledger, blockchain eliminates the need for intermediaries, thereby reducing transaction costs and enhancing efficiency. A similar argument was advanced by Mattsson, Criscione and Takes (2023), who analysed the circulation of the blockchain-based Sarafu community currency in Kenya. They found that the recorded transaction data improved transparency and traceability of exchange within the network, facilitating trust among community members and supporting economic activity and social cohesion within the community.

In addition to the advantages in terms of coverage and operation originating from the specific blockchain technology, literature offers various significant socio-economic implications of such community currencies. For instance, Kuk et al. (2024) studied the socio-economic role of complementary currencies for micro-entrepreneurs in Kenyan informal settlements. They found that the currencies helped sustain local economic activity, supported small businesses, and strengthened social connections within the community. Studies have highlighted the role of blockchain in enhancing the resilience and sustainability of local economies through community currencies (Lietaer & Dunne, 2013). By leveraging blockchain’s decentralized architecture, community currencies can enhance economic resilience, foster local trade, and empower community members.

Increasingly, practitioners, local communities and academia recognise the potential of blockchain technology in supporting community currencies; blockchain technology holds significant promise for transparent and secure operation of community currencies offering inclusivity to individual members and enhanced sovereignty of social and economic development to the local community.

3.2 Blind spots in literature on digital community currencies

Despite the growing interest in blockchain technology and community currencies, and the above discussed preliminary assessments, there are still notable gaps or even blind spots in understanding the comprehensive functioning of blockchain-based community currencies and their necessary preconditions (table 4). To the issues which still need to be addressed belong rather technical questions as interoperability with other digital devices or networks and scalability, as blockchain networks may face limitations in processing many transactions simultaneously. Moreover, privacy concerns by users who may expose sensitive information to the network as a result of the transparent nature of blockchain are not resolved, yet.

Another topic to be looked at more thoroughly is the long-term sustainability of blockchain-based community currencies in all three dimensions of sustainability: in terms of its operation and thus its business model, in terms of usage of resources and thus its substantial energy consumption associated with certain blockchain consensus mechanisms, and in terms of its inclusiveness and thus its accessibility particularly for vulnerable groups. It is particularly important to analyse how these systems can address the needs of marginalised communities, including those with limited access to technology or financial services, and identify avenues to overcome barriers to participation for vulnerable groups. Another critical aspect of sustainability is the capturing of the expected benefits, e.g. improvements in employment and income generation, by blockchain-based community currencies in order to ensure an equitable distribution of those benefits to and between members.

Finally, there are strong conceptual issues raised with the creation and running of digital community currencies related to their specific design (Metzger et al., 2023). To those conceptual issues belong all features, principles and rules which ensure empowerment taking into account that simple access is not identical with economic, social or political empowerment of individuals and civil society. Aspects particularly important for the

operation and economic functioning of the digital community currency comprise the decision-making about the issuance mechanism, the currency circulation, and the governance structure. These aspects include all supply-side decisions on the initial amount of community currency provided and its subsequent rise and all demand-side decisions related to its acceptance and adoption by peasants, local businesses and households.

Blockchain technology can facilitate the design and implementation process by providing a decentralized and consensus-based framework for decision-making and transaction validation. Swan (2015) argues similarly as he emphasizes the potential of blockchain to foster social cohesion due its capacity to trust-building as a result of its consensus-based mechanism. However, the blockchain-based-driven community currency could also deepen the rift between members who are technological literate and those who are not. Another conceptual layer refers to how community currencies are able to discourage progressing inequalities within the community and reverse this trend, contributing to a more egalitarian society. Furthermore, it is interesting to assess and possibly evaluate how and to which extent blockchain-based community currencies influence and change the agenda-setting and decision-making processes within local communities.

Table 4 Blockchain function and community currencies - benefits and challenges

Functions	Description	Benefits	Challenges
Data storage	• Blockchain provides a decentralized and immutable ledger for storing community currency transaction data, • Ensuring transparency and preventing unauthorized modifications.	• Enhanced security and integrity of transaction records • Increased transparency and trust in the community currency system • Prevention of fraud and tampering	• Scalability and energy consumption of the blockchain network • Technical complexity and implementation challenges • Integration with existing data systems and infrastructure

Functions	Description	Benefits	Challenges
Secure transactions	• Blockchain enables secure and tamper-proof transactions within the community currency system, enhancing trust and reducing the risk of fraud or double spending.	• Improved transaction security and reliability • Elimination of intermediaries and associated fees • Increased trust and confidence among participants	• Adoption barriers and limited awareness among community members • Legal and regulatory considerations • Ensuring privacy and confidentiality of user information
Transparent governance	• Blockchain allows for transparent governance and decision-making processes within the community currency system, fostering inclusivity and community participation.	• Enhanced transparency and accountability in governance • Democratization of decision-making processes • Increased community engagement and ownership	• Regulatory compliance and legal frameworks • Balancing centralized control with community participation • Ensuring consensus and alignment of community members
Traceability	• Blockchain's transparent nature enables the tracking and tracing of community currency transactions, facilitating insights into economic flows and patterns within the local economy.	• Improved visibility and understanding of economic flows. • Insights for policymakers and community leaders • Prevention of illicit activities and illicit transactions	• Privacy concerns and the need to balance transparency. • Technical challenges related to implementing traceability features

Functions	Description	Benefits	Challenges
Accountability	• By leveraging blockchain, community currency systems can enhance accountability by providing transparent records of transactions, ensuring the integrity of the currency circulation.	• Increased accountability and auditability of transactions • Prevention of fraud and misuse • Trust-building among participants and stakeholders	• Ensuring accuracy and reliability of transaction records • Balancing transparency with privacy requirements
Resilience and trust-building	• Blockchain's decentralized and secure nature contributes to building trust within the community, fostering resilience in the face of economic challenges, and promoting local trade.	• Strengthened local economy and economic resilience. • Increased trust among community members • Encouragement of local trade and community cooperation	• Overcoming initial scepticism and resistance to adopting blockchain technology • Ensuring accessibility and usability for all community members
Economic empowerment	• Community currencies on blockchain can empower individuals and local businesses by providing alternative means of exchange, fostering economic inclusion, and supporting local economies.	• Economic inclusion and empowerment of individuals and businesses • Increased financial access and opportunities. • Stimulated local growth and economic development	• Ensuring stability and integration with existing financial systems • Overcoming economic and regulatory challenges • Balancing the interests of diverse stakeholders

Source: own presentation

3.3 Technical challenges in the implementation of a digital community currencies

Examining various research studies from a technical perspective reveals significant challenges when it comes to using blockchain technology (Parikshit et al., 2022) for community currencies. While some sectors, like asset management and insurance, have started using blockchain, most other industries face some challenges. These challenges involve ensuring that the technology functions smoothly and can handle a high volume of tasks and dealing with the various rules and regulations related to smart contracts. In particular, scalability emerges as a vital consideration to accommodate the growth of community currency ecosystems. Optimization of network infrastructure and the deployment of scaling solutions, in line with Croman et al. (2016), become essential to ensure that the system can handle increasing transaction volumes effectively. Scalability safeguards against bottlenecks that could hinder the expansion of community currency usage. Research by Ali et al. (2020) emphasizes the significance of adhering to legal frameworks to mitigate regulatory risks and garner broader acceptance and legitimacy within the community. While regulatory compliance with local and national financial regulations becomes an indispensable component of a blockchain-based community currency system's operation, the complicated interplay between cryptocurrency usage and divergent legal frameworks in different countries introduces difficult challenges (Koens & Poll, 2018).

Technical complexities also arise in the context of blockchain technology implementation. These complexities include essential considerations, such as ensuring access control to specific facets of the technology, capacity planning to accommodate workloads efficiently, and defining data-sharing protocols within Distributed Ledger Technology (DLT) frameworks. Moreover, the establishment of consensus mechanisms that gather unanimous agreement among participants in the technology ecosystem presents a multifaceted challenge (Koens & Poll, 2018). Pertinently, the deployment of smart contracts within the blockchain necessitates examination due to the immutable nature of blockchain records, execution rectifications or alterations challenging in cases of errors or disputes (Koens & Poll, 2018).

Furthermore, it is necessary to develop and adopt a risk mitigation strategy (table 6), which should ensure the circulation of the community currency within the local economy, in particularly in rural areas with widely dispersed businesses across a large geographical area, stipulate liquidity management and provide the secure storage and maintenance of data,

including data encryption and privacy controls as recommended by Ali et al. (2020). These safeguards not only secure users' sensitive information but also maintain compliance with pertinent data protection regulations, reinforcing the trust and legitimacy of community currency systems.

Table 6 Risks and mitigation strategies

	Description	Mitigation Strategies
Technical Risk	Risk that arises from technical issues with the blockchain, such as scalability, security, or performance problems.	Regularly testing and upgrading the blockchain technology, implementing security measures such as encryption and multi-factor authentication, and partnering with trusted technology providers.
Regulatory Risk	Risk that arises from regulatory or legal issues, such as uncertainty around the legality of community currencies or changes in regulations that could affect their operation.	Conducting thorough legal research and seeking professional advice, engaging with regulators to ensure compliance, and advocating for favorable regulatory frameworks.
Operational Risk	Risk that arises from issues with the day-to-day operation of the community currency, such as management, maintenance, or user support.	Developing robust operational procedures, providing comprehensive user support and education, and investing in ongoing maintenance and upgrades.
Adoption Risk	Risk that arises from challenges in gaining widespread adoption and use of the community currency, such as lack of awareness, trust, or interest from potential users.	Conducting effective marketing and outreach, providing incentives and rewards for early adopters, and partnering with trusted organizations to promote the currency.
Financial Risk	Risk that arises from financial issues related to the community currency, such as fluctuating exchange rates, lack of liquidity, or exposure to fraud or theft.	Implementing appropriate financial controls, such as regular audits and reporting, diversifying the currency's assets, and partnering with trusted financial institutions.
Governance Risk	Risk that arises from issues related to the governance and decision-making processes of the community currency, such as conflicts of interest, lack of transparency, or insufficient community involvement.	Establishing clear governance structures and processes, promoting transparency and accountability, and engaging with the community to ensure their input and participation.

Source: own presentation

Interoperability, facilitating seamless transitions between various payment methods, further fosters adoption. A system that adheres to requirements for interoperability with other payment systems, as mentioned in table 5, can cater to diverse user preferences and enhance user-friendliness. The versatility inherent in interoperability aligns with the user-centric approach advocated by Koens and Poll (2018).

Table 5 Digital payment systems

Requirement	Explanation
Decentralization	The system should use a decentralized platform to eliminate the need for a central authority and ensure secure and transparent transactions.
Immutable ledger	The blockchain should provide an immutable ledger to keep an accurate and unalterable record of all transactions made using the community currency.
Fast transaction processing	The blockchain should provide fast and efficient transaction processing to enable the use of community currency for everyday transactions.
Scalability	The blockchain should be scalable to accommodate a large number of users and transactions as adoption grows.
Security	The blockchain should provide robust security measures, such as encryption, to protect user data and transactions from unauthorized access or manipulation.
Smart contract support	The blockchain should support the use of smart contracts to enforce the rules and conditions of the community currency.
Interoperability	The blockchain should be interoperable with other blockchain platforms and digital wallets to increase the reach and accessibility of the community currency.

Source: own presentation

While reducing costs are an important economic incentive as discussed earlier, it is by no means sufficient for the adoption of a blockchain-based community currency. Actually, user-friendliness in form of handling and user interface of the community currency are important drivers for the inclusion of a diverse user base comprising also households with only limited technological proficiency. Low technical barriers allow that the blockchain-based community currency system remains accessible to a broad spectrum of community members. Public sentiment towards cryptocurrency also exerts a considerable influence on its adoption, underscoring the importance of societal perceptions in shaping usage

patterns. The lower the technical barriers of the digital community currency are, the lower are reservations against it due to perceived or actual lack of understanding.

Finally, the provision of comprehensive user education and assistance emerges as a critical component for empowering individuals to utilise the blockchain-based community currency system widely and effectively. Educational initiatives, as advanced by Mqamelo (2022), have the potential to promote financial literacy and equipe users with the knowledge needed to make informed choices, thus improving the overall user experience.

In essence, the effective integration of blockchain technology within community currency systems offers multifaceted advantages, contingent upon the meticulous fulfilment of prerequisites related to digital payment systems, the creation of risk strategies and the provision of user-friendly interfaces as outlined in table 5 and 6. By addressing comprehensively these requirements and resolving the conceptual issues discussed above, community currencies can evolve into powerful tools for local economic resilience, social cohesion, and sustainable development.

4 The case of OurVillage in Cameroon

Several projects and initiatives have explored the use of blockchain technology to create and manage community currencies, often with the goal of supporting local economies and strengthening local communities. These projects vary in their implementation and objectives but share a common theme of using blockchain to empower communities socially and economically. One rather recent example is a project called *OurVillage in Cameroon*[6]; a group of communities introduced local blockchain-based community currencies in their respective villages Bameka, Batoufam and Fondjomekwet in the *Région de l'Ouest* in Cameroon.[7]

[6] The official project title is "OurVillage – Advancing Endogenous Economic Development through Digital Innovations." Primary executor is the Gesellschaft für Internationale Zusammenarbeit (GIZ). This initiative is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ), with the Ministry of Finance (MINFI) in Cameroon serving as the leading implementing agency. The project was set to run from 2020 to 2023. More details can be found here: https://www.giz.de/de/projekte/ourvillage-digitale-innovationen-zur-foerderung-endogener-wirtschaftsentwicklung

[7] We have to share one disclaimer here: In the project the community currency was either called digital means of payment or most of the cases even vouchers. The reservation of official project speech to call it what it actually was, a blockchain-based community currency, goes back to legal provisions saying that only the central bank of the CFA Franc zone is entitled to decide about issuance of domestically accepted currency.

The project had a two-phase approach: Initially, from March 2022 physical plastic tokens were issued to a small test group of up to 60 individuals plus 15 so-called backers in each village. The backers were of strategic importance as they function in the phase-in period as purchasers of last resort. Most of the backers are traders offering goods on the local market and dedicated to the idea of the introduction of the local community currency. In case, the local currency would be concentrated on only a few of the backers, the *Organe de Suivi d'Animation*, the council of elders, will intervene and re-allocate the stock of the local currency with the backers to a more equitable distribution. From Q4 2022 on, the digital community currency was introduced on a broader scale, requiring participants to register in the system. While those still owning physical tokens were offered to exchange them into the digital version of the community currency, most of these participants preferred not to depart from the physical token. Both during the pilot phase and then subsequently in the phase-in period of the digital form, the community currency was issued as a small lump sum to participants.

4.1 The project

The overall medium-term objectives of OurVillage in Cameroon had been a rise in economic resilience, an enhancement in social inclusion through targeting particularly vulnerable groups, and an increase of social cohesion in the local communities as a result of a rather inclusive boost of the local economy. The introduction of the local community currency in the three villages were expected to show various economic and social impacts as the following:

(i) A permanent increase of household income. With the lump sum amount of the digital community currency allocated to each participant after joining the system, participants' income will initially increase by exactly this lump sum amount. In the second period then, participants use this amount to purchase goods and services from other community members, who will have an increase in trade with goods and services and a corresponding increase in their income. The income of those participants -who sell in the second period goods and services- will have been increased by the initial lump sum in the first period and in addition by the amount of selling of goods and services. In the third period, these participants (who sold goods and services in the second period) will be able to purchase other goods and services from other participants of the system, who will now experience an increase of their income in addition to the lump sum. In sum, all participants

will have a higher income due to these typical multiplier effects. If participants would consume 80 per cent of their lump sum (and only save 20% of it), then the income in digital currency of all participants will increase by 5 times of the lump sum in the long term. If participants would consume even 90 per cent of their lump sum (and only save 10%), then their income will increase by 10 times of the lump sum over time.

(ii) Improvement of food security and other basic needs through higher permanent income. Due to the higher income, we can expect higher spending especially for basic needs, in particular food, health and education. However, this effect might be strongly dependent on the gender of the participant as studies show that women and men do have different spending preferences with women devoting more of their disposable income on these three expenditure categories.

(iii) Higher absolute savings. Due to the higher income, participants will also save absolutely more even if their saving preferences and hence their relative rate of saving remains unchanged. If they save for instance 10% of their income, they would also save 10% of the initial lump sum. Based on this example and the above-mentioned multiplier effects, participants would experience higher absolute savings over time.

(iv) Reduction of absolute or relative debt. As their income is increasing, participants save more in absolute terms. One option for the use of their savings would be a reduction of their debt with *tontines*, the local savings associations, with family members or with informal loan providers, if there are any. With this option, absolute debt of the individual participant would decline. An alternative use of the higher absolute savings of participants to the above mentioned down-payments would be a rise of their weekly contributions to tontines. This can be done either via an increase of membership in tontines or by an increase of individual contributions to tontines of which participants are already a member. In the medium term this option would allow participants to increase their loan entitlement with the tontines in which they are members. This increase of loan capacity in the medium term can either increase consumer spending or investment. In any case, the digital community currency allows a better income smoothing over the year and particularly across harvest cycles and the dry season.

(v) Lower costs for receiving remittances. Only residents of local communities are entitled to participate in the digital community currency system. Migrants from these villages owning wallets of the blockchain-based local currency can use them for making remittances

payments to their family members and at the same time stay attached to their home communities and not only in a purely pecuniary sense.

(vi Increase in local trade. The digital community currency as a means of payment can only be used within the community and therefore can acquire only local goods and services. Assuming there is no, or only low, rate of substitution between formerly CFAF purchases in the community with the digital means of payment, then there will be an increase in demand for local goods and services and hence an increase in local trade. The total demand for local products will be the former CFAF purchases plus the use of the lump sum. However, if CFAF purchases of the amount of the lump sum are completely substituted by the digital means of payments, then there would be no increase of the *local* trade, but rather an increase of trade *outside the communities*. Here it is important to ensure to participants a wide acceptance of the digital means of payment within the local communities to prevent leakage effects.

(vii) Increase in demand for labour. Suggesting that there is no or only low substitution of local purchases with CFAF with the digital community currency and hence assuming it is mainly the local trade which is benefiting from increased sales, then it is reasonable to expect a higher local production in the medium term and an increase in demand for labour in the communities in the long term. To what extent this increase of labour is distributed between self-employed producers who simply increase their working hours and day labourers, depends on whether the producers already work at their capacity limit.

(viii) Increase of investment spending. If higher demand for local products and labour is being assessed as permanently with only partial leakage effects, there will be higher investment spending in the medium term as a response to higher demand for locally produced goods and services.

(ix) Involvement of the economic and social position of vulnerable groups such as young adults and women. With specific measures this increase in local production and local labour demand could aim at vulnerable groups as women with on average lower income and young adults who are prone to leave the village.

(x) Reduction of inequality. In the medium term, a community fund financed through participant membership fees is envisaged. Communities could use this community fund to broaden participation and thus increase outreach of the system. In addition, the community

fund could provide and improve capacities (infrastructure as IT, capacity building) to reduce barriers which prevent community members from participating and thereby target poor households.

While the above-mentioned targets (i) to (v) would be achieved with the introduction of the blockchain-based community currency as such, the other impacts would materialise only in the mid-term perspective suggesting a critical number of users and a critical number of operation years of the system.[8] The acceptance of the digital community currency depends on many aspects, including the design and its implementation, which is of utter importance for the operation and technical functioning of the system.

4.2 Technological challenges – The Bafoka chain

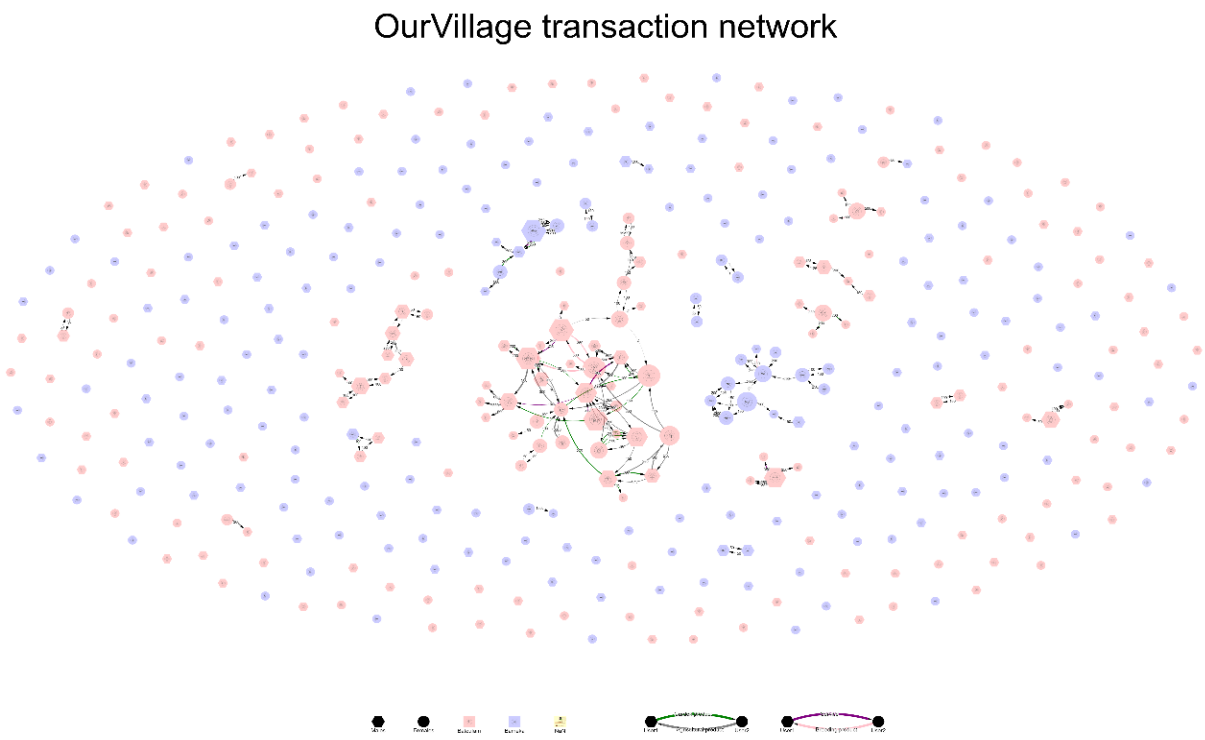
A mechanism products and services exchange through blockchain-powered community tokens, has been deployed across three communities Bameka, Batoufam and Fondjomekwet. The broader enrolment of new users into the digital community currency system built on blockchain technology " the Bafokachain" beyond the original test group was enacted from August 2022 on with Fondjomekwet being the last village to be served with the digital community currency in March 2023. There was an interruption in the running and operation of the system in Bameka and Batoufam of in total 6 months until February 2023 due to the change of the provider.

The implementation of *BAFOKACHAIN*, is centred on the use of Open Ethereum relying on a Proof of Authority consensus mechanism (table 2) to create blocks and enhance the security of the network. Users of the digital community currency only need to register with their phone number and participating in a survey, either in a rather comprehensive questionnaire or in just a USSD based survey with limited questions, depending on their individual preferences for receiving digital community currency as a lump sum starter kit (and hence respond to more questions) or rather just participating in the system (and hence prefer not to disclose personal features). Independent from the precise form of registering, residents can simply dial the designated phone code, which is #065' to access the blockchain-based services. Figure 1 shows different transactions within the 3 locations. As the three villages are spread across a substantial area, the project organisers did not expect participants of

[8] The OurVillage project is in its phase-out, thus the long-term targets (vi)-(x) cannot be evaluated anymore.

the three villages to interact with their local community currency. However, anecdotal evidence showed that the physical tokens actually crossed the village borders.

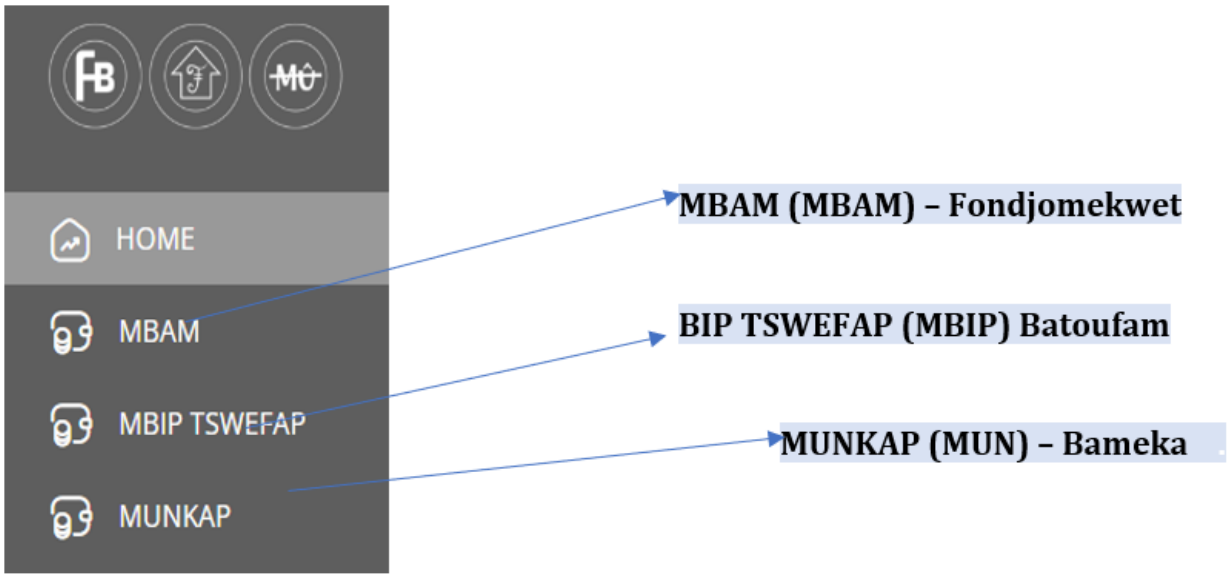
Figure 1 OurVillage transaction network



Source: own presentation based GIZ OurVillage dashboard data.

Figure 2 displays the names of digital community currencies per location along with the corresponding symbols used on the physical tokens, issued during the pilot phase to the test groups in the three communities.

Figure 2 Digital community currency per village



Source: own presentation.

This innovative system leverages distributed ledger technology to ensure the security of user accounts, while USSD technology enables access from any cell phone, even those without internet connectivity and APIs (Application Programming Interfaces) for more technologically adept users. This approach is inclusive, as it ensures that OurVillage community can benefit from the advantages of blockchain technology without facing barriers as with various other digital financial services which require the usage of apps on smart phones and hence exclude those who cannot afford a smart phone and are not literate to use one. The access to the system of the digital community currencies is open to participants independent whether they have a simple mobile phone or owe a smart phone.

4.3 Insights from OurVillage

The successful implementation of a blockchain-based community currency system requires careful consideration of several key factors of which security and usability are of strategic importance. While starting with a single node may offer initial cost advantages, it is imperative to plan for node redundancy as the system expands. The introduction of distributed nodes is a must, enhances system resilience and bolsters security against

potential failures. Moreover, robust security measures constitute a fundamental aspect of the system design. The implementation of comprehensive security protocols, encompassing encryption, routine security audits, and stringent user authentication processes, is essential to safeguard the system against external threats such as hacking and fraudulent activities.

In addition, scalability must be a central consideration for the system's design. In case of success, the user base will inevitably expand; in contrast to a community currency with physical tokens, who need to be produced and delivered, expansion and outreach to formerly non-participants can take place in a very short period of time for digital versions. Accordingly, the system should possess the inherent capacity to accommodate increased transaction volumes seamlessly from the very beginning. Exploring technologies such as sharding or sidechains can facilitate scalability management.

While security issues have to be addressed to keep the system functioning and operating, usability affect potential participants' acceptance of the system and willingness to join. It is advisable to prioritize the integration of the system with mobile devices. The development of an intuitive and user-friendly mobile application can significantly enhance accessibility and usability for a broader user base. Furthermore, digital literacy education of individual participants can enhance user understanding of the system and its security. Clear and comprehensive user instructions, coupled with comprehensive and robust user support mechanisms, are imperative to effectively mitigate the risk of errors and financial losses.

Lastly, community education initiatives should be a priority. The successful adoption, secure utilization and lasting maintenance of the system hinge on the community's understanding of blockchain technology, how to navigate the system without common user errors and to keep the data safe. Therefore, investment in comprehensive user education is crucial for long-term viability.

Conversely, the implementation of a blockchain-based community currency system entails a spectrum of inherent risks that necessitate diligent mitigation efforts. Firstly, relying solely on a single node presents a notable vulnerability and an operational risk which can be considered to be self-destructive for the system as such. A single point of failure, such as the node becoming inaccessible, could have detrimental consequences. Therefore, it is imperative to prioritize the establishment of redundancy measures to mitigate this risk. Technological obsolescence is another latent operational risk for digital community

currencies. It is often discussed in the context of firm innovation (Ma 2025), but similarly applies applying to digital innovations introduced by local communities. Ensuring that the chosen technology stack remains up-to-date and aligned with industry standards is vital to prevent obsolescence in a dynamically evolving technological landscape.

Moreover, security vulnerabilities represent a constant menace. Inadequate security measures can lead to breaches, theft, and fraud, thereby compromising the integrity of the system. Hence, routine updates, rigorous security audits, and stringent user authentication are pivotal for risk reduction. Similarly, regulatory compliance must be a primary concern. Adherence to local and international regulations pertaining to cryptocurrencies and blockchain technology is imperative to circumvent potential legal complications and liabilities. Even if the location of servers and the data gathered differs from the location of the digital community adaption, the jurisdiction of the communities where the digital community currency is implemented which has the lead and to whose rules the system has to confirm.

Another risk factor to contend with is the potential for limited adoption. For the community currency to last, a critical mass of users is required. Should the system fail to garner sufficient user interest and adoption, the circulation of the digital community currency will be limited and at risk to collapse (Metzger et al., 2023). Below this critical mass of users, there is a real risk of concentration of digital community currency with certain users, including traders, who finally stop accepting the community currency in exchange of their goods and services. Hence, sustainability of a digital community currency requires to address the issue of the (public) purchaser of last resort.

In addition, proactive community engagement initiatives, including effective marketing strategies and creating opportunities to use the community currency, are indispensable. Implementing a blockchain-based community currency requires the active engagement and participation of the community. It's important to involve community members in the design and implementation process, and to provide education and support to ensure widespread adoption and use of the currency.

In sum, implementing a sustainable, functioning blockchain system in a community requires a long-term commitment by all stakeholders and requires careful planning, design, and execution, as well as active engagement and participation from the community.

5 Conclusion

Existing research on digital community currency related to blockchain technology has made significant improvements in understanding the potential benefits and challenges. The specific features of decentralisation, transparency and immutability and thus data security due to its ledger and consensus mechanism make the Blockchain technology particularly appropriate for the application within community currency systems. Literature suggests that digital community currencies based on blockchain have actually the potential to bring about positive economic and social changes. In detail, these potentials entail its integrity due to transparency and traceability, its individual and collective inclusiveness due to the decentralisation and traceability of transactions, its lower transaction cost due to the elimination of intermediaries, and finally its simultaneous immutability and flexibility in order to prevent technological obsolescence. Moreover, some studies even identify significant socio-economic impacts as increased local economic activity and improved outreach to disadvantaged neighbourhoods.

Despite these potentials we argue that there are blind spots in understanding the comprehensive functioning of blockchain-based community currencies and their necessary preconditions. Those blind spots severely limit the application of blockchain technology within community currency systems and result in underperforming of actual community currencies. To these issues belong the long-term sustainability of blockchain-based community currencies in all three dimensions, inter alia its operation and thus its business model, in terms of usage of resources and thus its substantial energy consumption associated with certain blockchain consensus mechanisms, and in terms of its inclusiveness and thus its accessibility particularly for vulnerable groups. Other open conceptual issues relate particularly to the design of blockchain-based community currencies consisting of all features, principles and rules which establish processes on decision-making and influence economic, social and political empowerment of members. The design is decisive for the impact of blockchain-based community currencies on existing inequalities and thus on social cohesion, the distribution of benefits across member and thus ownership in the community currency or its influence on local agenda-setting and thus involvement and voice of members.

We also identify challenges of blockchain-based community currencies arising from the specific technology and its regulation. To these belong the interoperability with other

networks, scalability, exposure of sensitive information to the network and definition of data-sharing protocols, but also the necessary regulatory compliance and the creation of a risk management strategy. As we do not have an established international level playing field, the regulatory handling of blockchain-based financial instruments as well as community currencies as such strongly varies across countries or regions. This lack of international level playing field makes it more difficult to extract policy recommendations applicable for all and impair progress from a systemic perspective. Finally, the user-friendliness in form of handling and user interface of the community currency are important drivers for the inclusion of a diverse user base comprising also households with only limited technological proficiency. Low technical barriers require exactly the involvement of those members with reservations due to (perceived or actual) lack of understanding in the improvement process towards a more user-optimised interface as well as providing capacity building on eyes level.

Actual implementations are providing valuable insights into the practical difficulties and opportunities associated with blockchain-based community currencies. The three villages of Bameka, Batoufam and Fondjomekwet in the *Région de l'Ouest* in Cameroon have implemented a blockchain-based community currency system after a very brief phase-in period with physical tokens. Their major objectives had been the boosting of demand for local products and labour, the increase of individual well-being by for instance higher food security and the facilitation of income smoothing over the year and across harvest cycles. Based on the Open Ethereum platform, this blockchain infrastructure presents promising avenues for community transformation. To realise its full potential, an expansion of network nodes is paramount. Such an endeavour not only bolsters network security and decentralization but also strengthens its resistance to potential vulnerabilities and thus increases its resilience. Furthermore, the integration of smart contract functionality could be explored, automating various community processes such as record-keeping, resource allocation, and transparent governance. By focusing on these facets and encouraging active community involvement, the latent potential of the village blockchain can be unlocked, paving the way for a more efficient and transparent future for all stakeholders. However, in contrast to literature only related to non-blockchain-based community currencies, the literature on and case studies with blockchain-based community currencies is limited, which significantly constrains our analysis and thus conclusions. For better understanding of community currencies using blockchain technology.

While initial studies and few real-world case studies have shown promising results, it is essential to assess the long-term viability and sustainability and social and economic impact of these systems, as well as the challenges associated with their adoption and implementation on a larger scale. We conclude that the successful implementation of a blockchain-based community currency system requires a rather holistic approach, integrating technological, financial, economic, social and political aspects and combining them in a consistent and coherent manner.

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Appendix

Table A1 – More blockchain types

Blockchain Type	Description	Examples
Permissionless Blockchain	Similar to public blockchain, where anyone can participate, but there is no requirement for permission or identification	Bitcoin, Ethereum, Litecoin, etc.
Permissioned Blockchain	Similar to private blockchain, where access is restricted and requires permission or identification from an authority	Hyperledger Fabric, Quorum, Corda Enterprise, etc.
Hybrid Blockchain	A combination of public and private blockchains, where some elements are public, and others are private	Dragonchain, XinFin, Ardor, etc.
Consortium Blockchain	Similar to federated blockchain, where a group of organizations or individuals run the network, but decisions are made democratically	Energy Web Foundation (EWF), IBM Blockchain Platform, R3 Corda, etc.
Sidechain	A blockchain that is connected to a main blockchain, where transactions can occur on the sidechain without affecting the main blockchain	Liquid, Rootstock (RSK), Polygon (Matic), etc.
Sharded Blockchain	A blockchain that is divided into smaller sections, or "shards," that can process transactions simultaneously and increase the overall throughput of the network	Ethereum 2.0 (Beacon Chain), Zilliqa, Polkadot, etc.
Green Blockchain	A blockchain that utilizes sustainable energy sources to power the network, reducing the environmental impact of mining	Chia Network, Cardano (to become green through planned upgrades), etc.
Non-Fungible Token (NFT) Blockchain	A blockchain that supports the creation and trading of unique digital assets that cannot be replicated or divided	Ethereum (ERC-721 and ERC-1155 standards), Flow, Tezos, etc.

Source: own presentation



Table A2 Selected digital community currencies

Community Currency	**Description**	**Countries**
Bristol Pound	A local currency launched in Bristol, UK, in 2012. The currency is designed to support local businesses and keep money circulating within the city.	UK
Chiemgauer	A complementary currency used in the Chiemgau region of Germany. The currency is primarily used by local businesses and consumers to support the regional economy.	Germany
Sardex	A digital currency used by businesses in Sardinia to trade goods and services among themselves. The currency is designed to promote local economic activity and reduce dependence on national and global financial systems.	Italy
RES - Regionalwährung Vorarlberg	A complementary currency used in the Vorarlberg region of Austria. The currency is primarily used by local businesses and consumers to support the regional economy and reduce dependence on national and global financial systems.	Austria
Eco-Pesa	A complementary currency used in the city of Dar es Salaam in Tanzania. The currency is designed to promote sustainable development and reduce poverty by supporting local economic activity. The Eco-Pesa is used alongside the Tanzanian shilling.	Tanzania

Source: own presentation

Table A3 Selected blockchain-based community currencies

Community Currency	**Description**	**Blockchain Platform**
FairCoin	A blockchain-based currency that aims to support fair trade, social and environmental justice, and a collaborative economy. FairCoin is used by several grassroots movements and cooperatives worldwide, and it is designed to operate as a stable currency with a low carbon footprint.	FairCoin blockchain
Duniter	A blockchain-based currency that operates on a Universal Dividend system. Duniter is designed to promote economic equality, reduce financial speculation, and encourage community building. The currency is used in several communities in France, Belgium, and Switzerland, and it is intended to be accessible to anyone without discrimination.	Duniter blockchain
Common Good	A blockchain-based currency that supports local economies and social initiatives. The currency is used in several communities in Germany, and it is designed to promote sustainable development, social equality, and ethical consumption. The Common Good currency is backed by a local basket of goods and services, and it can be exchanged for euros at a fixed rate.	Ethereum
Grassroots Economics	A blockchain-based currency used in several communities in Kenya. The currency is designed to support local economies, reduce poverty, and empower marginalized groups. The Grassroots Economics currency is backed by community resources, such as land, labor, and local goods, and it is governed by local community members.	Sarafu blockchain

Source: own presentation.

RAMICS in Rio 2026
Plurality of Social Currencies: solidarity economy, municipal and community currencies for inclusive and sustainable futures
Pluralidade das Moedas Sociais: economia solidária, moedas municipais e comunitárias para futuros inclusivos e sustentáveis
8 - 12 Jun 2026 | Rio de Janeiro (Brazil)

LONG-TERM SUSTAINABILITY OF COMMUNITY CURRENCIES IN VIEW OF EVOLUTIONARY INSTITUTIONAL DESIGN AND COMMUNITY DOCK: A CASE STUDY OF "SARARI" IN SARABETSU VILLAGE

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Abstract

During Japan's "Lost Two Decades," depopulation, aging, economic decline, and community breakdown worsened in regional peripheral areas. This crisis triggered a community currency (CC) boom in the early 2000s, characterized primarily by non-convertible, non-commercial "Eco-Money". Driven largely by administrative initiatives and reliant on temporary subsidies, the vast majority of these Eco-Money systems, along with various

international monetary experiments, ultimately failed to achieve long-term survival due to structural circulation stagnation or rapid redemption into fiat currency. Challenging this global landscape of high attrition, *Sarari*—the public welfare CC of Sarabetsu Village, Hokkaido—has successfully sustained continuous operations for 18 years since its launch in 2008. This paper explores the institutional conditions and underlying mechanisms enabling Sarari's exceptional longevity through the lenses of "Evolutionary Institutional Design" and the participatory action research framework of the "Community Dock".

In contrast to neoclassical "Mechanism Design," which models markets as static top-down price mechanisms, "Media Design" based on Evolutionary Institutional Design redefines community currency as an integrative communication media that dynamically balances the market, the state, and civic reciprocity. Methodologically, this study examines longitudinal data spanning nearly two decades: early action research evaluations (2006 and 2011) and recent tracking analyses (2022–2025) utilizing the Liveable Well-Being City Indicator (LWCI) developed by the Smart City Institute Japan (SCI-Japan).

Our conclusions demonstrate that Sarari's long-term sustainability is the combined result of five interconnected structural pillars: (1) an adaptive, multi-circulation voucher architecture enabled by national Structural Reform Special Zones; (2) a resilient, resident-driven NPO governance model that structurally balances local economic activity with non-commercial volunteer reciprocity; (3) strong administrative coproduction, where fiscal autonomy is secured through municipal facility management contracts rather than subsidy reliance; (4) stable core leadership combined with face-to-face communicative infrastructures, such as the community café; and (5) continuous university-community collaboration via the "Community Dock" framework, which permanently provides systemic feedback and reinforces institutional legitimacy and trust. Furthermore, factorial analysis reveals that while the currency effectively acts as an institutional stabilizer that secures high community ties, child-rearing environments, and an expansion of resident self-efficacy (climbing to 69.1 points in 2025), it must be integrated with spatial and digital planning to address rural well-being polarization.

Keywords: 1.Community Currency; 2. Sustainability; 3. Well-Being; 4. Evolutionary Institutional Design; 5. Community Dock

Introduction: Why are community currencies unsustainable in the long term?

1.1 Why has "Sarari" endured since the CC boom in Japan in the 2000s?

Amid Japan's "Lost Two Decades," depopulation, declining birthrate, aging population, economic decline, and community breakdown intensified in rural areas including Hokkaido, sparking a community currency (CC) boom in the early 2000s. More than 600 CCs circulated in Japan at the end of 2003 (Lietaer, 2004), but after the number of CCs peaked in 2005, it gradually declined (Izumi, 2013).

Numerous "Eco-moneys" emerged across Japan, characterized by non-convertibility to cash, non-use in commercial transactions, and exclusive use for mutual aid and volunteer activities. In Hokkaido, Kuriyama Town's "Kurin" represented a relatively large-scale (several hundreds of participants) and long-lived (about 10 years) attempt (Hasegawa 2013). However, Eco-moneys driven by administrative initiatives and reliant on subsidies ultimately failed to endure (Nishibe, 2012b, 2013).

In addition, paper-based local currencies that could not be exchanged for legal tender, as well as account-based mutual credit systems such as LETS, were implemented across the country; these were used not only for volunteer work and mutual aid but also to pay for a portion of purchases at local stores. The CC boom was triggered by support and subsidies from the central and local governments. Local currencies like Eco-Money, which were intended solely for volunteer work and mutual aid, faced a serious problem of stagnation, where funds accumulated among a select few members and went unused. Furthermore, there were many cases where operations could not continue once the subsidies—which typically lasted only three or four years—expired. Community currencies were unable to become self-sustaining and sustainable endeavors.

Prior to the boom, "Volunteer Labor Bank" (now the NPO Volunteer Labor Network), often cited as the world's first time-dollar or time-banking system and Japan's first community currency, was launched in Osaka in 1973. It introduced a "currency of love" based on the principle of one hour equaling one point, designed to facilitate mutual aid during emergencies such as childbirth, childcare, illness, or accidents. In 1992, the "Sawayaka Welfare Foundation," established by Tsutomu Hotta, took over this initiative and launched the "Fureai Kippu" (Mutual Touch Ticket) time-deposit system, which eventually expanded nationwide. However, when the government enacted the public Long-Term Care Insurance

System in 2000, long-term care support began to be provided using the legal tender, the yen, and the system gradually shifted toward a time-based currency for daily living support (Tsuruyama, 2013).

In Japan, Structural Reform Special Zones emerged in 2002 as a local revitalization measure, including Special Zones for CC. Deregulation allowed multiple circulations of commercial vouchers within the zone, with Neyagawa City's “Genki (vigor)” being a prime example of such CCs, though it closed its doors in 2024 after 20 years (Miwa 2013).

The peak in new issuances of CCs was 130 in 2002, after which the number gradually declined. During the early boom in CCs up through the early 2000s, the purpose of “fostering connections among people” (such as Eco-Money) were the most common. However, starting in 2002, CCs aimed at “revitalizing the local economy” (in the form of reusable gift certificates) became the most prevalent, and by 2011, those aimed at “environmental protection” had gained prominence (Kobayashi, Miyazaki,Yoshjida, 2020).

Entering the 21st century, with resource depletion and environmental/energy issues becoming severe, the view is growing that economic growth and expansion are no longer the means to increase human well-being. Since the purpose of CCs is to revitalize the local economy and community, conserve the environment, and, above all, increase people's well-being, their mission lies not in expanding scale (in terms of transaction volume or the number of participants) but in long-term sustainability. CCs should not pursue fleeting trends or short-term growth precisely because they must be sustainable so that residents can rely on them for mutual aid and care when truly needed.

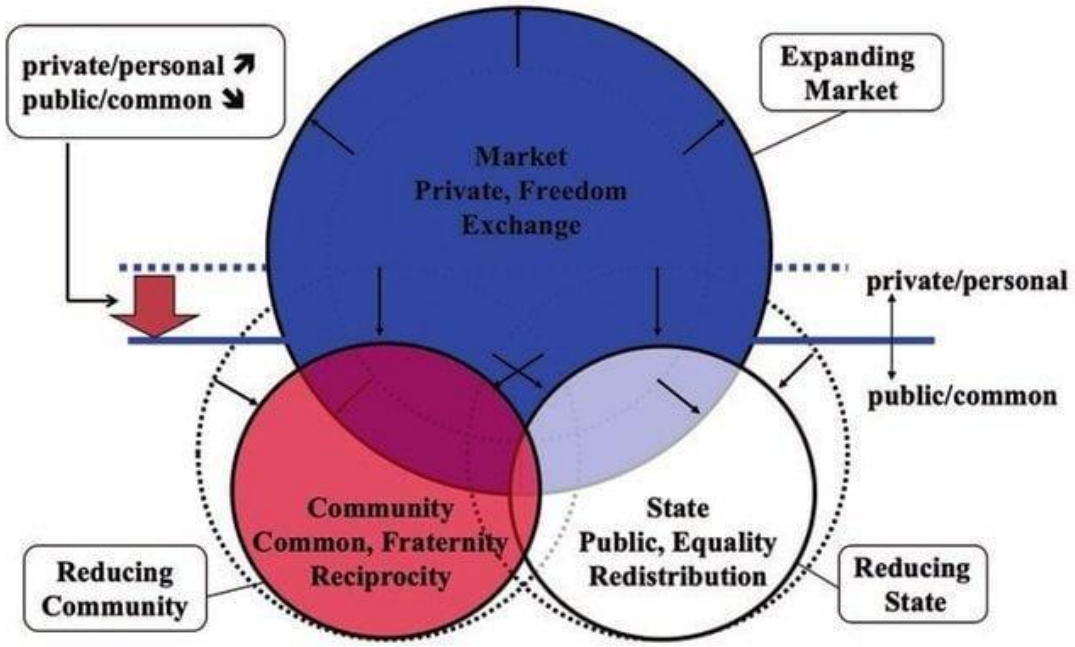
Sarari, the public welware currency of Sarabetsu Village, Hokkaido (with population 3,000), has sustained operations for 18 years since its 2008 launch. Except for systems like WIR, CCs in Europe, North America, and South America also tend not to last very long (e.g., US's Ithaca Hour, Canada's Toronto Dollar, Argentina's RGT, the UK's Bristol Pound and Brixton Pound etc.). Globally, CCs with long-term sustainability are not that common. This paper explores the secrets behind its longevity of Sarari. Before that, we need to consider the theoretical reasons why many local currencies are not sustainable in the long term. Let’s start by examining this issue here.

1.2 The Macro Background: Globalization and the Erosion of Community

Modern global capitalism is not merely a cyclical economic phenomenon; it represents a long-term, structural trend of "globalization" characterized by the universal expansion of the market economy and the intensive deepening of commodification. Historically, any economic society maintains its reproduction through a delicate balance among three distinct social institutions: **the market** (the private principle for free exchange based on price mechanisms), **the state** (the public principle for equitable redistribution via tax and social security), and **the community** (the communal principle for fraternal reciprocity rooted in mutual aid)(Polanyi, K. 1944).

Under global capitalism since the 1970s, however, market principles have aggressively expanded, progressively replacing and reducing the institutional roles of both the state and the community (**Figure 1**). This total commodification extends beyond general goods into essential daily domains such as childcare, elderly care, and domestic services, fostering an ethos of market-driven "free investmentism" (Nishibe, 2015, 2019). Consequently, altruism and the capacity for mutual aid within local communities have severely faded. This institutional imbalance has weakened traditional safety nets, exposing local socio-economies—particularly rural areas—to profound social and economic instability.

(Figure 1) Globalization as the long-term tred of global capitalism



1.3. The Institutional Crisis: Double Failures and the Rise of Community Currencies

This systemic imbalance has manifested in severe institutional crises, resulting in what can be termed "double failures"—the simultaneous failure of both the market and the government. While the state frequently fails to maintain a level playing field—arbitrarily bailing out giant financial institutions during crises like the 2008 Lehman Brothers collapse while abandoning ordinary citizens under the guise of "personal responsibility"—traditional macroeconomic policies have hit a structural impasse. In Japan, this impasse was typified by the prolonged deflationary stagnation and community breakdown that intensified in rural areas during the "Lost Two Decades."

To transcend this gridlock and reconstruct the sphere of reciprocity, significant attention shifted toward Community Currencies (CCs). Driven by grassroots momentum, CCs emerged globally as autonomous, bottom-up mechanisms designed to reactivate the community's principle of reciprocity alongside the market and the state. In Japan, a massive CC boom peaked around 2005, with over 650 experiments implemented nationwide. These

included "Eco-Money" systems designed exclusively for volunteer work, as well as voucher-based systems utilizing deregulation within Structural Reform Special Zones.

1.4. The Challenge of Sustainability and the Position of "Sarari"

Despite their initial promise, the vast majority of these initiatives were short-lived. Why is it? Put simply, this is because even CCs—which began with determination and passion as well-intentioned efforts to counter globalization—could not withstand the ever-increasing pressure for market expansion and deepening brought about by globalization. This pressure is so overwhelming that it cannot be resisted, even with government subsidies and support. Bound by temporary administrative subsidies, rigid institutional designs, or the stagnant accumulation of unspent funds, most CCs failed to become self-sustaining. Because the primary mission of a CC lies not in expanding its scale but in ensuring long-term sustainability to increase local well-being, its survival depends heavily on how dynamically the system can adapt to and transform its local environment, including the norms and values of its residents.

Amidst this global landscape of high attrition, **"Sarari,"** the public welfare community currency of Sarabetsu Village in Hokkaido (population: 3,000), stands as **a notable case of long-term survival, having maintained its operations for 18 years since its inception in 2008.** While Japan hosts a small number of resilient CCs that have endured for over two decades, Sarari's high durability within a small rural municipality raises a significant academic question: *What are the underlying causes and institutional conditions to resit globaslization behind the steady longevity of Sarari?*

1.5. Objective, Methodology, and Structure of This Study

To address this question, this paper examines the trajectory of Sarari through the lens of **"Evolutionary Institutional Design"** and the **"Community Dock"** approach, both of which are rooted in action research.

The structural foundation of Sarari directly incorporates crucial lessons from a preceding community currency experiment conducted in Tomamae Town (2004–2006). Although the Tomamae experiment lasted only three years across its primary and secondary circulation phases, it yielded two vital insights:

1. **The Institutional Lesson**: To keep a community currency circulating effectively, its velocity must be increased. Commercial transactions alone (e.g., consumers shopping at local stores, business-to-business transactions) are insufficient because the currency is too quickly converted back into legal tender. Instead, when non-commercial transactions (such as volunteer work and mutual aid) mediate commercial ones, the currency's velocity accelerates, thereby effectively revitalizing the local economy and community.
2. **The Organizational Lesson**: Management structures dominated by local governments and chambers/ societies of commerce and industry fail to encourage spontaneous resident participation in non-commercial activities. Therefore, it is essential to first establish a resident-driven NPO to anchor operations, while commercial associations step back into a supportive role.

These lessons, derived by researchers (Nishibe and others), were communicated to the local operational leader in Sarabetsu Village (Oikawa). Consequently, the newly organized management body tailored Sarari's institutional design to fit the specific socio-economic characteristics of Sarabetsu. We define this policy approach—which embraces past failures and refines systems through iterative trial-and-error—as **"Evolutionary Institutional Design"** (Nishibe, 2002, 2012a, 2012b, 2013). Sarari serves as a prime empirical example of this evolutionary economic approach.

Furthermore, this study highlights the implementation of the **"Community Dock"** methodology before and during Sarari's operations (Nishibe, 2006, 2013, 2018, Kusago, Nishibe, 2018). This process involved conducting resident questionnaire surveys regarding currency awareness, environmental recognition, and life satisfaction. The survey results were then presented during Focus Group Discussions (FGDs) comprising representatives from the local government, the society of commerce and industry, the social welfare council, local shops, and residents. These discussions stimulated self-reflection and spontaneous insights among stakeholders, which they subsequently integrated into their operational practices. Oikawa's testimony confirms that this "dock" significantly enhanced residents' awareness of the currency's value and boosted their performance in local activities. Notably, the fact that their activities were studied and publicized by researchers provided participants with recognition, fostering strong intrinsic motivation and incentives for continuous engagement.

Crucially, this paper itself represents the outcome of an active, interactive research methodology. It is co-authored through a deep, ongoing dialogue between the academic researchers (Nishibe and Miyazaki) and the practitioner-leader (Oikawa). By reviewing the 18-year history and evolution of Sarari, this collaborative writing process embodies the very spirit of the "Community Dock" at a meta-level.

The remainder of this paper is structured as follows. First, we trace the history, unique design, and multi-faceted operations of Sarari. Second, we explore the theoretical and evolutionary processes behind its longevity, highlighting the synergy between its NPO management structure and administrative collaboration. Third, we discuss the methodological implications of the Community Dock by comparing the institutional shifts from Tomamae to Sarabetsu. Finally, we analyze the empirical data from the subjective Well-Being surveys to evaluate the long-term impact of Sarari on the rural community's quality of life.

2. The Trajectory and Institutional Features of "Sarari"

2.1. Pre-history: Lessons from the Tomamae Town Experiments (2005–2006)

In the early 2000s, small-scale municipalities across Japan faced a severe crisis as depopulation and the decline of local businesses became increasingly tangible. Against this backdrop, community currencies (CCs) gained widespread attention as a potential remedy for local revitalization. In June 2004, Hokkaido Federation of Societies of Commerce and Industry commissioned Associate Professor Makoto Nishibe (then at University of Hokkaido) to conduct a feasibility study on a CC based on the idea of **Double Triangle System (DTS)** that he adovoctaed in the booklet entitled 'Recommendations for Community Currencies' (Nishibe, 2004) for **accelarationg circulation of CC by combining commercial transactions and non-commercial transactions**, selected Tomamae Town as the site for the pilot program. The experiment was launchedt in November 2004. This initiative immediately caught the attention of the Sarabetsu Village Society of Commerce and Industry, where Sueo Oikawa served as a business advisor. In October 2005, under the leadership of the Society of Commerce and Industry, Sarabetsu Village Local Currency Project Review Committee (hereinafter referred to as Sarabetsu CC review committee) was established. This committee was highly inclusive, comprising representatives from local

administrative bodies, commercial networks, social welfare organizations, and resident participants. Crucially, the committee invited Nishibe to serve as an academic advisor.

The operational insights gained from the preceding two rounds of Tomamae experiments (2004–2006) served as the primary foundation for Sarabetsu's project. The action research in Tomamae empirically demonstrated that the currency velocity of a well-designed CC could significantly surpass that of the national fiat currency (Bank of Japan notes), thereby exerting a substantial multiplier effect on the local economy (It has been demonstrated that its velocity of circulation is 6 to 7 times that of fiat currency (Nishibe 2006, Kichiji, Nishibe 2008)). Furthermore, it proved that a CC could function as an effective socio-economic tool to reinforce community ties and mutual aid.

However, Tomamae also exposed critical institutional and organizational limitations. From a structural standpoint, the experiment revealed that relying mainly on commercial transactions—such as consumers shopping at local retail stores or business-to-business transactions—was insufficient for sustaining long-term circulation because the currency was too rapidly converted back into legal tender. To maintain dynamic circulation, commercial transactions needed to be mediated and complemented by non-commercial flows, such as volunteer activities and mutual aid.

Organizationally, the Tomamae experiment illustrated that management structures dominated strictly by its society of commerce struggled to foster spontaneous resident participation in non-commercial, mutual-aid activities.

2.2. Inception and Evolutionary Institutional Design of "Sarari" (Figure 2)(2005–2008)

To transcend these limitations, the Sarabetsu CC Review Committee conducted an extensive comparative study of advanced cases nationwide, such as CC "Genki" in Neyagawa City, Osaka. Through a deliberative dialogue between the practitioner (Oikawa) and the researcher (Nishibe), the committee deliberately pursued a unique institutional design tailored specifically to the socio-economic characteristics of Sarabetsu Village—a structure fundamentally distinct from both traditional commercial gift vouchers and standard volunteer-based "Eco-Money" systems.

This hybrid policy framework was characterized by several innovative institutional features:

- **The Labeling of "Public Interest Currency"**: To clearly demonstrate that this currency serves to promote the public welfare and the well-being of the community rather than narrow personal or commercial interests, they chose the neologism “public interest currency” instead of referring to it simply as a “local currency.”
- **Autonomous NPO Management**: To avoid the top-down, bureaucratic rigidity of a government-led or commerce-led association, the committee decided to establish an independent nonprofit organization (NPO), ensuring that residents held the ownership and initiative of the operation while commercial societies stepped back into a supportive role.
- **The Triad of Revitalization Targets**: The currency explicitly targeted the simultaneous reactivation of three local spheres: the community, volunteer networks, and the commercial regional economy.
- **No Expiration Date for Paper Notes**: Unlike typical commercial vouchers that expire to force short-term spending, Sarari notes were designed with no expiration date, reducing the psychological barrier to holding and circulating the currency within the community.
- **Integration with Public Administration**: The institutional design allowed the currency to be accepted within municipal administrative services, bridging the gap between informal civic mutual aid and formal public governance.
- **The Appointment of a Permanent Volunteer Coordinator**: To dynamically match the supply and demand of local mutual aid services, preventing the structural stagnation common in previous Japanese CC experiments.

After approximately three years of preparation, **Nonprofit organization Donguri Mura (Acorn Village) Sarari** (hereinafter referred to as the **NPO**) was established in April 2008. Subsequently, the operating entity submitted the necessary documents for NPO certification and was officially certified in July.

In October 2008, it completed the registration of Sarari as a third-party issuer of prepaid vouchers; and in November 2008, it began circulating “Sarari,” the public interest currency of Sarubetsu Village.

The key feature of the Sarari is that it is limited to use within the local community and among members, with no expiration date. In addition to being used by volunteers, it can be used as a gift certificate or to pay village taxes and administrative fees; ultimately, it is accepted as payment for goods and services at most shopping districts within the village. The main needs and concerns include support for the elderly and others, such as transportation, weeding and pruning, house cleaning and window washing, taking out the trash, snow removal, and accompanying residents on shopping trips. In addition to addressing these needs, the service is also used as a tool for community-building activities at the level of residents' groups and neighborhood associations.

The NPO's contracted public service support includes managing public facilities such as the village social welfare center, as well as conducting water quality tests for the village's tap water and snow depth observations. It also manages part of the community center, "Sarubetsu Machinaka Koryukan ma·na·ca," which is located in the town center and is owned by the Society of Commerce and Industry. These contracted services are made possible precisely because the NPO shares the principle of public interest with the local government and the Society of Commerce and Industry and maintains strong collaborative relationships and human ties with them; as a result, the NPO has secured an important source of revenue in the form of Yen, ensuring the long-term sustainability of its operations.

Furthermore, the café within ma·na·ca was previously operated by a private group, but following their withdrawal, the NPO Sarari has suceeded to operate it as a venue for community interaction and relaxation.

2.3. Eighteen Years of Institutional Evolution and Current Multi-Faceted Operations (2008–Present)

Since its inception in 2008, Sarari has achieved a high level of adaptability, durability, and institutional embedding within Sarabetsu Village. We have found out in **Table 1** that, over its 18-year trajectory, the NPO has gradually increased its issuarance volume responding to the change of the volume of redenptions of Sarari, and reached up to 4 milion Sarari taking the time of seven yeards, and finally stabilized around the level of 3 ~4 million afterwards. As of now, 18 years later, the unredeemed amount stands at 3.17 million Salari, which represents the money stock circulating or held within the community. This minimal gap indicates a remarkably high resemption rate, reflecting the absence of psychological or physical "hoarding" that typically causes the stagnation of community currencies. This figure is

slightly below the average annual issuance of 3.35 million over the past five years. The amount seems neither too high nor too low, maintaining an appropriate level. While this amount is by no means large, it can be viewed as a sustainable, appropriate scale that meets the entire needs for CC Sarari from the village population of 3,000 people.

Figure 2: 100 Sarari and 500 Sarari vouchers (left) and its circulation scheme (right)



As of the end of March 2025, the association had 231 members, 15 of whom were supporting members. Approximately 8% of the population are members, which is a significantly higher participation rate compared to typical community currencies. The organizational membership structure of the NPO reflects the active civic foundation supporting the currency's circulation.

The annual total operating expenses for Sarari (FY2024 figures) are approximately 13 million yen, and the organization is run by a staff of five regular employees. It has 14 board members (all of whom serve without compensation).

From its inception through FY2022, the organization received subsidies from the village government (up to 1.3 million yen annually, with the final amount being 500,000 yen); however, since then and up to the present, it has operated independently, relying on revenue from its business activities rather than government support. Sarari's long-term sustainability stems from its ability to maintain independent operations without relying on subsidies from local governments or financial support from the Society of Commerce and Industry.

The adaptation process in evolution during 2008 to 2011 can be understood as the take-off phase to the establishment of foundations of Commercial and Non-commercial Reciprocal Circulation supported by the municipal government.

Immediately following the launch of the currency in November 2008, the NPO focused on building both the commercial and non-commercial pillars of circulation. Itinitiated a crutial collaborative service with the Sarabetsu Village Social Welfare Council to manage volunteer transport services, integrating a reciprocal non-commercial system where volunteer activities and mutual aid were connected with the commercial system of "Sarari" currency. Since there were no taxi companies in Sarubetsu Village at the time, an individual launched a welfare taxi service. Because the operator was well-versed in social welfare services, he also joined the board of Sarari. The welfare taxi service and the NPO have filled the gaps in local transportation by collaborating and coexisting.

To ensure the currency's practical economic utility, a landmark commercial partnership was established. "Sarari" has also invited local retailers, restaurants, auto repair shops, and other businesses to participate, expanding its usability to almost all stores in the village, including major supermarkets, gas stations, and national convenience store chains (such as Seven Eleven and Seicomart)

In March 2010, the first "Sarari Community Currecy Gathering" was held, and it has been held annually ever since (the current name is "Sarari Gathering: Because You Are Here, I Am Here")(**Figure 3)**. Residents have been gathering regularly to enjoy events together and have worked with local shops and the Social Welfare Council to set up dessert stands and food and beverage areas, thereby maintaining and strengthening the bonds within the local community.Additionally, in June 2010, Professor Nishibe from University of Hokkaido, Professor Nozomi Kichiji from Asahikawa University, and six others visited Sarubetsu Village as part of an action research project. They observed Sarari's activities and exchanged necessary advice and opinions through training and interaction. Through the interviews, Q&A

sessions during site visits, and subsequent surveys and focus group discussions conducted as part of this action research, “Community Dock” provided guidance and inspiration to both organizers and participants. It can be said that this played a significant role in facilitating Sarari’s swift transition from its initial launch phase to a period of stability.

(Figure 3) Sarari Gathering in 20 Marrh, 2025 (left) and the building of ma・na・ca (right)



This total commercial integration and methodical expansion successfully overcame the liquidity constraints that had caused the stagnation and failure of earlier Eco-Money initiatives in Japan, establishing a robust baseline for local economic circulation.

A major breakthrough in Sarari’s long-term sustainability occurred through deep institutional collaboration with the local government, shifting from reliance on temporary subsidies to a model of public-civil coproduction. Sarabetsu Village became a pioneer by allowing residents to use Sarari for the payment of local municipal taxes, including resident tax, property tax, and light vehicle tax.

Simultaneously, the NPO secured stable operational revenues by dynamically transitioning into a public service contractor for the municipal government. In April 2010, the NPO officially began managing, maintaining, and operating of major public facilities within the village, including the Sarubetsu Village Social Welfare Center, the Ikoi-no-Ie (funeral hall), the Workers’ Hall, the restrooms at the village bus stop, and the management building at the sports field. In subsequent years, the NPO was commissioned to conduct surveys on pedestrian traffic in the town center, water quality testing, meteorological (snowfall) observations, and the preparation of village council meeting minutes. This allowed the NPO

to secure stable contract revenue to fund its core community currency project while simultaneously providing flexible local employment opportunities and active aging opportunities for the elderly.

As Sarabetsu Village faced intense population aging, the NPO progressively focused its core mission on mutual aid, comprehensive elderly care, and subjective well-being. In May 2015, the members of the NPO was formally appointed to the Village Environmental Beautification Promotion Council. In November 2015, the office moved from the Village Social Welfare Center to “Sarubetsu Machinaka Koryukan ma·na·ca,” a downtown revitalization and community center operated by the Sciety of Commerce and Industry. By running a café and other initiatives, the NPO grew even closer to the residents so that they can gather daily for mutual communication, thereby directly combating social isolation among the elderly and increasing the number of women volunteering with the NPO.

The NPO subsequently joined several committees and received external recognitio as followsn, and succeeded in boosting the intrinsic motivation of both organizers and participants.

- **July 2018**: Appointed to the Sarabetsu-version "Active Senior Town" Promotion Council.
- **August 2018**: Participated in the active senior review meeting for the Sarabetsu-version "Active Senior Town."
- **September 2019**: Covered by journalists from *Nikkei Business*.
- **September 2019**: The chairperson of the NPO presented practical insights at the 5th Reaserch Association of Monetary Inovation and Community Complementary Currency Systems (RAMICS) held in Hida-Takayama, Japan.
- **October 2019**: Held a local reporting session within the village to share the conference outcomes.

The institutional resilience of Sarari has drawn substantial external and internal recognition. In July 2018, the NPO was appointed to the Sarabetsu-version "Active Senior Town" Promotion Council. Sarari’s success as an endogenous regional development model attracted national media coverage, notably by *Nikkei Business* in September 2019. In the same month, the NPO's chairperson presented their practical insights at the 5th

International Conference on Community Currency Research (RAMICS) held in Hida-Takayama, which was followed by a local reporting session in October 2019 to share this global recognition back with the villagers. Through a deliberate generational transition and the active inclusion of younger generations and women on its board of directors, the organization continues to sustain its operational metabolism, ensuring that the spirit of evolutionary institutional design remains vibrant for the decades to come.

The quantitative trajectory of Sarari's annual issuance and redemption from its inception in October 2008 to March 2025 is systematically compiled in **Table 1**. All Japanese fiscal year indicators from the original operational ledger have been converted to the Western calendar for analytical consistency.

Table 1: Annual Issuance and Redemption Volumes of the "Sarari" Currency (2008–2025)

Fiscal Period (Year/Month)	Issued 100 Sarari	Issued 500 Sarari	Issued Total (Sarari)	Redemped 100 Sarari	Redempted 500 Sarari	Redempted Total (Sarari)
2008.10 – 2009.09	71,700	247,000	318,700	8,600	44,500	53,100
2009.10 – 2010.09	24,700	853,000	877,700	32,200	604,000	636,200
2010.10 – 2011.09	57,500	375,500	433,000	45,000	555,000	600,000
2011.10 – 2012.09	163,400	1,009,000	1,172,400	123,200	756,500	879,700
2012.10 – 2013.09	2,203,200	873,500	3,076,700	1,970,100	961,000	2,931,100
2013.10 – 2014.03*	667,900	2,018,000	2,685,900	453,700	1,436,000	1,889,700
2014.04 – 2015.03	974,400	3,057,000	4,031,400	1,008,300	2,760,000	3,768,300
2015.04 – 2016.03	143,100	800,500	943,600	368,000	1,503,000	1,871,000

Fiscal Period (Year/Month)	Issued 100 Sarari	Issued 500 Sarari	Issued Total (Sarari)	Redemped 100 Sarari	Redempted 500 Sarari	Redempted Total (Sarari)
2016.04 – 2017.03	801,400	3,287,500	4,088,900	620,600	2,713,500	3,334,100
2017.04 – 2018.03	856,600	3,060,500	3,917,100	751,500	2,846,500	3,598,000
2018.04 – 2019.03	903,600	3,166,500	4,070,100	878,900	3,028,000	3,906,900
2019.04 – 2020.03	719,500	2,881,500	3,601,000	711,500	2,702,000	3,413,500
2020.04 – 2021.03	508,200	1,713,000	2,221,200	540,800	1,730,500	2,271,300
2021.04 – 2022.03	615,100	2,538,500	3,153,600	554,400	2,444,500	2,998,900
2022.04 – 2023.03	651,600	2,610,500	3,262,100	614,200	2,492,000	3,106,200
2023.04 – 2024.03	777,000	3,560,500	4,337,500	715,300	3,196,000	3,911,300
2024.04 – 2025.03	697,500	3,124,000	3,821,500	665,600	3,001,000	3,666,600
Cumulative Total	10,836,400	35,176,000	46,012,400	10,061,900	32,774,000	42,835,900

Note: The period from October 2013 to March 2014 represents a transitional 6-month adjustment phase in the operational ledger.

Unredempted Sarari Currency Stock (As of March 2025)

- **100 Sarari Notes**: 7,745 sheets (774,500 Sarari)
- **500 Sarari Notes**: 4,804 sheets (2,402,000 Sarari)
- **Total Unredemped Active Stock**: **3,176,500 Sarari**

3. Theoretical and Evolutionary Analysis of Long-Term Sustainability

3.1. Mechanism Design vs. Media Design: Money as Media in Evolutionary Institutional Design

To theoretically evaluate the 18-year survival of Sarari, it is essential to contrast the paradigm of **Evolutionary Institutional Design** (Nishibe, 2002, 2012a, 2013)with the dominant neoclassical framework of **Mechanism Design**. Mechanism design primarily operates within the framework of general equilibrium analysis and game theory on the assumption of rationarility of agents and reachability to equilibrium as the stationary state (Hurwicz and Reiter, 2006; Maskin, 2008). It views the market strictly as a price mechanism—often formalized as an auction format—where standard fiat money is treated merely as a neutral veil or a frictionless medium of exchange to facilitate resource allocation. In this rigid mathematical optimization framework, rules are designed top-down under strict assumptions of investor rationality, informational asymmetry, and incentive compatibility to reach a static equilibrium.

In sharp contrast, Evolutionary Institutional Design, rooted in evolutionary economics, redefines money not as a mere transaction tool, but as an **integrative communication media** for **Media Design** (Nishibe, 2002, 2012a, 2013). Rather than treating economic society as a closed system operating solely on market principles, this approach recognizes that a socio-economy is reproduced through the dynamic co-existence and interlocking of three distinct principles: the market (free exchange), the state (redistribution), and the community (reciprocity), as originally conceptualized by K. Polanyi (1944). When global capitalism forces the intensive deepening of markets and strips away the safety nets of the state and community, community currencies (CCs) are introduced not to reach an optimal static equilibrium, but to act as a media that reactivates the faded principle of reciprocity (Nishibe, 2013). Therefore, institutional design cannot be a one-time, top-down configuration; it must be an evolutionary policy process that allows parameters or rules to be continuously updated through trial-and-error based on the bounded rationality and shifting values of local stakeholders.

3.2. Hybrid Circulation in DTS: Complementarity between Commercial and Non-Commercial Flows

The core structural reason why many Eco-Money and community currency initiatives failed nationwide was their inability to sustain fluid circulation. Eco-Money systems designed exclusively for volunteer and mutual-aid activities faced chronic stagnation, where funds accumulated linearly among a select few active members and remained unspent. Conversely, purely commercial vouchers failed to foster broader social reciprocity because they were too rapidly redeemed for legal tender at local retail shops, reverting the system back into standard market transactions.

Sarari overcomes this structural gridlock by adopting a hybrid circulation design that capitalizes on the institutional and organizational lessons of the Tomamae Town experiments conducted between 2004 and 2006. In the Tomamae experiment, network analyses of circulation flows empirically demonstrated a vital economic principle: **non-commercial transactions (such as volunteer work and mutual aid) and commercial transactions (shopping at local retailers) must complement each other to accelerate currency velocity in Double Triangle System (DTS)** (Nishibe 2004, Kichiji and Nishibe, 2008). When a community currency is generated through volunteer services and then spent in commercial stores, the non-commercial reciprocity acts as a driving catalyst that increases the overall circulation tree and network density. However, if the system is driven strictly by commercial entities like chambers/ societies of commerce and industry, it fails to trigger spontaneous resident participation in mutual aid, reducing the currency to a mere commercial voucher.

By applying this evolutionary lesson, Sarari was intentionally designed to capture both commercial liquidity and non-commercial reciprocity. It secured participation from local retailers (including supermarkets and convenience stores), which eliminated the liquidity trap. Simultaneously, it integrated volunteer transport and care services. As shown in the cumulative empirical data in **Table 1**, this hybrid design prevented the hoarding of unspent funds, maintaining a balanced relationship where high annual issuance is consistently matched by a high redemption rate back into the system.

3.3. Organizational Sustainability and Metabolic Turnover

Beyond the structural flow of the currency media, the long-term sustainability of Sarari is heavily driven by its organizational governance, which avoids both market and government failures (Ostrom, 1990). Traditional Japanese CCs often collapsed after three to four years because they were heavily reliant on temporary administrative subsidies and led by bureaucratic local governments or top-down business associations such as chambers/ societies of commerce and industry.

Sarari's evolutionary resilience stems from three organizational strategies aligned with sustainable governance of the commons:

- **Transition to Public-Civil Coproduction**: While the NPO accepted administrative subsidies from its inception until 2022 to stabilize initial operations, it successfully transitioned to complete fiscal autonomy by contracting public facility management from the municipal government (e.g., the Social Welfare Center, etc). These revenue-generating public contracts provide a stable, long-term financial foundation that funds the NPO's core community operations without administrative dependency (Pestoff, 2012).
- **Institutional Nesting with Public Functions**: By allowing Sarari to be used for local municipal fees or taxes and collaborating with administrative bodies, the system elevates the community currency from an informal barter ring into a formally nested public institution, drastically reducing the transaction and psychological costs for residents (Ostrom, 1990).
- **Smooth Organizational Metabolism and Inclusive Leadership**: The governance of the NPO is sustained by uncompensated, dedicated local leaders, combined with the active inclusion of women and younger generations on the board of directors. The operation of the community café inside the "ma・na・ca" (**Figure 3**) exchange facility acts as a decentralized, physical infrastructure where communication is constantly face-to-face, allowing the organizational structure to dynamically adjust its parameter designs to match the village's shifting social environment.

4. The "Community Dock" Methodology and Its Empirical Impact

4.1. The Framework of Community Dock and Action Research Process

The unique methodological contribution of this study lies in the application of the "Community Dock" framework. Unlike conventional top-down socioeconomic evaluations, the Community Dock operates as a participatory policy checkup, utilizing iterative resident surveys and focus group discussions to trigger reflexive learning and institutional adjustments among local stakeholders (Nishibe, 2006, 2013,2018, Kusago, Nishibe, 2018). This action research process in Sarabetsu Village was executed via two foundational operational waves: a Preliminary Survey conducted prior to the currency's launch on October 13, 2006, and an extensive Post-Implementation Survey conducted in December 2011 to evaluate intermediate impacts.

The 2006 Pre-Survey selected 500 households from within the village, capturing general awareness of village life, knowledge of local currencies, and the usage rates of existing commercial gift certificates (such as the Donguri Village Gift Certificates and Stamps). It yielded 183 responses (a 36.6% response rate). In December 2011, the Post-Survey tracked 500 households using an expanded questionnaire covering subjective happiness, community activities, life satisfaction, and explicit interactions with the public welfare currency Sarari. This survey achieved an exceptional response rate of 93.0% (465 respondents), establishing a robust empirical dataset (Nishibe, 2018).

4.2. Comparative Analysis of Pre- and Post-Implementation Data

A longitudinal comparison between the 2006 and 2011 datasets reveals a profound transformation in civic awareness and conceptualizations of community value.

Structural Shift in Currency Awareness and Perception

As illustrated in the tracked metrics, resident familiarity with the concept of a community currency grew substantially after implementation:

- **Familiarity (Question: "Are you familiar with local currency?")**: In the 2006 Pre-Survey, only 24.2% (45 people) answered they were "very familiar". By 2011, this segment expanded to 37.4% (174 people). Combined with those who "had heard of it" (58.3% in 2011), the overall baseline awareness reached 95.7%, while the "not at all familiar" segment plummeted from 15.6% to 3.2%.

- **Perception (Question: "What is your perception of local currency?")**: The conceptualization of what a currency represents underwent a clear qualitative shift. The association of local currency with "Volunteering" grew from 18.6% (34 people) to 26.0% (121 people), reflecting an advanced cognitive linking between money and civic mutual aid. Meanwhile, "Community Revitalization" remained the dominant institutional identity, recognized by 39.4% of the population in 2011.

Inflow Channels and Transaction Utilization

The 2011 survey mapped the concrete behavioral integration of Sarari into daily life:

- **Acquisition Channels**: When asked how they obtained Sarari (multiple answers allowed), 60.2% reported they had never obtained it. However, among active circulators, the primary acquisition channels were deeply tied to reciprocity and communal support: 12.0% obtained it as a "gratuity for assistance," 9.5% "as a token of appreciation for participating in local volunteer activities," and 14.0% through informal social networks as "gifts, celebrations, or get-well wishes". Direct purchases at the NPO accounted for only 8.0%.
- **Utilization Purpose**: In terms of expenditure (multiple answers allowed), "shopping in a shopping district" emerged as the primary functional destination at 29.9% (139 respondents), confirming that social reciprocity effectively converted into local economic liquidity. This was followed by "a thank-you for helping out" at 8.4%. Institutional utilizations, such as the "payment of taxes" or "fees for public facilities," registered at an initial baseline of 0.4% each during this phase.

4.3. Subjective Happiness and Community Ties: The 2011 Baseline

The 2011 Community Dock established an empirical connection between community currency systems and Subjective Well-Being (SWB). The average happiness score for Sarabetsu Village residents was recorded at **7.04 points** out of 10. This represents a significant elevation—approximately 10% higher—compared to the national baseline average of 6.47 points reported in the Cabinet Office survey.

Crucially, cross-tabulation analysis confirmed that SWB is heavily stratified by civic engagement and institutional recognition:

- **Community Engagement and SWB**: Residents who actively participated in community activities consistently exhibited higher average happiness scores than non-participants. This divergence was most pronounced in volunteer networks (Participants: 7.73 points vs. Non-participants: 6.93 points), PTA activities (7.55 vs. 6.96), and local women's associations (7.49 vs. 6.99).
- **Currency Awareness and SWB**: A direct positive correlation was verified between the cognitive awareness of Sarari and subjective well-being. Individuals who were "very familiar" with Sarari registered the highest average happiness score at **7.24 points**. Those who "had heard of it" averaged **6.96 points**, whereas residents who were "completely unaware" of the currency fell to a baseline of **6.07 points**. This gap provides strong evidence that institutional visibility and integration into local media design are tied to higher individual well-being.

4.4. Longitudinal Well-Being Indicators (2022–2025): SCI-Japan LWCI Analysis

To track Sarari's long-term institutional impacts, the analysis incorporates recent individual survey data (2022–2025) derived from the municipal dashboard of the "Liveable Well-Being City Indicator (LWCI)" operated by the Smart City Institute Japan (SCI-Japan)(Smart City Institute Japan (SCI-Japan, 2022).

Table 2: Trends in the Sarubetsu Village Comprehensive Well-Being Index (FY2022–2025)

Indicator / Metric	FY 2022 (n=944)	FY 2023 (n=750)	FY 2024 (n=517)	FY 2025 (n=411)	Range of Change
Individual Happiness (0–10 points)	7.1	7.1	7.1	7.1	±0.0
Life Satisfaction (0–10 points)	—	6.7	6.6	6.9	+0.3 (6.6➔6.9)

Indicator / Metric	FY 2022 (n=944)	FY 2023 (n=750)	FY 2024 (n=517)	FY 2025 (n=411)	Range of Change
Happiness in 5 Years (0–10 points)	—	6.5	—	—	—
Happiness in the Town (0–10 points)	6.5	6.5	6.5	6.5	±0.0
Perceived Happiness of Others (1–5 points)	—	3.4	3.4	3.4	±0.0

Note: "—" indicates items that were not measured during that specific fiscal year. All scores denote localized sample averages.

As shown in **Table 2**, individual happiness has remained remarkably stable at **7.1 points** over the four-year period, showing no significant variation from the 2011 survey results and remaining consistently higher than the national 6-point average. The statistical mode for happiness was a score of 8 across all years (accounting for 23.5%–23.9%), with the high-score group (6–10 points) encompassing over 70% of the entire population.

Concurrently, "Life Satisfaction" experienced a positive shift, rising to its highest level of **6.9 points** in FY2025, a trajectory correlated with the full-scale deployment of the Super Village Initiative launched in June 2022. In contrast, the "town-wide happiness score" remained rigid at **6.5 points**. This minor gap (0.6 points lower than individual scores) reflects a structurally common national trend where residents rate their personal status highly while evaluating the broader collective context somewhat more conservatively. The metric "People around me seem happy" remained stable at 3.4 points out of 5, sitting comfortably above the median of 3.0.

4.5. Factor Analysis: The Dichotomy of Rural Abundance and Convenience

To dissect the structural drivers of Sarabetsu's SWB, **Table 3** lists the standardized subjective scores (where the national average is calibrated to 50) and objective statistical indicators across 24 specific factors.

Table 3: Factorial Breakdown of Subjective and Objective Well-Being Scores (FY2022–2025)

Factor Classification	Subjective FY2022	Subjective FY2023	Subjective FY2024	Subjective FY2025	Objective 2025
Environmental Harmony	—	108.8	98.4	106.3	57.9
Connection to the Community	87.8	105.8	81.8	87.0	55.2
Child-rearing	—	91.5	82.4	75.4	48.0
Nature's Bounty	83.0	76.7	77.9	78.7	50.5
Housing Environment	82.9	72.3	77.3	78.7	55.1
Natural Disasters (Security)	—	92.0	74.6	85.0	48.7
Culture and Arts	82.3	81.6	68.9	72.5	44.4
Self-efficacy	—	57.8	60.5	69.1	68.3
Healthcare and Welfare	65.1	71.6	60.1	65.9	53.7
Local Government	75.0	70.5	61.9	63.2	51.0
Accidents and Crimes	—	76.9	54.8	59.5	66.5

Factor Classification	Subjective FY2022	Subjective FY2023	Subjective FY2024	Subjective FY2025	Objective 2025
Primary/Secondary Education	—	60.8	54.5	55.4	40.8
Diversity and Tolerance	—	73.4	56.6	55.5	44.5
Abundance of Ed. Opportunities	—	59.8	50.1	53.6	46.1
Digital Life	—	58.7	50.2	50.3	41.1
Public Spaces	70.8	63.1	51.5	48.5	44.2
Urban Landscape	—	53.4	43.0	43.7	35.7
Business Creation	75.4	53.0	39.6	37.7	44.0
Recreation & Entertainment	—	37.6	31.1	36.7	56.3
Transportation	—	36.1	34.4	35.5	27.5
Employment and Income	—	42.8	32.8	32.7	67.5
Shopping and Dining	—	17.2	15.9	19.9	41.4

Note: Standardized scores are scaled such that 50 represents the national average. High subjective groups and critically low groups reveal the internal polarization of rural well-being.

Key Structural Insights from Factorial Tracking

1. **The Core Strengths of Rural Abundance**: Factors such as "Environmental Harmony" (106.3 in FY2025), "Connection to the Community" (87.0), and "Child-rearing" (75.4) have consistently tracked at exceptionally high levels. This confirms that the village's agricultural landscape, paired with well-established mutual-aid networks, provides deep subjective value to the residents.
2. **The Chronic Constraints of Living Convenience**: Conversely, "Shopping and Dining" remains extremely low (19.9 in FY2025), matching the structurally low scores of "Mobility and Transportation" (35.5). This reveals a stark dichotomy: while the objective economic status of the large-scale farming sector is high (Objective Income: 67.5), subjective satisfaction with occupational freedom and lifestyle convenience remains restricted (Subjective Income: 32.7).
3. **The Erosion of Public and Administrative Capital**: Over the 4-year tracking window, "Business Creation" suffered a steep drop of approximately 38 points (75.4➔37.7), highlighting a severe decline in entrepreneurship metrics. Concurrently, both "Public Spaces" (48.5) and "Local Government" (63.2) exhibit a steady downward trend.
4. **The Expansion of Self-Efficacy**: In direct opposition to the declining trends, "Self-Efficacy" marked a substantial rise, climbing from 57.8 in FY2023 to **69.1** in FY2025. This improvement is structurally interpreted as a joint product of expanding resident participation via the Super Village concept and the active face-to-face mutual-aid networks sustained by the community currency Sarari.

In conclusion, while the public interest currency Sarari successfully acts as an institutional stabilizer that secures high community ties, child-rearing environments, and individual self-efficacy, its current parameter configurations do not directly alleviate the structural deficits in shopping convenience or local economic mobility. Sarabetsu Village presents a classic polarized well-being profile: individual happiness is securely insulated by rural environmental abundance and civic reciprocity, yet bounded by long-term concerns regarding future regional sustainability and lifestyle convenience.

5. Conclusion and Discussion

5.1. Addressing the Core Question: Why Most CCs Fail vs. Why Sarari Succeeds

This study has addressed the fundamental question raised at the outset of this paper: **Why are community currencies (CCs) generally not sustainable over the long term, and conversely, what explains the exceptional 18-year survival and continuous operation of Sarari in Sarabetsu Village?**

As contextualized in the literature and early historical waves, the vast majority of CC initiatives globally and within Japan have trended not to last very long. The non-convertible, non-commercial "Eco-Money" systems that boomed throughout Japan in the early 2000s—including Hokkaido's relatively large-scale "Kurin" experiment in Kuriyama—ultimately failed to endure because they were driven by administrative initiatives, remained heavily reliant on temporary subsidies, and suffered from monetary stagnation within isolated volunteer circles. Similarly, prominent international examples like Argentina's RGT or the UK's Bristol Pound and Brixton Pound faced structural limitations in maintaining long-term circulation. Precisely because the fundamental mission of CCs lies not in the infinite expansion of transaction scale but in sustaining a long-term, reliable mutual aid safety net for residents, understanding the secrets behind Sarari's longevity is of paramount academic and practical importance.

Based on the empirical findings and action research documented in this paper, Sarari's remarkable 18-year longevity is considered the combined result of the following five structural factors:

1. **"Evolutionary Institutional Design" and Multiple-Circulation Architecture**: Sarari was institutionally designed as a public welfare currency (The NPO describes itself as a "public interest currency") to simultaneously revitalize the local economy and the community. Rather than adhering to a rigid static model, it evolved through trial-and-error refinement of past failed systems. Specifically, it introduced a multiple-circulation voucher system, which was made operationally and legally possible by actively utilizing the regulatory easing of the national Structural Reform Special Zones tailored strictly to Sarabetsu's regional realities. This longevity strongly indicates the practical validity of the method of **Evolutionary Institutional Design** (Nishibe, 2002, 2012a, 2013, 2016, 2018).

2. **NPO Governance Structure Balancing Dual Objectives**: Building directly on the critical operational lessons from the Hokkaido Federation of Societies of Commerce and Industry' early CC experiment in Tomamae Town, Sarabetsu Village established an independent NPO—rather than a society of commerce and industry or a government office—as the core operating body. This specific organizational structure successfully balances the dual objectives of local economic revitalization (secured via broad commercial shop participation) and local community revitalization (sustained through the continuous practice of volunteerism and mutual aid).

3. **Strong Administrative Cooperation and Public-Civil Coproduction**: Structural cooperation with the village administration is exceptionally strong. Sarari is deeply embedded into formal public functions, allowing residents to use the currency for the payment of resident taxes and administrative facility fees. Furthermore, the local government formally entrusted the NPO with public facility management contracts, securing a stable operational income that ensures the fiscal autonomy of the currency system without relying on temporary project subsidies.

4. **Stable Core Leadership and Inclusive Communicative Infrastructure**: The internal governance of the NPO is underpinned by the stable, resilient leadership provided by its core members. The active, front-line participation of many female staff members has provided deep social trust and community embeddedness. Crucially, the daily operation of the physical café functions as a casual consultation and communication space, preventing social isolation and keeping parameter adjustments responsive to residents' daily needs.

5. **Participatory Action Research via the "Community Dock" Framework**: The academic research group maintained an active posture of participatory action research rather than detached observation. Through the long-term execution of the **Community Dock** framework, the continuous involvement of researchers in system design, the empirical feedback of longitudinal life-satisfaction and well-being surveys, and the active facilitation of multi-stakeholder dialogue successfully fostered deep interpersonal ties and shared values. This university-community collaboration strengthened essential bonds of trust among the local administration, residents, and users, serving as a key institutional source of legitimacy and reliability

supporting Sarari's long-term operation (Nishibe, 2006, 2013, 2018, Kusago, Nishibe, 2018).

5.2. Policy Implications for Regional Well-Being and Sustainability

The synthesis of these five factors yields critical policy implications for regional revitalization and sustainable commons governance in aging, depopulating rural societies. The polarized well-being profile of Sarabetsu Village analyzed in Chapter 4—where immense material agricultural abundance co-exists with chronic subjective deficits in daily lifestyle convenience (shopping and mobility)—demonstrates that economic growth alone can no longer serve as the sole vehicle to increase human well-being.

Therefore, a sustainable CC must not pursue fleeting trends or mere expansion. Instead, policy interventions must treat CCs as an integrative communication media designed to cross-lock with spatial and digital welfare infrastructures—such as the recent Super Village Initiative. By transforming external economic revenues into internal, non-market reciprocal networks, a properly docked community currency can successfully foster civic self-efficacy and long-term subjective well-being.

5.3. Concluding Remarks

In conclusion, Sarari stands as an international benchmark proving that money can be consciously re-designed to serve as a resilient medium for civic mutual aid and regional care. As a collaborative academic artifact, this paper itself—co-authored through reflexive dialogue between localized NPO practitioners, regional project design analysts, and evolutionary and institutional economists—embodies the very essence of the trial and error and learning loop championed by the Evolutionary Institutional Design andn Community Dock methodology.

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ARCHITECTURE AS POLICY: VELOCITY OUTCOMES IN THE WÖRGL DEMURRAGE EXPERIMENT AND THE WIR CLEARING NETWORK

Dimitris Platchias[1]-[2]

Abstract

Contemporary central bank digital currency (CBDC) designs rely on constraints, such as holding limits, non-remuneration, and intermediation rules to manage the tension between circulation and storage. This paper argues that architectural choices, not constraints, are a potentially important determinant of monetary velocity, drawing on two historical cases where deliberate design features produced sustained circulation outcomes. These findings are consistent with the proposition that architecture shapes incentives in ways that constraints alone do not. In the 1932–33 Wörgl experiment, a 1% monthly demurrage fee on labour certificates produced a circulation rate estimated at 8–14 times higher than the national schilling, coinciding with an approximately 25% decline in local unemployment (a figure that combines fiscal-multiplier and velocity effects, as discussed in §3.3) during a period of national economic contraction. The experiment ended not through internal failure but through regulatory intervention by the Austrian central bank. In the WIR Bank (est. 1934), a closed-network clearing architecture sustained bilateral and multilateral B2B settlement among Swiss SMEs for nine decades without demurrage, achieving countercyclical stability during recessions. Using Blanc's (2011) framework for monetary plurality, we classify the architectural features — demurrage, convertibility rules, network membership, clearing design — that determined circulation outcomes in each case. We ask: under what conditions can an architecturally distinct monetary instrument sustain its circulation function alongside a dominant national currency? Our findings

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suggest that architectural separation of spending and saving functions is a historically attested condition for sustained velocity enhancement, while the specific mechanism (demurrage vs. network clearing) determines the character but not the existence of the velocity effect. These historical findings have direct implications for contemporary CBDC design, where the velocity problem has re-emerged in digital form.

Keywords: monetary velocity, complementary currencies, demurrage, WIR Bank, Wörgl, CBDC design, monetary plurality, architectural separation

1. Introduction

The problem of monetary velocity is not new. John Maynard Keynes identified the liquidity preference trap — the tendency for agents to hoard money rather than spend it — as a central obstacle to monetary policy transmission (Keynes, 1936). Irving Fisher, writing in the depths of the Great Depression, proposed stamped scrip as a mechanism for forcing circulation (Fisher, 1933). Silvio Gesell, whose work influenced both, argued that money bearing a carrying cost would circulate more freely than money that could be held costlessly (Gesell, 1916/1958). These insights were largely set aside as monetary economics developed through the post-war period, when velocity appeared stable and monetary transmission appeared reliable.

However, the risk of money being hoarded rather than circulated has returned in a new institutional form. Four of the world's most significant central banks are currently designing retail CBDC architectures, namely the European Central Bank (ECB, 2023, 2024, 2025), the Bank of England (BoE, 2023), the Monetary Authority of Singapore (MAS, 2023), and Brazil's Banco Central (BCB, 2024). Each institution is independently encountering the same structural tension: digital money that is sufficiently attractive to hold tends to be held, not spent. Each is responding with constraints, such as holding limits, non-remuneration and conditionality that manage the hoarding incentive without addressing its architectural source.

This paper argues that the historical record offers a more instructive guide than is currently recognised in the CBDC design literature. Two cases from the 1930s produced sustained monetary circulation outcomes through deliberate architectural choices directly relevant to the design questions currently under active consideration. The 1932–33 Wörgl experiment in

Austria produced a locally circulating demurrage certificate whose velocity was estimated at 8–14 times that of the national schilling (Schwarz, 1951; Broer, 2007). The WIR Bank, established in Switzerland in 1934, created a closed-network clearing architecture that has sustained B2B settlement among Swiss SMEs for nine decades, exhibiting countercyclical properties formally documented in the monetary economics literature (Stodder & Lietaer, 2016). In neither case was the high-velocity outcome produced by an administrative quantity constraint on holding. In Wörgl, circulation was accelerated by demurrage: a carrying cost imposed on idle balances. In WIR, circulation emerged from the architecture of the mutual credit network itself — membership restrictions, limited convertibility, and clearing rules that made balances most useful when spent rather than held. We acknowledge at the outset that the institutional gap between these historical instruments and a sovereign retail CBDC is substantial: current designs respond to legitimate financial-stability and bank-disintermediation concerns that the historical cases did not face. The argument of this paper is not that constraint based approaches are wrong, but that the architectural dimension of the velocity problem has been left underexplored alongside them.

The paper proceeds as follows. Section 2 develops the theoretical framework. Sections 3 and 4 present the Wörgl and WIR cases respectively. Section 5 offers a comparative analysis and derives the central finding. Section 6 discusses implications for contemporary CBDC design. Section 7 concludes.

2. Theoretical Framework: Monetary Plurality and Architectural Classification

Before proceeding, it is worth clarifying the terminology used throughout this paper. Holding limits are administrative quantity constraints: externally imposed ceilings on the volume of currency an individual or institution may hold. Non-remuneration is the decision to pay no interest on balances, reducing the instrument's attractiveness as a store of value relative to interest-bearing alternatives. Demurrage is a carrying cost: a periodic deduction from face value that imposes a direct price on holding idle balances. Network closure is a structural restriction on the set of counterparties or transactions in which the instrument can be used. These mechanisms differ in their efficiency, distributional, and institutional implications.

The analysis draws on Blanc's (2011, 2017) framework for monetary plurality, which provides a systematic basis for understanding monetary instruments operating alongside national

currencies. Blanc defines monetary plurality as the coexistence of multiple means of payment and/or units of account within a single economic space, and identifies four dimensions along which complementary currencies vary: the instrument's unit of account (whether it is tied to the national unit or autonomous), its convertibility (whether and at what rate it can be exchanged for national currency), its governance structure (the rules determining who can issue, hold, and spend the instrument), and its circulation mechanism (the features that shape velocity and holding patterns).

The most important dimension for this paper is the circulation mechanism. We distinguish three mechanisms through which complementary currencies promote circulation. First, incentive-based circulation: positive rewards or discounts encourage spending. Second, disincentive-based circulation: explicit costs on holding idle balances — as in demurrage, where a periodic deduction of face value encourages more rapid expenditure. Third, structurally embedded circulation: the architecture of the monetary network itself creates transactional incentives. Network-based clearing instruments such as the WIR Bank occupy this position — circulation arises not from yield adjustments but from the restricted use-domain of the network, where balances can only realise value through exchange with other members.

This typological distinction maps onto a broader argument about the relationship between monetary architecture and monetary velocity. The standard quantity-theoretic treatment of velocity (Fisher, 1911) and the inventory-theoretic models of Baumol (1952) and Tobin (1956) both treat the architectural features of the monetary instrument as a fixed background condition rather than as a policy variable. The liquidity preference tradition (Keynes, 1936) brings the demand to hold money into the analysis but treats it primarily as a behavioural response to uncertainty rather than as an architectural variable. This paper argues that the architectural features of the monetary instrument are not merely a fixed background condition but a potentially important policy variable — one that historical and institutional evidence suggests can be deliberately designed to produce sustained circulation outcomes.

Architectural features of the monetary instrument — specifically, whether its design creates costs to holding, or structurally embeds circulation through network membership — are material determinants of velocity not explicitly modelled in standard treatments. This is not a novel theoretical claim: Gesell (1916/1958) and Fisher (1933) both made versions of

it. What is novel is the availability of two historical cases that allow the claim to be evaluated with quantitative evidence, and the contemporary relevance of CBDC design decisions currently under active consideration.

This paper's framing as a study of monetary architecture is directly complementary to recent theoretical work on CBDC as a question of monetary system design. Niepelt's work (2024, 2026) represents the most developed contribution at the theoretical level: both studies frame CBDC design explicitly as an architectural question about how digital money interacts with the balance sheet structure of the banking system and the transmission channels of monetary policy. The present paper's historical findings can be read as complementary empirical evidence for the architectural questions Niepelt raises theoretically; specifically, whether instrument design determines circulation and hoarding incentives in ways that are not captured by standard quantity-theoretic or inventory-theoretic frameworks. The cases of Wörgl and WIR do not resolve Niepelt's theoretical questions, but they illustrate that the architectural dimension he identifies at the theoretical level has historical precedent and measurable empirical consequences.

3. The Wörgl Experiment, 1932–33

3.1 Historical Context

The Wörgl experiment took place in a small Austrian town of approximately 4,300 inhabitants during one of the most severe episodes of economic contraction in Austrian history. Between 1929 and 1933, Austrian output fell by roughly one-fifth, unemployment rose above

30% by some measures, and municipal governments faced severe fiscal pressure from declining tax revenues and rising welfare demands (Broer, 2007). Wörgl's situation was typical: by mid-1932 the town had accumulated substantial debt to its creditors, planned municipal projects had stalled for lack of funds, and local businesses were experiencing acute liquidity constraints.

Michael Unterguggenberger, the mayor of Wörgl, was familiar with the work of Silvio Gesell through the Freiwirtschaft movement, which had advocated stamped scrip and "free money" as a response to deflationary hoarding since the 1920s. In July 1932, with the support of the town council and with schilling reserves deposited as backing,

Unterguggenberger introduced Wörgl's own complementary currency: the Arbeitsbestätigung, or labour certificate.

3.2 Architectural Features

The Wörgl labour certificate had four defining architectural features that distinguish it from both the national schilling and from standard complementary currencies. Demurrage at 1% per month. Each certificate required a monthly stamp costing 1% of face value to maintain its full redemption value (for example, a holder of a 10-schilling certificate who failed to stamp it after one month would face a 0.1-schilling loss in redemption value unless the missing stamp was purchased). This imposed a direct and predictable cost on holding idle balances, creating a strong incentive to minimise holding duration and spend the certificate quickly.

Parity with the national schilling. Each certificate was issued at parity with the schilling, and local banking arrangements allowed conversion back into schillings at par, subject to a conversion fee (commonly cited as 2%). This anchored the instrument's value to the national currency and reduced merchant acceptance risk.

Localised acceptance network. Certificates were initially distributed as wages to municipal workers, and local merchants agreed to accept them as payment. Although there was no formal geographic restriction, the practical acceptance network was highly localised, creating a natural circulation boundary without administrative enforcement.

Revenue recycling to the municipality. Stamp revenues generated by the demurrage mechanism flowed back to the town administration and were used to finance public works. This gave the circulation mechanism a fiscal dimension, linking monetary circulation to local public investment.

3.3 Circulation and Economic Outcomes

The quantitative evidence on the Wörgl experiment is drawn primarily from Schwarz (1951), whose archival study of Wörgl municipal records remains the most detailed primary source analysis of the experiment, and from Broer (2007), whose reassessment of the Schwarz data provides the most methodologically careful quantitative treatment available in the secondary literature.

The most widely cited finding is the circulation velocity estimate. Schwarz (1951) estimated that certificates circulated at 8–14 times the velocity of the national schilling during the experiment's active period (July 1932 to September 1933). This estimate is derived from the total value of transactions recorded in the Wörgl certificate ledger relative to the outstanding stock of certificates at each point in time. The range of 8–14 reflects genuine uncertainty about the completeness of transaction records: the lower bound of 8 times is derived from confirmed and legible ledger entries; the upper bound of 14 times extends the estimate to include transactions that Schwarz identifies as likely but for which documentary evidence is partial or illegible. Broer (2007) treats the lower bound as the more defensible figure and uses 9–10 times in his own calculations; this paper cites the full Schwarz range to preserve transparency about the evidential basis.

The economic impact data are consistent with high monetary velocity. Wörgl's unemployment, measured by workers registered with the municipal employment office, fell by roughly 25% between July 1932 and July 1933, according to Broer's (2007) reanalysis of Schwarz's municipal archive data. This contrasted with the national trend: Austrian unemployment remained at or near peak levels for much of the same period (Stiefel, 1979). During the experiment, the town completed several public works projects, including road repairs, a ski jump, and improvements to the municipal water system — projects that had previously stalled for lack of funds. However, the decline in unemployment likely reflected multiple channels. Because the certificates were issued as municipal wages to finance construction work, the programme combined a standard fiscal multiplier effect with the intended velocity mechanism. With the available data, it is difficult to isolate the effect of the monetary design from the underlying fiscal stimulus; both probably contributed to the observed outcomes.

Tax receipts to the municipality also increased substantially. Schwarz (1951) records that municipal tax arrears—unpaid taxes that had accumulated during the preceding years of contraction—were substantially reduced during the experiment period, as businesses and individuals used certificates to settle obligations to the town. This is consistent with a high velocity local currency: agents who held certificates faced a carrying cost and therefore had a strong incentive to use them for any available purpose, including tax payment. One piece of contemporary experimental evidence qualifies the inference from the velocity data. Boehm, Fize and Jaravel (2025) found in a randomised experiment that hard expiry raised

one-month spending propensity from 23% to 61%, while slow continuous melting — the configuration closest to Wörgl's 1% monthly fee — produced a statistically insignificant effect. The Wörgl velocity evidence is consistent with a circulation outcome; the experimental evidence suggests the demurrage mechanism specifically may not have been the primary driver, with the fiscal channel and arrears-settlement effects remaining plausible alternatives the data cannot exclude.

3.4 Termination

The experiment ended not through internal failure (there does not appear to be any evidence that the certificates lost the confidence of local users or that circulation declined) but through intervention by the Oesterreichische Nationalbank, which invoked the federal statutory monopoly on currency issuance and prohibited the continuation of the Wörgl scheme in September 1933. Unterguggenberger's legal challenge was unsuccessful. The experiment had attracted international attention — visitors from across Europe and the United States came to observe it, and numerous other Austrian communities were reportedly preparing to introduce similar schemes when the prohibition was issued (Schwarz, 1951). The political economy of the termination is itself instructive: the central bank's intervention appears to have been driven primarily by concern about the proliferation of parallel currencies and the erosion of its monetary monopoly, not by any failure of the scheme to achieve its stated circulation objectives. It is also worth noting that the Nationalbank did not adopt demurrage itself as a policy tool; its concern was with unauthorised parallel currency issuance rather than an assessment of demurrage's economic merits, a distinction that matters for interpreting the institutional lessons of the case.

4. The WIR Bank, 1934–Present

4.1 Historical Context and Founding

The WIR Bank was established in Zurich in October 1934 by a group of sixteen Swiss businessmen who had experienced severe liquidity constraints during the deflationary crisis of the early 1930s. The founders were influenced by the Freiwirtschaft movement and by the cooperative banking tradition of the Swiss Raiffeisen network. Unlike the Wörgl experiment, which was a municipal initiative with a defined geographic scope,

WIR was conceived from the outset as a national mutual credit network for small and medium-sized enterprises.

The WIR franc (CHW) was introduced as a unit of account distinct from the national Swiss franc (CHF), although it was initially pegged at parity conceptually. It is important to note that this parity is a unit-of-account convention, not a standard fixed exchange rate regime: WIR convertibility into CHF is structurally restricted and discouraged, meaning that WIR balances cannot be freely exchanged for Swiss francs at will. This restricted convertibility is itself a key architectural feature, not a minor technical detail. The founding principle was that members of the network could transact with one another in WIR francs without requiring Swiss franc liquidity; a direct response to the credit constraints that had strangled SME activity during the Depression. The WIR Bank recorded bilateral and multilateral credits and debits among members within a mutual credit clearing system, without requiring one-for-one Swiss franc reserves to back WIR balances.

4.2 Balance-Sheet Mechanics and the Inside Money Character of WIR

A theoretically important distinction separates the monetary character of WIR from that of the Wörgl certificates. Wörgl certificates were issued against a reserve of national schillings held by the municipality: each certificate corresponded to a schilling deposit, making them a form of outside-like scrip — a warehouse claim on a fixed stock of the national currency. The WIR franc, by contrast, is created through mutual credit: when member A purchases from member B, A's WIR account is debited and B's is credited, with the WIR Bank intermediating the ledger, setting credit limits, and managing defaults. No prior accumulation of WIR francs is required; the act of purchase creates the currency. This makes WIR closer to inside money in the Gurley-Shaw (1960) sense: it is a liability of the banking institution (the WIR Bank) rather than a claim on an exogenous asset stock, and its total supply expands and contracts endogenously with the transactional demand of the network.

This distinction has macroeconomic significance that the Minsky-Kindleberger tradition helps to illuminate. In Minsky's financial instability framework (1986), systemic fragility arises from the endogenous creation of inside money against speculative positions. The WIR system instantiates a structurally distinct version of inside money creation: WIR credit is extended against trade obligations rather than financial assets, and its convertibility restrictions mean that WIR balances cannot easily migrate into speculative

circuits. Kindleberger's (1978) historical work on financial crises supports this interpretation: mutual credit systems providing trade finance independently of the national credit cycle can stabilise commercial flows precisely during the deleveraging episodes when conventional credit contracts sharply.

This reading does not imply that WIR is without fragility. The inside money character of WIR also means that the system carries its own credit risk: member defaults require the WIR Bank to absorb losses, and the possibility of default cascades through the clearing network is a structural fragility that any scaled implementation of mutual credit logic would need to address explicitly, a limitation that demurrage-based instruments with full backing do not share.

4.3 Architectural Features

Closed-network membership. Participation in the WIR system is restricted to registered members of the WIR Bank, which has historically been limited to Swiss SMEs. Members agree to accept WIR francs from other members in partial payment for goods and services. This closed-network architecture appears to be the primary driver of WIR velocity: a WIR balance can only be spent within the network, creating a strong incentive to find uses for WIR balances rather than accumulate them. Unlike demurrage, this is a structural rather than a cost-based circulation incentive.

No demurrage. WIR francs bear no carrying cost in their mature and current form. Historically, negative-interest or free-money devices similar in spirit to demurrage were used in WIR's early years from approximately 1934 to 1948, before being dropped in favour of the pure mutual credit model that has characterised WIR since (Stodder & Lietaer, 2016, p. 574). Readers should note that the 1934–48 WIR and the post-1948 WIR represent institutionally distinct arrangements; this paper focuses on the mature post-1948 architecture, which is the design whose countercyclical properties have been formally documented. The mature architecture imposes no periodic deduction of face value, no stamp fee, and no explicit penalty for holding. The circulation incentive is predominantly structural: the limited convertibility of WIR balances into Swiss francs means that accumulated WIR balances have diminishing marginal utility beyond a certain point, encouraging spending within the network. This institutional history is itself instructive for the comparative argument: the early WIR (1934– 48) employed demurrage-like devices alongside network closure, while the post-1948 WIR sustained circulation through network

closure alone. The transition suggests that demurrage may serve a useful bootstrapping function even where the durable circulation mechanism is structural — a possibility relevant to design choices for new monetary instruments that lack an established member base.

Partial payment convention. WIR transactions are typically settled in a combination of WIR francs and Swiss francs, a convention known as mixed billing (Mischfaktur). The WIR component is typically 10–30% of the total transaction value, with the balance settled in CHF. This convention serves two purposes: it allows sellers to manage their WIR exposure without being required to accept 100% WIR payment, and it ensures that WIR balances circulate within the network rather than accumulating with individual members who might not have matching WIR spending opportunities.

Countercyclical design. The WIR system exhibits a structural countercyclical property that has been formally documented in the literature (Stodder & Lietaer, 2016, discussed below). During periods of Swiss franc credit tightening (during recessions, banking crises, or deflationary episodes), the demand for WIR credit increases as SMEs seek alternatives to unavailable CHF credit. This produces an increase in WIR circulation precisely when national monetary conditions are most restrictive, which Stodder and Lietaer (2016) interpret as a stabilising effect on SME activity during downturns.

4.4 Velocity and Countercyclical Evidence

The most comprehensive quantitative study of WIR's velocity and countercyclical properties is Stodder and Lietaer (2016), which analyses WIR Bank transaction data from 1948 to 2013. Their central finding is a strong negative correlation between WIR transaction volumes and Swiss GDP growth: WIR turnover increases when the Swiss economy contracts and decreases when it expands. This countercyclical pattern is statistically robust across multiple specifications and is present in both WIR credit issuance and transaction velocity.

Stodder and Lietaer (2016) estimate, based on WIR Bank annual reports and Swiss National Bank data for the period 1948–2013, that WIR credit turnover represents approximately 1–2% of Swiss GDP in any given year, with the share rising during recessions. The absolute scale is modest, but the countercyclical stabilisation function is significant: their analysis suggests that WIR activity reduces the amplitude of Swiss GDP fluctuations by a measurable amount, operating as an automatic stabiliser for the SME sector.

The velocity of WIR francs is lower than that of Wörgl certificates, but this is structurally predictable: WIR lacks the demurrage mechanism that creates an explicit cost to holding, and the mixed billing convention means that not all WIR balances are spent quickly. What Stodder and Lietaer (2016) document is not a direct velocity comparison to CHF but a well-evidenced countercyclical turnover pattern: WIR circulation increases during Swiss economic downturns precisely when CHF credit is tightest, suggesting that the network architecture produces a stabilising circulation dynamic even without imposing explicit holding costs.

4.5 Nine Decades of Continuity

The durability of the WIR system (nine decades of continuous operation, with cumulative membership reaching tens of thousands of Swiss SMEs across its operational history) is itself an important finding. No demurrage-based complementary currency has achieved comparable longevity; the Wörgl experiment lasted fourteen months before regulatory termination, and many subsequent demurrage-based experiments have had relatively short operational lives. The WIR's durability suggests that network-based mutual credit clearing architectures may provide a more robust institutional foundation for sustained complementary currency operation than demurrage-based designs, particularly in the absence of supportive regulatory environments.

The WIR has survived multiple Swiss financial crises, the Bretton Woods transition, and the digital transformation of Swiss payments — institutional resilience reflecting both member loyalty and the structural value of WIR as a credit alternative genuinely distinct from the national banking system.

5. Comparative Analysis and Central Finding

5.1 Architectural Classification

Table 1 summarises the architectural classification of the two cases using Blanc's (2011) monetary plurality typology.

Table 1: Architectural Classification Using Blanc's (2011) Monetary Plurality Typology

Dimension	Wörgl Labour Certificate	WIR Franc
Unit of account	Parity with national schilling	Parity with CHF (historically)
Convertibility	Limited; subject to demurrage and redemption fees	Restricted; discouraged conversion
Governance	Municipal administration; merchant network	Cooperative bank; member SMEs
Circulation mechanism	Demurrage (1%/month carrying cost)	Network closure (structural incentive)
Velocity/turnover effect	8–14× national currency velocity (estimated)	Moderate velocity; countercyclical turnover (~1–2% GDP)
Termination mechanism	Regulatory prohibition (Oesterreichische Nationalbank)	Ongoing — 9 decades of operation

5.2 The Central Finding: Architectural Separation as a Driver of Sustained Velocity The Wörgl certificate followed a self-reinforcing circulation cycle: the municipality issued certificates as wages for public works; each holder faced a 1%/month carrying cost, creating a strong incentive to spend rather than hold; certificates passed through local merchants, who used them to settle tax obligations and pay suppliers; they returned to the municipality through tax payment and were reissued for the next wage cycle. Stamp revenues fed back into public works financing, linking monetary circulation directly to local fiscal investment.

The WIR system follows a countercyclical activation cycle of a different character: when Swiss franc credit tightens during a recession, SME demand for WIR credit rises; the WIR Bank extends mutual credit by debiting the purchasing member and crediting the selling member; the seller spends WIR within the network, sustaining trade flows that would otherwise contract; as recovery proceeds and CHF credit eases, WIR demand normalises. The velocity mechanism is structural rather than cost-based: WIR balances can only be spent within the network, so accumulated balances have diminishing utility, creating a

persistent preference for circulation. The balance-sheet dynamic is endogenous: WIR supply expands with trade demand and contracts with it, with the WIR Bank managing credit limits and default risk throughout.

The comparative analysis supports the paper's central claim: architectural separation of spending and saving functions is a historically attested mechanism for sustained monetary velocity enhancement. The specific mechanism determines the character but not the existence of the velocity effect.

The two cases differ substantially in their mechanism. Wörgl used a cost-based approach: demurrage imposed a direct penalty on holding, creating an explicit incentive to spend. WIR used a structural approach: network closure made holding progressively less attractive by limiting the uses to which WIR balances could be put. These are genuinely different mechanisms with different welfare implications, different distributional effects, and different institutional requirements.

What they share is the architectural principle of separation. In both cases, the monetary instrument operates as an instrument best used for spending rather than saving. In Wörgl, this was achieved by making holding costly. In WIR, it was achieved by making the instrument structurally unsuitable for saving; its limited convertibility and network-bound character mean that accumulated WIR balances have diminishing utility as a store of value beyond the agent's projected spending capacity within the network.

This suggests that a monetary instrument that creates a structural or cost-based separation between its spending and saving functions tends to exhibit higher velocity than one that does not. The separation need not take the form of demurrage; it need not involve explicit penalties; it need not be enforced by external authority. What is required is that the architectural design of the instrument makes holding less attractive than spending, whether through direct costs or through structural constraints on the instrument’s utility as a store of value.

5.3 Architectural Separation: Dimensions and Comparisons

The degree of separation between spending and saving functions varies across monetary instruments along several dimensions. The most analytically useful are: the carry cost imposed on idle balances (whether explicit, as in demurrage, or implicit through alternative opportunity costs); the friction associated with converting the instrument into

other stores of value; the restriction on the domain of use (whether the instrument can be spent freely or only within a defined network or category of transaction); and the degree to which acceptance is mandatory or structurally incentivised. Historical cases differ not simply in the presence of these features but in their combination and intensity.

Wörgl scores high on carry cost and moderate on use-domain restriction and convertibility friction. WIR inverts this: carry cost is absent, but use-domain restriction and convertibility friction are high. Both produce circulation effects, but through different combinations of these features. The early WIR (1934–48), which employed demurrage-like devices alongside network closure, may have scored high on multiple dimensions simultaneously — which could explain why it required the demurrage mechanism to be dropped once the network had established itself, as the structural incentive alone proved sufficient. This dimensional view suggests that architectural separation is a matter of degree and combination rather than a binary property, and that different instrument designs may achieve comparable velocity effects through different routes. Future empirical work across a wider range of contemporary complementary currency cases (including Sardex and other digital mutual credit networks) could provide a more rigorous basis for evaluating how these dimensions interact and which combinations are most durable across different institutional contexts.

5.4 Demurrage vs. Network Clearing: Two Mechanisms, One Principle

The distinction between the Wörgl and WIR mechanisms has important implications for institutional design. Demurrage is a powerful but fragile mechanism. In the Wörgl case, it appears to have generated unusually high circulation velocity (commonly estimated in the range of 8–14 annual turnovers), but it depends on a supportive regulatory environment and institutional infrastructure that has proven difficult to sustain in most jurisdictions. The Wörgl experiment was terminated by regulatory intervention, and subsequent demurrage-based experiments have generally been short-lived.

Network clearing is a more durable but less intensive mechanism. WIR's velocity effect is real and economically significant. Its countercyclical stabilisation function is documented and quantified, but it is more modest than the Wörgl circulation rates. The mechanism works because the network boundary limits the instrument's utility as a store of value, but it does not impose the direct holding cost that makes demurrage so powerful as a circulation incentive. The trade-off is between intensity and durability: demurrage

produces higher velocity but is institutionally fragile; network clearing produces lower but sustained velocity over long periods.

Both mechanisms suggest that the question 'how do we make money circulate?' has architectural answers that are distinct from, and potentially complementary to, the constraint based answers currently being deployed in CBDC design — addressing a velocity dimension that constraint-based approaches do not directly target. The design question is not whether to impose holding limits or non-remuneration, but whether to design an instrument whose architecture makes circulation the natural behaviour by aligning incentives with function.

It is worth noting that contemporary retail CBDC proposals have largely converged on a structural-constraint approach through mechanisms such as holding limits, non-remuneration, and intermediated account architectures. In institutional terms, this approach is architecturally closer to the WIR model than to the Wörgl model. Given the political-economy constraints discussed in Section 6, this may represent the more institutionally sustainable design choice. However, the historical evidence also suggests that it is associated with a more modest circulation effect. The stronger velocity mechanism (an explicit carrying cost on money holdings) remains, at least for now, the path not taken in sovereign digital currency design.

5.5 A Contemporary Comparator: Sardex

Table 2: Architecture Levers and Contemporary CBDC Design Analogues

Architecture lever	Historical instrument	Architectural dimension	CBDC design analogue
Demurrage (1%/month carrying cost)	Wörgl certificate	High carry cost	Negative remuneration; time decay on programmable balances; expiry date on fiscal transfers
Network closure (spend-only within member network)	WIR franc / Sardex	High use-domain restriction	Purpose-bound / permissioned domains; sector restricted instruments; MAS PBM framework

Mixed billing (partial WIR + CHF settlement)	WIR franc (Mischfaktur)	Moderate convertibility friction	Co-settlement with bank deposits; partial CBDC payment with commercial bank top up (waterfall model)
Tax acceptability (certificates accepted for municipal obligations)	Wörgl certificate	Moderate settlement compulsion	CBDC acceptance for tax and public-sector payments; mandatory acceptance rules for state transfers
Restricted convertibility (CHW ≠ CHF at will)	WIR franc	High convertibility friction	CBDC holding limits (partial accumulation constraint); non interoperability Between permissioned domains

CBDC = central bank digital currency. MAS PBM = Monetary Authority of Singapore Purpose-Bound Money. The table maps historical architecture levers to their architectural dimensions and identifies contemporary CBDC design features that are functionally analogous to them. Architecture levers in the left column produce circulation effects through the mechanisms identified in Sections 3–4; the CBDC analogues in the right column are the nearest functional equivalents in current design discussions.

The architectural separation principle finds a contemporary digital analogue in the Sardex mutual credit system in Sardinia, which has operated as a B2B complementary currency since 2010. Sardex shares key structural features with the WIR Bank: it is a closed mutual credit network restricted to registered SME members, transactions are denominated in a unit pegged to the euro, and circulation is structurally embedded through network membership rather than enforced through demurrage. Reyns et al. (2025) provide the most recent empirical analysis of Sardex, documenting enhanced resilience among participating small firms during periods of credit tightening — findings consistent with the architectural separation principle. Whether the architectural features identified in the 1930s cases produce comparable circulation effects in a contemporary digital context remains an open empirical question. The Sardex case neither confirms nor refutes the architectural separation principle, but it provides a data-rich contemporary context against which the historical findings can be evaluated.

5.6 Velocity Concept: A Note on Scope

A clarification of the velocity concept used in this paper is warranted. The argument concerns retail transactional velocity: the rate at which monetary instruments circulate through real-economy exchanges such as goods and services purchases, wage payments, and tax settlements. In this sense, the analysis is conceptually closer to the transactional velocity associated with narrow monetary aggregates such as M1 than to broader measures incorporating wholesale financial flows and balance-sheet transactions.

Modern banking systems contain institutional and policy mechanisms that partially mitigate idle balance accumulation through interest rates, credit intermediation, and portfolio reallocation. However, these mechanisms operate primarily through wholesale finance and the savings dimension of the monetary circuit. The architectural separation problem re-emerges at the retail transactional layer, particularly where a new digital monetary instrument operates partially outside the conventional commercial bank deposit architecture.

This tension is visible in contemporary CBDC design debates. Retail CBDC proposals incorporating holding limits can be interpreted as responses to the same underlying architectural problem: quantity constraints are used to discourage large-scale balance accumulation at the retail CBDC layer, where conventional bank-deposit transmission mechanisms may operate less effectively. This is the relevant velocity dimension for the CBDC design comparison in Section 6.

5.7 Alternative Explanations and Dissent

The central finding of this paper, namely that architectural features drove the velocity outcomes in Wörgl and WIR, should be assessed against competing explanations. A reasonable orthodox challenge is that the observed effects reflect fiscal multipliers and confidence shocks rather than monetary architecture.

For Wörgl, four alternative channels deserve acknowledgment. First, the municipal spending multiplier: the certificates were distributed as wages for public works construction, introducing a standard fiscal stimulus. Second, an arrears and tax settlement channel: the carrying cost of certificates gave holders an incentive to use them for any available transaction, including paying off accumulated tax debts to the municipality, which is a fiscal resolution effect rather than a purely monetary one. Third, a novelty and

confidence effect: the scheme attracted substantial media attention and visitor interest, and the psychological effect of a community taking active steps to address its unemployment crisis may have produced a confidence multiplier independent of the demurrage mechanism. Fourth, selection effects: Wörgl's mayor was unusually enterprising and the local merchant network was particularly cohesive; comparable interventions in less favourable institutional contexts might not have produced equivalent results.

For WIR, the alternative explanations include member selection (firms that join mutual credit networks may be systematically more resilient than non-members), sectoral composition (WIR membership has historically been concentrated in construction, hospitality, and retail — sectors with cyclically variable credit needs), credit rationing effects that make WIR attractive regardless of its architectural features, and network effects that are independent of the specific architectural design.

The Boehm, Fize and Jaravel (2025) randomised evidence on demurrage is the most relevant controlled data: slow continuous melting produced a statistically insignificant spending effect, consistent with a reading in which the fiscal channel drove a substantial part of the Wörgl outcome.

5.8 Limitations

The architectural separation principle should be interpreted with caution given the limitations of the two cases analysed.

First, the comparative base is narrow. The comparative base consists of only two cases, both drawn from 1930s Europe, limit the generalisability of the findings. The cases were selected because they are the two best-documented historical instances of the architectural mechanisms the paper analyses, not because they constitute a representative sample of complementary currency experiments. The paper makes no claim that the principle applies universally, only that the two cases provide evidence that it operates under at least some institutional conditions.

Second, the two cases are not directly comparable. The Wörgl experiment was a fourteen-month municipal intervention with a defined geographic scope and a single employer (the municipality) as the initial distributor. The WIR Bank is a nine-decade national mutual credit network with tens of thousands of SME members and a cooperative governance structure. Differences in scale, governance, institutional context, and duration make

direct quantitative comparison of velocity outcomes unreliable. The paper's central argument is about an architectural principle, not about the quantitative magnitude of the effect.

Third, Wörgl data quality is a genuine limitation. The velocity estimate of 8–14 times national currency derives from Schwarz's (1951) archival analysis of municipal ledger records. The range reflects genuine uncertainty about the completeness of the transaction records, and Broer's (2007) methodologically careful reassessment treats the lower bound as more defensible. The paper reports the full Schwarz range to preserve transparency, but readers should treat the precise multiplier with caution. There is also a measurement distinction that the data does not resolve: Schwarz's estimate measures instrument-level transactional turnover (as discussed in §3.3 and §5.6), not velocity in the strict sense of the quantity theory. These are related but analytically distinct concepts. Compounding this, the public-works fiscal channel, arrears settlement, confidence effects, and institutional selection factors identified in Section 5.7 cannot be cleanly separated from the demurrage velocity effect with available data.

Fourth, there is a significant institutional gap between complementary currencies and sovereign CBDC. Both cases operated as opt-in instruments in local or sectoral contexts; a general-purpose retail CBDC at national scale operates within a regulatory and financial stability framework that has no historical precedent. The architectural principles identified may generalise, but the institutional conditions for their application are substantially different.

6. Implications for Contemporary CBDC Design

The velocity problem in contemporary CBDC design is structural, not incidental. Four of the world's most significant central banks are independently encountering the same architectural tension: digital money that is attractive to hold tends to be held, not spent. Each is responding with constraints, such as holding limits, non-remuneration and intermediated account architectures that manage the hoarding incentive without addressing its architectural source. The historical record examined in this paper suggests that this design lever is at best an incomplete one.

Constraint-based approaches address the symptom rather than the architecture. They impose quantity ceilings on how much can be held but do not alter the

instrument's fundamental attractiveness as a store of value relative to its attractiveness as a medium of exchange. The evidence from Wörgl and WIR suggests that this is the relevant design question: not how much can be held, but whether the instrument's design makes holding less attractive than spending. Wörgl answered this by imposing a direct carrying cost. WIR answered it by making the instrument structurally unsuitable as a store of value through network closure and restricted convertibility. Both approaches produced documented higher circulation than the national currency instruments with which they coexisted.

The theoretical literature has begun to engage these questions at the level of monetary system architecture. Niepelt's work (2024, 2026) represents the most developed contribution at this level, framing CBDC design as an architectural question about how digital money interacts with bank balance sheet structures and monetary policy transmission. The present paper's historical findings provide empirical grounding for these theoretical questions: the architectural dimension Niepelt identifies theoretically has historical precedent and measurable consequences. Instrument design contributes to determining circulation and hoarding incentives in ways that standard quantity-theoretic and inventory-theoretic frameworks do not capture.

The historical record suggests three conclusions for CBDC design, stated here more directly than the policy context typically permits.

First, the architectural principle is a first-order design variable, not the constraint level. Holding limits and non-remuneration settings are second-order parameters within a constraint based framework. The first-order question is whether the instrument's architecture creates a structural preference for spending over saving. Programmability makes architectural separation feasible in digital money: the monetary instrument itself can embed a structural preference for spending over saving directly, without demurrage administration or mutual credit infrastructure.

Second, the historical cases examined here do not support the claim that architectural separation is necessarily incompatible with monetary stability. Wörgl maintained parity with the schilling throughout its operation and generated no documented inflationary pressure. WIR has operated for nine decades as an automatic stabiliser, not a source of instability. The stability concern is legitimate at national scale, where the systemic implications of a high-velocity general retail CBDC are qualitatively different from a

municipal scrip scheme but it is not a decisive argument against architectural design as a policy instrument. It is an argument for careful design, not for abandoning the architectural dimension entirely.

Third, the mapping from historical mechanism to contemporary instrument type is conceptually direct, even if institutional implementation remains context-dependent. Wörgl like logic — time-bound or fee-bearing instruments with explicit carrying costs — maps to targeted fiscal transfers, purpose-bound vouchers, and programmable instruments with defined spending windows. WIR-like logic — network closure and structural circulation incentives — maps to permissioned settlement networks, sectoral clearing facilities, and programmable restricted-use instruments. The MAS Purpose-Bound Money framework is a contemporary implementation of WIR-like architectural logic at institutional scale. These are not exotic proposals; they are design choices already being made, in some cases without explicit reference to the architectural principle they instantiate.

Important components of the velocity problem appear to have been addressed, in different institutional contexts and through different mechanisms, by monetary architectures designed to privilege circulation over storage. The historical cases examined in this paper suggest that architectural design may therefore represent a more significant policy variable in CBDC development than current constraint-based approaches typically acknowledge. Whether contemporary CBDC design will draw on that historical record remains an open question.

7. Conclusion

This paper has argued that architectural choices, not constraints, are a potentially important determinant of monetary velocity, drawing on two historical cases that have direct relevance to contemporary CBDC design. The Wörgl labour certificate achieved a velocity estimated at 8–14 times that of the national schilling through a demurrage mechanism that imposed a direct cost on holding. The WIR franc has sustained countercyclical circulation for nine decades through a network clearing architecture that structurally limits the instrument's utility as a store of value. Both cases suggest that the question 'how do we make money circulate?' has architectural answers that are potentially complementary to the constraint-based approaches currently being deployed in retail CBDC design — addressing a velocity dimension that constraint-based approaches do not directly target.

The central finding that the architectural separation of spending and saving functions can contribute to sustained circulation effects under certain institutional conditions is not merely of historical interest. It has potential relevance for contemporary CBDC design discussions at institutions such as the ECB, Bank of England, MAS Singapore, and Banco Central do Brasil, all of which are grappling with the tension between the attractiveness of digital money as a store of value and its desired use as a medium of exchange. The historical cases examined here suggest that constraint-based responses may leave an important architectural dimension of the velocity problem underexplored.

Future research should extend the comparative analysis to contemporary digital cases. The Sardex system, already discussed in Section 5.5, is the most data-rich contemporary comparator; a systematic quantitative analysis across Wörgl, WIR, and Sardex, building on Stodder and Lietaer (2016) and Reyns et al. (2025), could provide a more rigorous empirical basis for evaluating the architectural separation principle and the dimensional framework proposed in Section 5.3.

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COMPLEMENTARY LOCAL CURRENCIES AND ENVIRONMENTAL BEHAVIORS AND PERCEPTIONS: EVIDENCE FROM A FRENCH CASE

Léo Revelli[1]

Abstract

While the socio-economic effects of complementary local currencies (CLCs) have been widely studied, their environmental impacts remain empirically unexplored. This paper investigates the causal effects of a representative French CLC on its users' environmental outcomes through a mixed-method approach that combines survey data from 37 CLC users and 31 comparable non-users with 30 semi-structured interviews. It constitutes the first counterfactual analysis of the environmental contributions of a CLC. Quantitative results indicate that CLC use does not significantly impact users' levels of local and organic food consumption, nor environmental knowledge and awareness. However, it significantly increases demand for environmentally plant-based alternative. Drawing on the Theory of Planned Behavior, applied for the first time to the decision of adopting or not a CLC, qualitative findings suggest that most users adopted the CLC because they were already engaged in local and environmentally friendly consumption practices, while few reported behavioral changes following CLC use. This result indicates that sustainable consumption practices and environmental perceptions are more likely determinants than outcomes of CLC use. Interviews further suggest that effects on sustainable food demand are driven by users who are constrained to spend more CLC than they would voluntarily choose, such as individuals receiving a share of their income in CLC units. These findings indicate that CLCs can influence consumption choices even among already environmentally committed

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individuals, particularly when functioning as self-regulation tools. Overall, the results highlight the importance of designing CLCs that move beyond self-selection dynamics and engage more diverse and less environmentally committed populations.

Keywords - *Ecological economics, Complementary currency, Behavioral economics, Sociology of money, Mixed methods*.

1. Introduction

Amid the perceived limited impact of green monetary policies and financial instruments, grassroots monetary innovations (GMIs) have emerged to address environmental challenges at the territorial level (Seyfang & Longhurst, 2013). Among these initiatives, complementary local currencies (CLCs) have sparked debate over their potential to promote environmental sustainability (Blanc, 2024; Larue, 2022). While existing research has focused on the social and economic effects of CLCs (Fare & Ould Ahmed, 2017), their actual environmental impacts remain unexplored (Michel & Hudon, 2015; Revelli, 2026).

This article addresses this gap by empirically examining claims that CLCs can enhance the environmental sustainability of their user community (Douthwaite, 2000; Lietaer, 2013). CLCs are alternative payment instruments backed one-to-one by official fiat money, designed to circulate alongside official currencies within a defined territory and network of businesses (Blanc & Fare, 2016). By embedding exchanges within a territorially bounded network of environmentally friendly actors, CLCs can make consumption and production patterns greener and may enhance users' environmental awareness and knowledge by prompting reflection on the sustainability of their behaviors and consumption practices (Douthwaite, 2012; Graugaard, 2012; Hornborg, 2017). Thus, CLCs have the potential to help mitigate environmental challenges arising from unsustainable consumption (Jackson, 2014; Sahakian, 2014; Seyfang, 2006).

However, because CLCs rely on voluntary participation and constrain spendability, they may primarily attract users already engaged in local environmentally friendly consumption practices and with higher levels of environmental awareness and knowledge before joining the scheme (Didier, 2022). Consequently, their impact on pro-environmental consumption and perceptions may be smaller for such users compared with less engaged individuals. Hence, a central question remains: do CLCs generate structural changes by inducing shifts

toward more environmentally friendly consumption practices and perceptions, or do they merely replace transactions in official currency that would have occurred anyway without altering underlying behaviors?

Determining whether the use of different currencies merely changes the social meaning of consumption (symbolic change) or triggers behavioral and perceptual changes (structural changes) requires examining user motivations (Witt, 2010). The sociology of money suggests that participation in CLCs follows social values, such that the desire to support - or publicly signal support for – local environmentally friendly businesses (Didier, 2022). Since CLCs do not provide economic benefits at the user level, sustained participation is more likely among value-driven individuals for whom the lack of economic returns is less consequential (Evans, 2009). This pattern aligns with behavioral economics, which suggests that self-determined rather than extrinsic motivations drive CLC use (Bruers, 2024; Darner, 2009; Joachain & Klopfert, 2014). Because motivations underlying continued CLC use may shape its effects on individual users, additional questions warrant examination: What motivations lead individuals to use CLCs? How do they influence the environmental benefits generated by CLCs?

To answer these questions, we examine a French CLC, the *Lien*, using the first counterfactual dataset designed to assess CLCs' environmental effects (Michel & Hudon, 2015). Focusing on this case strengthens external validity, as this currency is representative of the average French CLC in terms of user number, circulation volume, and operating budget (Blanc et al., 2023). Studying a regional-scale CLC complements existing research focused on particularly successful cases (Gelleri, 2022) or town-based schemes (Marshall & O'Neill, 2018; Place et al., 2021). This study also contributes methodologically by developing a mixed-methods research design that addresses limitations inherent in the study of GMIs, including self-selection biases, poorly specified indicators, and lack of longitudinal data (Revelli, 2026).

First, to address self-selection biases, we compare users with individuals willing to use the CLC but unable to because they live just outside its circulation area. These non-users were identified through associative networks linked to the managing association of the *Lien*, ensuring that users and non-users shared similar motivations, perceptions, and consumption patterns before CLC adoption. Interviews support the assumption that the absence of the *Lien* in the control territory is due to exogenous factors rather than

differences in local demand or population characteristics. This sampling strategy limits the risk of attributing pre-existing differences between treated and control groups to CLC participation. However, estimated effects pertain to individuals with specific characteristics, rather than the general population. Post-survey interviews further explore self-selection mechanisms and assess the comparability of users and non-users (Morvant-Roux et al., 2014; van Dongen et al., 2025).

Second, the dataset developed for this study addresses the scarcity of comprehensive data on CLC by collecting detailed information on respondents' lifestyles and environmental outcomes of respondents (Despotović et al., 2021; Kalbar et al., 2016; Lange & Dewitte, 2019). Although the sample size remains relatively small, the breadth of the dataset offers control for many confounding factors. The integration of qualitative materials enables discussing spillover effects and endogeneity issues, reducing omitted-variables bias and the risk of overlooking existing but unobserved outcomes (Michel & Hudon, 2015). Given the low adoption rates of CLCs and limited effects on community-level outcomes, focusing on individual users as units of analysis is relevant for identifying potential impacts that might otherwise remain invisible (Matti & Zhou, 2022). This approach complements existing micro-level studies on CLCs, which have focused on businesses (Marshall & O'Neill, 2018; Reyns, 2024).

Although the long-standing existence of the *Lien* constrains the collection of longitudinal data and the direct identification of CLC causal effects, the mixed-methods approach allows for inference of causal mechanisms. By mitigating endogeneity issues common in studies of complementary currencies (CCs), this approach also provides a foundation for future empirical research (Michel & Hudon, 2015; Place et al., 2021).

Results indicate that while using the *Lien* does not significantly increase users' levels of environmental awareness and knowledge, it may increase the consumption of environmentally friendly food items. The 30 semi-structured interviews conducted suggest that users who are constrained to use larger amounts of CLC units than they would voluntarily choose, because receiving a share of their income in *Lien*, drive the effects of CLCs on consumption patterns. While we observed no significant differences between users and non-users regarding their share of local or organic products consumed, interviews confirm that many users adopted the CLC because they already engaged in local, environmentally friendly consumption practices.

This paper provides the first empirical assessment of their environmental effects, contributing to ecological economics literature (Alves et al., 2022; Engler et al., 2024). By integrating the theory of planned behavior and the sociology of money to examine the adoption and effects of CCs, this paper advances the behavioral economics and socio-economics literature on green consumption and monetary innovations (Joachain & Klopfert, 2014; Oettingen & Gollwitzer, 2025; Seyfang & Longhurst, 2013). Broadly, it contributes to ecological monetary theory by supporting the view of money as a social institution able to shape economic choices toward environmental objectives (Ament, 2020; Zelizer, 1989).

The following sections present the literature, study context, theoretical framework, data, and methodology. Then, in the results section, materials are examined using a multiphase design (Creswell & Plano Clark, 2017). Qualitative findings are first presented to ensure the robustness of the quantitative results, and are subsequently used to infer causal mechanisms, with quantitative outcomes discussed alongside interview data. The final section discusses these findings by examining how CLCs may operate as identity-labeling and self-regulation tools.

2. Context and literature

While a substantial body of literature has examined the contribution of CLCs to territorial sustainability, few have assessed their environmental impacts (Fare & Ould Ahmed, 2017; Michel & Hudon, 2015). The limited empirical evidence relies on experiences in the United Kingdom (Graugaard, 2012; Marshall & O'Neill, 2018; Place et al., 2021; Scott Cato & Suárez, 2012), Spain (Garcia-Corral et al., 2020), and France (Fare, 2012; Mouvement Sol, 2021; Seang, 2021). Existing studies, although subject to self-selection, suggest that CLCs can enhance their users' environmental perceptions and local and green consumption patterns (Revelli, 2026).

Despite limited empirical evidence, ecological objectives are the third most frequently cited motivation among French CLC managing groups for launching their project (Blanc et al., 2023). Alongside social and economic goals, these ecological aims have contributed to the proliferation of CLCs in France, with 73 in circulation in 2022. Moreover, given the environmental effects attributed to CLCs (Dittmer, 2013; Lenis Escobar et al., 2020), French schemes have been the subject of several proposed amendments during parliamentary budget discussions, reflecting sustained public policy interest (Assemblée Nationale, 2023;

Sénat, 2025). Examining a typical French case is particularly relevant for discussing whether public investments in such schemes can effectively support ecological transition.

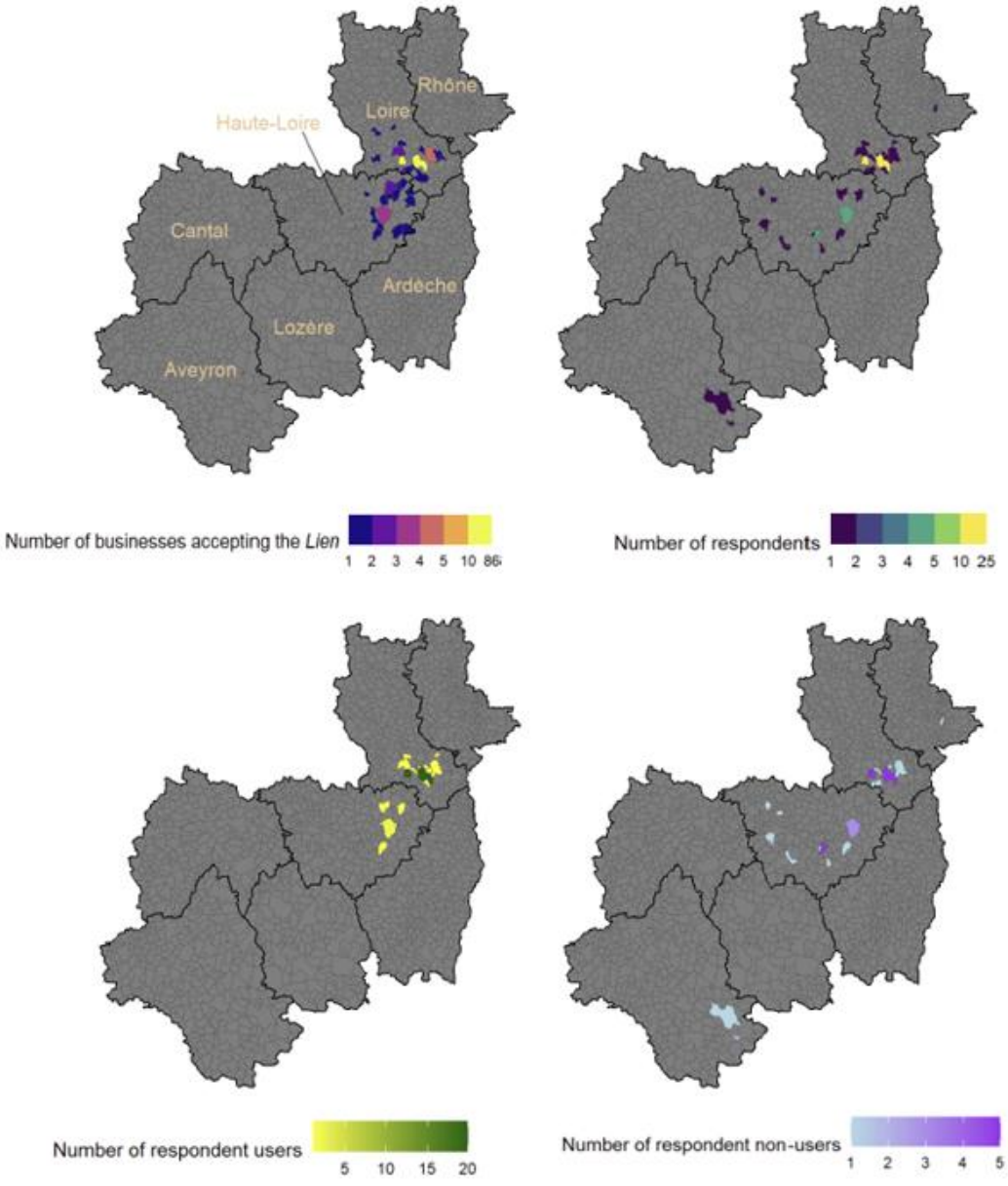


Figure 1: Spatial distribution of Lien-affiliated businesses and survey respondents

The *Lien* was launched in 2016 by the *MLCC42* association to pursue sustainable development objectives. The CLC operates exclusively within a territory covering northeastern *Haute-Loire* and southern *Loire*, with Saint-Etienne at its center, hosting 86 of the 137 affiliated businesses (Figure 1). To be authorized to accept payments in *Liens*, businesses must operate within this designated territory and comply with a charter that "*reaffirms the sustainable development values that [MLCC42] wishes to find among the professionals in its network*" (MLCC42, 2023). The charter excludes affiliates of large national retail chains and prioritizes small-scale, organic producers and businesses with explicit environmental commitments (MLCC42, 2016). Users must also support a transition toward local and environmentally friendly consumption and production patterns and participate in the Social and Solidarity Economy.

Participating professionals can obtain Lien units by voluntarily converting euros or by receiving payments in CLC units. To encourage recirculation within the network, a 5% conversion fee, earmarked for local environmental projects, is applied when businesses exchange *Lien* units back into euros. Individual users can convert euros into *Liens* at a 1:1 rate but cannot reconvert them. Initially, users had to visit exchange counters to convert euros into *Lien* paper bills. However, due to the limitations of a paper-only system, *MLCC42* introduced a digital payment application in September 2019. This platform allows users to convert euros voluntarily into digital *Liens* and set up monthly automatic conversions. It also enables the payment of a share of wages in *Lien*s. Today, most payments are conducted through the application. The introduction of the digital payment system has facilitated the use of the *Lien* and supported its network growth, reaching 137 professional and over 200 individual users in 2025.

3. Theoretical framework

This paper draws on behavioral economics to conceptualize the effects of CLCs on pro-environmental behaviors (PEBs), consumption choices, and perceptions (Figure 2; Joachain & Klopfert, 2014). The Theory of Planned Behavior (TPB) helps explain the decision to use a CLC and how individuals obtain CLC units. It has already been applied to study green consumption (Liobikienė et al., 2016; Rozenkowska, 2023; Vermeir & Verbeke, 2008; Yadav & Pathak, 2017) and currency adoption decisions (Anser et al., 2020; Nugroho et al., 2018; Radic et al., 2022).

According to TPB, three types of beliefs guide human behaviors (Ajzen, 2002; Vermeir & Verbeke, 2008): attitudes toward the behavior, reflecting the extent to which an individual has a favorable appraisal of the behavior (behavioral beliefs); perceived social pressure to perform the behavior (normative beliefs); and perceived ease of performing the behavior (control beliefs). These beliefs shape behavioral intentions, which could translate into the behavior implementation when opportunities arise.

Attitudes toward the behavior, here, CLC use, are shaped by environmental perceptions, which include environmental knowledge (i.e., information acquired through education or experience about environmental problems and the actions that address them; Frick et al., 2004; Joshi & Rahman, 2019) and awareness (i.e., beliefs and attitudes toward environmental issues, Kim et al., 2023). Individuals with higher levels of environmental perceptions are more likely to hold positive attitudes toward CLC use (Didier, 2022). They may be better able to understand its potential impacts and to believe in the effectiveness of using the CLC. Behavioral beliefs may explain self-selection into CLC use, as individuals with lower environmental concerns are less likely to constrain their everyday monetary practices to pursue objectives they do not value. Furthermore, individuals are more likely to use a CLC when many of their peers do so, highlighting the role of normative beliefs (Anser et al., 2020).

Lastly, individuals inclined toward local and environmentally friendly consumption are more likely to adopt a CLC. Because they may already patronize businesses within the currency network or outside it, but meeting its selection criteria, they may face fewer constraints in spending their CLC units. Consequently, the greater the perceived ability to spend CLC, the more likely individuals are to use it. The perceived ability to find ways to spend CLC relies on the constraints imposed by selection criteria on purchasing behaviors. Since CLCs can be spent exclusively within a defined territory at businesses that respect specific criteria, they restrict the range of possible purchases compared with official currency and tend to appear more difficult to use (Marshall & O'Neill, 2018).

Therefore, individuals are likely to adopt the currency scheme if they hold favorable beliefs about its effects or experience social pressure to do so. Adoption also requires individuals to possess sufficient confidence in their ability to use the CLC despite constraints imposed by limited spendability and convertibility. When individuals meet these conditions, they form an intention to use the CLC, which can translate into actual behavior when opportunities arise (Ajzen, 2002).

Beyond the TPB, the Motivation-Ability-Opportunity (MOA) framework defines opportunities as external factors that enable or constrain behaviors (Ölander & Thøgersen, 1995; Snow et al., 2022). While our framework incorporates the opportunity component from MOA, TPB remains central, as it explicitly captures the role of control beliefs in behavior adoption. In our context, opportunities are the presence of a CLC within an individual's territory or their proximity to participating businesses (Kwon et al., 2017).

In our econometric framework, we assume that treated and control groups differ only in their exposure to opportunities to use the CLC, while sharing similar beliefs. This identification assumption implies that such exposure depends on random factors, consistent with the assumption of random treatment assignment.

H1: *Treated and control individuals exhibit similar pre-existing levels of pro-environmental consumption, behaviors, and perceptions. The only difference between them is the random presence of facilitating factors.*

Then, individuals with the opportunity to use the CLC can translate their intention into actual use. Once individuals decide to use the currency, they must determine how to obtain CLC units. Users can convert official currency voluntarily into CLC units or receive a portion of their income in CLC. Voluntary conversion is more likely among individuals with strong behavioral or normative beliefs but weak levels of perceived control, reflecting uncertainty about their ability to spend CLC units. Voluntary conversion allows these individuals to convert only the amount they are confident to spend.

Some users may choose to obtain more CLC units than they would voluntarily convert. We refer to this behavior as "self-constrained use". It occurs when individuals agree, without external constraints or incentives, to receive part of their income in CLC, as is the case for employees of participating organizations or independent workers within the CLC network. While self-constrained users likely share similar behavioral and normative beliefs with other users and non-users, they tend to exhibit higher levels of perceived control. For these individuals, the CLC functions as a self-regulation tool, allowing them to increase their share of local and green consumption by allocating more money to these expenditures than they would without the CLC (Nielsen, 2017; Oettingen & Gollwitzer, 2025).

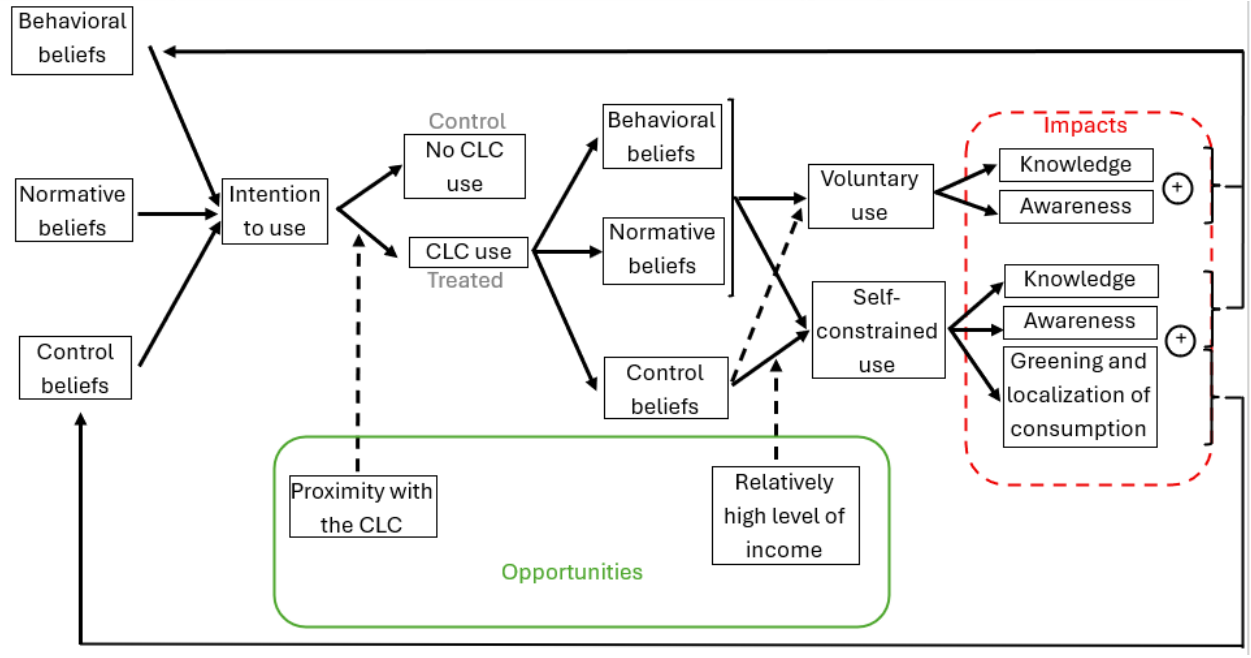


Figure 2: Determinants and impacts of CLC use

A factor facilitating self-constrained use is higher income. Individuals with relatively high incomes may be more willing to obtain more CLC units than they would voluntarily convert, as they can afford the risk of not spending all units within a given month. By contrast, individuals with lower incomes may be less willing to hold more CLC than they are certain to spend, as they rely on all of their income to meet monthly needs (Evans, 2009).

Voluntary CLC users are less likely to generate additional local or environmentally sustainable trade relationships, as they tend to substitute existing purchases denominated in official currency with the same transactions denominated in CLC units (Lafuente-Sampietro, 2022). In contrast, self-constrained users may be forced to find new ways to spend their CLC units, thereby experiencing structural changes in their consumption patterns. New trade relationships created through CLC use may influence pro-environmental behaviors and perceptions beyond consumption. Interactions with other environmentally aware users can reinforce pre-existing environmental perceptions, especially when combined with awareness-raising activities organized by the association managing the CLC (Revelli, 2026).

H2: *CLC use reinforces pre-existing environmental outcomes, particularly among individuals with self-constrained use.*

4. Data and methodology

This paper adopts a mixed-methods approach to examine the relationship between individual environmental outcomes and CLC use. Outcomes include local and green consumption patterns, as well as environmental perceptions. Data collection follows an explanatory sequential design, beginning with a quantitative survey complemented by a qualitative phase. The qualitative component enables the examination of the assumptions underlying the econometric analysis and sheds light on the mechanisms that may explain quantitative results (Baker et al., 2008; Creswell & Creswell, 2017; Starr, 2014).

a. Data

Given the absence of counterfactual datasets on individual-level effects of CLCs, we collected quantitative data between December 2024 and January 2025 through a questionnaire administered to 37 users and 31 non-users (Table 3A). This sample size is consistent with other mixed-methods studies (Starr, 2014; van Dongen et al., 2025). Drawing on established instruments from behavioral and ecological economics, the survey gathered detailed information on respondents' diets, consumption habits, PEBs, and environmental perceptions (Table 1A; Despotović et al., 2021; Kalbar et al., 2016; Lange & Dewitte, 2019), focusing on food consumption, the main expenditure category in CLCs (ADEME, 2016). To minimize researcher demand effects, no explicit references to the CLC were made during the questionnaire administration. Furthermore, all ambiguous terms, such as "local" or "organic", were explicitly defined to ensure consistent understanding among respondents.

As the Lien has circulated since 2016, this study examines the effects of a mature CLC whose impacts are likely representative of typical CLC initiatives (Blanc et al., 2023). However, the currency's long-standing existence prevents the collection of baseline data before CLC adoption. Consequently, observed differences between users and non-users may reflect pre-existing characteristics or behavioral patterns that influence both environmental outcomes and the likelihood of CLC use. Moreover, the relatively small sample size raises potential statistical power issues, increasing the risk of incorrectly concluding that the CLC does not significantly affect observed outcomes.

The interviews help address potential self-selection and small-sample issues (Jefferson et al., 2014; van Dongen et al., 2025). They are used to assess whether users self-select into CLC use based on pre-existing consumption patterns, PEBs, or perceptions, and whether similar dispositions exist among non-users, thereby testing H1. Interviews also support the random allocation of treatment by verifying that the absence of the *Lien* in control territories results from exogenous factors, rather than local demand or residents' characteristics. The absence of public subsidies influencing the circulation of the *Lien* further supports this assumption (Blanc et al., 2023). Qualitative materials also provide insights into the mechanisms through which CLC use may affect environmental outcomes, contributing to the assessment of H2.

We conducted 30 semi-structured interviews between November 2025 and February 2026. Survey respondents were contacted via a mailing list, with an initial email in October 2025, followed by reminders in December 2025 and January 2026. Non-respondents were contacted through personalized email. On average, interviews lasted 30 minutes, although those with non-respondents were longer (69 minutes) than those with survey respondents (26 minutes), as non-respondents included key *MLCC42* members. Interviews with users were also longer than those with non-users, as more time was devoted to discussing their CLC use patterns. As saturation progressed, interview duration tended to decrease over time (Table 2A). Among interviewees, 27 completed the questionnaire, representing approximately 40% of the survey sample. This subsample comprises 18 users (referred to as user-respondents) and 9 non-users. Furthermore, we conducted 3 semi-structured interviews with *MLCC42* administrative council members who did not complete the questionnaire, including the association's only current employee and a former employee. These additional interviews provide insights into the development, history, and objectives of the *Lien*.

b. Methodology

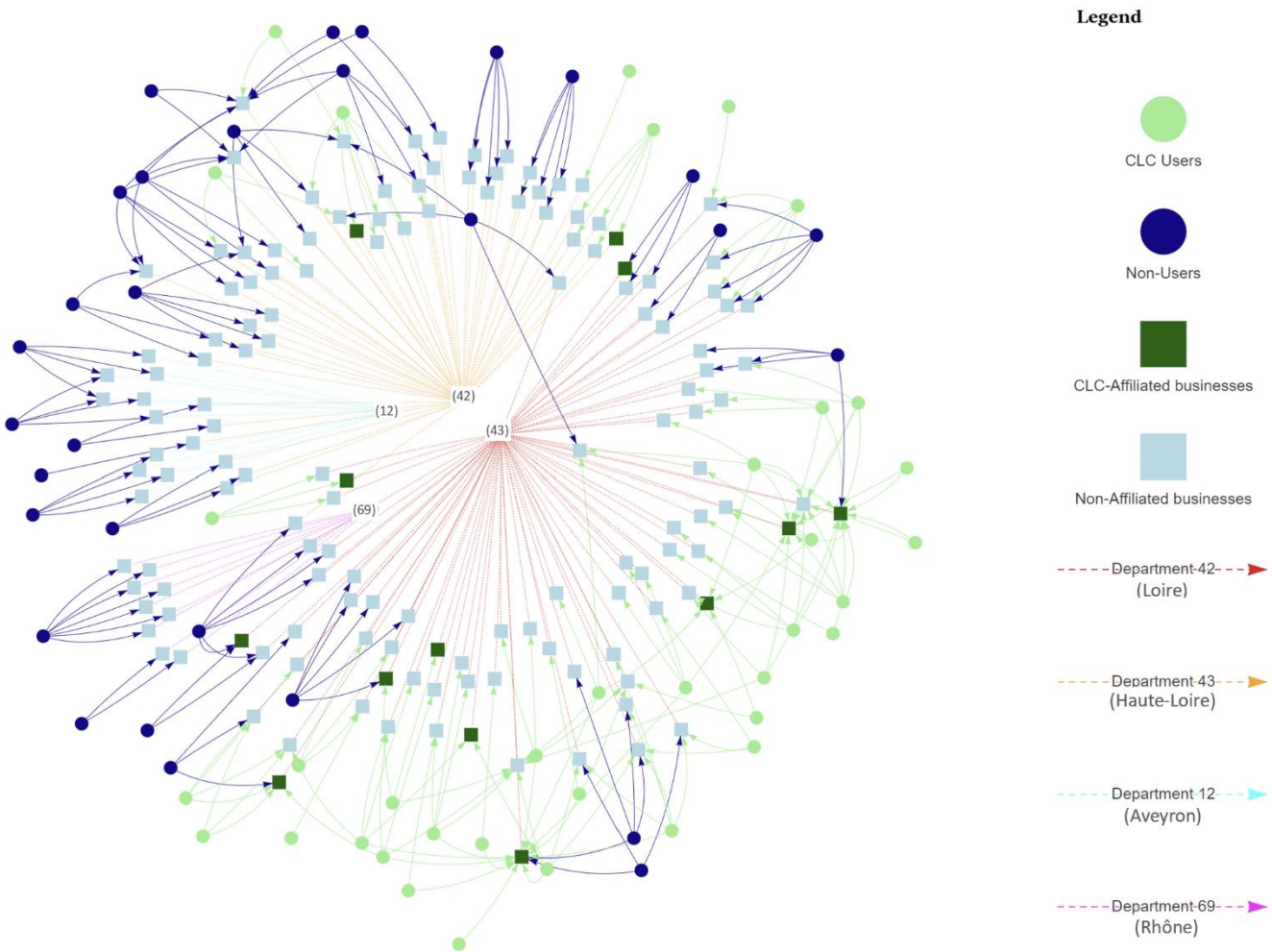


Figure 3: Respondent-business network based on questionnaire responses

To obtain the 68 questionnaire responses, the survey was first disseminated to *Lien* users through the monthly newsletter of *MLCC42*, yielding 37 responses from individual users. These respondents constitute the treatment group and represent approximately 20% of the active user base (MLCC42, 2024). To construct the control group, we collected responses

from a few non-users unwilling to use the CLC if it were available (n=5), and more from *Aveyron, Haute-Loire*, *Rhône,* and parts of *Loire* where the *Lien* does not circulate, who declare being willing to use a CLC but cannot because none is available in their territory (n=26).

This lack of access was corroborated by 6 of the 9 non-users interviewed, who held favorable attitudes toward CLC but reported lacking opportunities to use it: "*We considered joining the Lien. Unfortunately, we are somewhat at the edge of the Lien's circulation area, which is why we did not join"* (Interview 9). Furthermore, 7 of the 9 non-users interviewed reported patronizing businesses that meets the *Lien* selection criteria but located outside the circulation area, or within the CLC network (Figure 3), suggesting they would likely adopt the currency if access were easier: "*A priori, we would fit well within the local currencies network if it were to expand in the area, since it includes organic cooperative supermarkets and organic producers*" (Interview 13).

Non-users were identified through the questionnaire dissemination in the network of associations to which *MLCC42* belongs. The survey was circulated through the newsletter of a renewable energy cooperative, *ERE 43*, whose director sits on the administrative board of the *Lien*. Members of this cooperative are likely to share similar levels of PEBs and perceptions as users. They may be willing to use the currency if one were available in their territory: "*Both within the MLCC42 association and the ERE43 cooperative, the sociological composition is the same*." (Interview 14). They may also hold positive attitudes toward CLC use and have a social pressure to use it, as the cooperative regularly offers members the option to receive a part of their benefits in *Lien* units: "*I have heard about local currencies because I am a member of ERE 43, which operates with a local currency. When it comes to the remuneration of members' share, they favor people who are paid in local currency*." (Interview 1). This sampling strategy was designed to uphold the assumption that users and non-users are comparable in terms of beliefs, with the main difference being the presence of opportunities. It explains why most users are concentrated around Saint-Etienne, while non-users are located outside the CLC's circulation area (Figure 1).

Although this sampling strategy supports the identification assumption, it generates compositional differences between treatment and control groups (Table 3A). The treatment group includes a higher proportion of women and individuals holding at least a 3-year post-baccalaureate degree, while control respondents are, on average, older and more likely to

live in rural areas. We account for these socio-demographic characteristics in econometric specifications and our robustness tests show that they do not influence the likelihood of becoming a user, avoiding endogeneity issues (see replication package). To assess whether CLC use influences its users' environmental outcomes, we compare levels of environmental awareness and knowledge, as well as food consumption patterns.

Environmental knowledge is proxied by a binary indicator equal to 1 if the respondent selects the correct range for the increase in global temperature due to human activity since the pre-industrial period, and 0 otherwise (Table 1A). Therefore, we use a logit model to assess whether CLC use increases the probability of providing the correct answer to this question. Logit models are also used to estimate the effect of CLC use on the likelihood that respondents report consuming more than 50% local (*most_local*) or more than 50% organic (*most_bio*) products in their total food consumption.

We use an OLS model to test whether average environmental awareness differs between users and non-users. Environmental awareness is measured on a 1-7 Likert scale, from low to high sensitivity to environmental issues. Additionally, we estimated two OLS models with respondents' self-reported average weekly consumption of meat and plant-based alternatives (PBA) as dependent variables. Comparing the consumption of a non-sustainable product and its sustainable substitute allows us to assess whether CLC affects demand for environmentally sustainable products (Tilman & Clark, 2014; Willett et al., 2019).

All specifications include a common set of demographic controls (Table 3A) to account for the influence of environmental perceptions and socioeconomic characteristics on food consumption. It includes respondents' sex (*female*), income (*u_2000*), education (*more_bac_3*), and occupational status (*worker*) (Joshi & Rahman, 2019; Kim et al., 2023; Maichum et al., 2016; Milford et al., 2019). Territorial heterogeneity is captured through an indicator for residence in a rural department (*rural_dept;* Popkin, 2006).

In models where consumption outcomes are dependent variables, we additionally control for *environmental knowledge* and self-reported *connection to nature* (Table 1A), as pro-environmental perceptions influence green consumption (Harguess et al., 2020; Lange & Dewitte, 2019). For models with meat and plant-based consumption, we control for respondents' preference for organic products (*most_bio*; Arnaudova et al., 2022). In these models, price effects are not included as demand for meat and plant-based alternatives is

generally price inelastic (Gallet, 2010; Wagner, 2016), and because plant-based products tend to be less expensive than meat (Faber et al., 2012; Nagelhout et al., 2017).

To address potential endogeneity, dietary information is excluded from all specifications (Milford et al., 2019). As a robustness check, we re-estimate models using propensity score matching (PSM, Appendix 9). Even though baseline regressions control for characteristics that may determine CLC use, and qualitative interviews confirm the similarities between users and non-users, PSM allows us to estimate the average treatment effect by comparing individuals with similar probability of receiving the treatment, i.e., being a CLC user, based on their baseline covariates, driving out potential self-selection biases (Rosenbaum & Rubin, 1983). We use this approach only as a robustness check as it reduces the effective sample size. As estimates remain consistent despite the small sample size (Caliendo & Kopeinig, 2008; Pirracchio et al., 2012), this approach confirms the absence of self-selection bias (Table 5A).

Furthermore, all baseline models use heteroskedasticity-consistent standard errors and White's tests indicate no heteroskedasticity (Hausman & Palmer, 2012). We control potential spillover effects and confounding factors. Since 6 of the 19 users interviewed report being members of a cooperative supermarket and having modified their consumption habits as a result, we include a control for respondents who report frequenting this cooperative in the survey. We also account for the influence of particularly invested respondents, by including controls for being a member of the *MLCC42* board or having agreed to participate in an interview. Our results remain robust to these controls, indicating that confounding factors and spillover effects identified through interviews are unlikely to bias our findings. Despite the small sample size, correlation matrices reveal no evidence of multicollinearity issues (Figure 1A), and exclusion of outliers do not alter results, except for specification (3) (Table 1).

5. Results

Dependent Variable	PBA	Meat		Organic share	Local share	Knowledge	Awareness
Model	(1) OLS	(2) OLS	(3) OLS	(4) Logit	(5) Logit	(6) Logit	(7) OLS
Robust SEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Outliers excluded	No	No	Yes	No	No	No	No
Robust to exclusion of outliers ?	Yes	No	-	Yes	Yes	Yes	Yes
User	**3.799*****	**-1.578***	**-1.053**	**0.212**	**1.227**	**-0.253**	**0.160**
	(2.80)	(-1.84)	(-1.42)	(0.30)	(1.51)	(-0.34)	(0.57)
Female	**0.585**	**-0.0222**	**0.260**	**0.114**	**0.815**	**-0.604**	**0.111**
	(0.47)	(-0.03)	(0.42)	(0.16)	(1.06)	(-0.87)	(0.45)
U_2000	**-0.199**	**0.0735**	**0.316**	**-1.089**	**-1.244***	**0.201**	**-0.261**
	(-0.15)	(0.09)	(0.38)	(-1.51)	(-1.87)	(0.30)	(-1.12)
More_bac_3	**1.223**	**1.492***	**1.232**	**0.126**	**0.477**	**0.632**	**0.258**
	(0.85)	(1.88)	(1.63)	(0.18)	(0.68)	(0.92)	(1.04)
Worker	**-1.446**	**-0.623**	**-0.772**	**-0.215**	**0.167**	**1.870*****	**-0.564****
	(-1.08)	(-0.75)	(-0.94)	(-0.31)	(0.24)	(2.93)	(-2.52)
Rural_dept	**1.127**	**1.789***	**2.244****	**1.004**	**0.662**	**-0.517**	**0.587****
	(0.71)	(1.77)	(2.37)	(1.13)	(0.81)	(-0.62)	(2.13)
Connection with nature	**0.184**	**0.218**	**0.209**	**0.745****	**1.412*****		
	(0.24)	(0.47)	(0.47)	(2.00)	(2.65)		
Environmental knowledge	**0.498**	**-0.155**	**-0.407**	**0.539**	**0.0187**		
	(0.34)	(-0.19)	(-0.51)	(0.70)	(0.03)		
Most_bio	**2.071**	**-2.255*****	**-1.930*****				
	(1.64)	(-2.96)	(-2.71)				
Constant	**2.295**	**4.718*****	**4.094****	**-2.558***	**-5.544*****	**-1.633****	**6.185*****
	(0.79)	(2.69)	(2.52)	(-1.54)	(-2.87)	(-1.74)	(21.05)
R^2	0.236	0.227	0.222				0.139
Pseudo-R^2				0.139	0.269	0.152	
N	68	68	67	68	68	68	67

Table 1: Quantitative results

Table 1 indicates that CLC use does not significantly increase the likelihood of correctly identifying the range of global temperature increase due to human activity since the pre-industrial period. Similarly, despite the awareness-raising activities implemented by *MLCC42*, CLC users do not report significantly higher levels of environmental awareness than non-users. From the TPB perspective, this pattern suggests that environmental perceptions are determinants rather than outcomes of CLC use. Individuals with higher pre-

existing levels of environmental awareness and knowledge are more likely to form positive attitudes toward CLC use, as they better understand its intended environmental impacts and perceive their participation as meaningful: "*That could be a barrier to development. Someone who is less engaged, less activist… they don't really understand what the local currency is for.*" (Interview 12). Thus, high levels of environmental awareness and knowledge appear to shape behavioral beliefs conducive to adoption, rather than being reinforced by CLC use.

Similarly, Table 1 indicates that CLC use does not significantly affect the likelihood of consuming a majority of local or organic products within total food consumption. This pattern is consistent with interviews. All 14 non-users and user-respondents asked about their food purchasing criteria reported considering primarily organic or local attributes when making food choices, and questionnaire data reveal no differences in purchasing determinants between users and non-users. Furthermore, 12 of the 18 user-respondents explicitly stated that their consumption habits did not change following CLC use: "*I don't want to drive long distances to shop somewhere just because they accept the Lien. I don't need the Lien to consume locally*" (Interview 22). These findings suggest that pro-environmental consumption patterns are more likely to be determinants of CLC participation than consequences.

This pattern underscores the role of control beliefs. Individuals tend to become users because they already frequent businesses within the *Lien* network, as confirmed by 13 of the 18 user-respondents: *"No, I didn't discover any new shops. I haven't changed my consumption habits, because in any case I would have gone to those shops [that accept the Lien]"* (Interview 8). Consistent with this interpretation, 11 of the 18 interviewed user-respondents reported determining the amount of CLC units they obtain according to their ability to spend them without altering their existing consumption routines: "*No, using the CLC does not make me discover especially new places, Lien use should remain practical compared to my way of life.*" (Interview 12). This suggests that control beliefs, through perceived ease of use and compatibility with established practices, shape CLC adoption and intensity of use. Regarding normative and behavioral beliefs, 7 of the 18 users-respondents interviewed reported that social pressure influenced their decision to adopt the CLC, whereas 3 indicated that uncertainty about the currency's usefulness had delayed their

adoption. Hence, normative beliefs constitute a strong driver of adoption, while behavioral beliefs are present among the majority of users.

Therefore, most users tend to substitute pre-existing euro-denominated transactions with payments in CLC units, experiencing symbolic rather than structural changes. Users convert into *Lien* units only the amount of euros they are confident to spend due to the restricted spendability of the CLC: "*In shops where I go, they use the Lien. So, instead of paying in official money, I use Liens up to a given amount. […] Using the Lien does not change my consumption habits, because the main part of the shops that I frequent use the Lien.*" (Interview 7). Thus, most individuals do not convert euros into *Lien* to find new environmentally friendly consumption options, but rather identify where the *Lien* can be used and convert the exact amount of euros they are sure to spend into CLC.

Moreover, specifications (1) and (2) indicate that, *ceteris paribus*, CLC users consume on average about four more meals with plant-based alternatives and two fewer meat-based meals per week than non-users. This pattern may reflect a reallocation of food purchases toward lower-impact items following CLC adoption. While this interpretation should be considered cautiously due to sensitivity to outliers in specification (3), two lines of evidence support it. First, interviews do not reveal systematic pre-existing differences in food consumption patterns between control and treated individuals, reducing the likelihood that observed differences merely reflect prior dietary preferences. Second, CLC use is not significantly associated with higher consumption of food items less directly linked to environmental sustainability (e.g., eggs, vegetables; see replication package). Hence, the divergence between the consumption of meat and plant-based alternatives may reflect a stronger preference and higher demand among users for food products with lower environmental footprints.

Therefore, while CLC users do not change the businesses they patronize or the criteria guiding their purchases, the observed dietary difference between users and non-users may suggest that CLC use leads to a reallocation of expenditures toward environmentally friendly products within existing shopping routines, rather than structural changes in shopping locations or decision-making frameworks: "*[CLC use] encourages me to spend more at businesses that accept the local currency, without changing the places I usually visit. For the places I used to go to less often, I now use the local currency more frequently there.*" (Interview 26).

An additional mechanism concerns a subgroup of users, as 5 of the 18 user-respondents interviewed reported changing their consumption patterns following the *Lien* adoption. These individuals receive, or have previously received, CLC amounts exceeding what they would have voluntarily converted. It occurs when they receive a share of their income in CLC units, either through an arrangement with their employer (Interviews 2, 5, 15, and 17) or because they are professional users of the *Lien* who use their CLC earnings for personal consumption (Interviews 11 and 17). Having more units than they would convert constrains users to identify additional spending opportunities within the *Lien* network or to increase purchases at CLC-participating businesses they already frequent. This effect is particularly pronounced when *Lien* units constitute the only remaining liquidities: "*We don't have very high incomes, and I had heard the same for other Lien users, at the end of the month, when things are a bit tight, we notice that there is still money left in Lien. So, even if we can't spend it immediately, we may go to places that accept the Lien when there is a real need. It's like a form of savings that we forget about, or at least that we don't really see.*" (Interview 2).

This suggests that having a sufficiently high income may serve as a facilitating factor for agreeing to receive a share of its wage in *Lien*. Indeed, failing to spend all CLC units by the end of the month is less constraining for individuals who do not face financial difficulties in meeting their end-of-month expenses : "*The fact of having automatically a monthly amount of local currency credited to our account, it pushes us. The local currency forced me, but maybe that's not the right word, it rather encouraged me to move towards more ethical, more virtuous consumption. […] There was the step of becoming a professional user of the Lien, which meant even more Liens coming into on my account. When you start receiving payments in Liens, you're no longer just dealing with around a hundred euros per month in Liens. So, you have Liens and you start wondering how you're going to manage to use them.*" (Interview 11).

Hence, users with a self-constrained use of the currency may afford the possibility of not spending all their CLC units at the end of the month (Evans, 2009): "*Yes, without a doubt, using the CLC has influenced my consumption. It also aligns with the fact that I earn more now than I did ten years ago when I started using the local currency. […] I can afford it. I was able to engage in this process toward what could be considered more virtuous consumption. I don't know if everyone has the same possibility. In recent years, I've had the opportunity to earn somewhat higher income, which allowed me to say, "Yes, I can do this." At the same*

time, I have spent a portion of this higher income in Liens. Perhaps, if I hadn't experienced this increase in income, things would have been different. This financial comfort allows me to feel more confident taking Liens and deciding where to spend them." (Interview 11). Therefore, control beliefs are stronger for individuals with higher income levels, as those with lower income may worry about not being able to meet their needs if they are left with only *Liens*, given the currency's limited spendability: "*The first time I heard about the Lien, it was during my master's program. I was a student and didn't have much of a budget, so I couldn't get started immediately. [...] Now, I am on a monthly recharge of 50 Liens, and quite often, by the end of the month, I don't have any left. I could increase the amount I receive, but it's also a budget issue. I don't want to tie up too much money and want to keep a minimum amount in my euro account*" (Interview 5).

In addition to control beliefs, the presence of normative beliefs also helps explain self-constrained use: "*I have been self-employed for a few years. I now also accept the local currency in my professional activity. But it was necessary that [the members of MLCC42] encourage me to start accepting the Liens.*" (Interview 11). Thus, individuals who already have a positive experience with CLC use, manage to spend the CLC units they voluntarily convert, and are actively invested in the development of the CLC are more likely to become self-constrained users. Taken together, these results suggest that the less control a user has over the amount of CLC units they receive, the greater the structural impact of CLC use on their consumption patterns. Conversely, higher levels of control, as with voluntary use, are more likely to result in symbolic changes. This explains why professional or independent workers who receive *Lien* units through CLC payments exhibit more substantial behavioral changes than users receiving a share of their wage in *Liens*, as the latter can negotiate the amount they receive with their employer to avoid constraining their spending: "*I adjusted the portion of my pay in Liens on what I expected to spend during the month. I set it according to expenses I was already making. So, it wasn't a constraint at all.*" (Interview 5).

Beyond consumption, CLC participation does not appear to increase levels of environmental perceptions or broader PEBs (see replication package). Therefore, qualitative and quantitative material suggest that the absence of broader effects is not due to overlooked impacts but rather to self-selection into voluntary currency use. CLC participation may reinforce green consumption primarily when users are self-constrained.

6. Discussion

Our findings contribute to environmental psychology and consumer research, as the *Lien* CLC serves both as an identity-labeling tool and a self-regulation instrument, influencing real-world green purchasing decisions (Allen, 1982; Nielsen, 2017; Schwartz et al., 2020).

First, CLCs operate as an identity-labelling tool that enables users to signal a pro-environmental identity and communicate their preference for sustainable products (Didier, 2022; Schwartz et al., 2020; Witt, 2010). The weak effect of CLCs on the purchasing decisions of voluntary users is consistent with research showing that convenience and established routines dominate sustainability considerations in everyday consumption (Cornelissen et al., 2007; Eby et al., 2019). Moreover, most voluntary users reported already patronizing local and environmentally oriented businesses before adopting the CLC, allowing them to express their pro-environmental identity. Hence, CLCs are additional tools for expressing an existing identity, with limited influence on already established sustainable consumption practices. This pattern suggests diminishing marginal effects of green identity-labelling tools when layered onto pre-existing pro-environmental commitments: "*I'm involved in ecological transition-oriented associations, so my awareness increases every week, but not specifically because of the local currency*." (Interview 12). When consumers already enact their green identity through institutionalized practices and networks, the addition of another signaling mechanism yields symbolic rather than structural changes.

Furthermore, our findings indicate that CLCs primarily attract environmentally conscious users whose practices already align with the values promoted by these schemes. Consequently, individuals who do not perceive themselves as environmentally conscious are unlikely to respond to green identity-labelling techniques, here, by adopting the CLC (Schwartz et al., 2020). In this respect, CLCs face challenges similar to other identity-labelling tools in engaging a more diverse audience (Brough et al., 2016). Thus, the potential for additional behavioral change among CLC users is inherently limited, as they exhibit a relatively low margin for further improvement compared to individuals with weaker pro-environmental identity (Fare, 2012; Marshall & O'Neill, 2018). Nevertheless, our results suggest that CLC adoption may still reinforce sustainable consumption practices when use is self-constrained.

Individuals who agree to engage in a self-constrained use of the CLC are more likely to adopt greener consumption patterns. In this configuration, the CLC operates as both an identity-

labeling device and a self-regulation mechanism (Baumeister & Heatherton, 1996). For users intending to adopt more environmentally sustainable consumption practices, committing to receiving a predefined amount of CLC helps align behavioral outcomes with pro-environmental intentions. By receiving more units than the amount required for their existing green purchases, self-constrained users use the CLC as a commitment device that limits the liquidity available for conventional spending and reduces exposures to habitual or tempting non-green purchases (Nielsen, 2017). Under self-constrained use, the CLC functions as a hybrid instrument through which users affirm their pro-environmental identity and implement self-defined environmental goals. By structuring part of their budget around a currency accepted only in specific businesses, self-constrained users translate abstract commitments into routinized practices, thereby operationalizing goal-setting and implementation processes of self-regulation theory (Oettingen & Gollwitzer, 2025).

This paper highlights a limitation inherent in the study of GMIs: impact assessments focus on already environmentally motivated users, limiting insights into potential impacts on less aware individuals. In this context, limited effects among environmentally motivated users do not imply that CLCs are unable to generate environmental benefits. The impact of CLCs may increase by expanding self-constrained use or targeting a more diverse audience.

One way to broaden CLCs' reach is through partnerships with public institutions, for example, by distributing part of employees' remuneration or rewards for PEBs through CLCs or using them as vehicles for public transfers or basic income distribution. Although some municipalities have adopted this approach to direct funds toward local sustainable businesses, the effects of policy-driven CLCs on recipients' environmental outcomes remain untested (Barinaga et al., 2025; Belmonte et al., 2021; Chung, 2020; Kim et al., 2020; Lee et al., 2020). This would complement our study as financial incentives may attract individuals who would not otherwise use CLCs, yet their participation is likely driven by extrinsic rather than self-determined motivations, potentially altering schemes' effects (Larue et al., 2022; Revelli, 2026).

Consequently, our paper shows that CLCs can guide users in addressing environmental challenges at their own level, thereby enhancing their capacity to implement self-defined PEBs. Simultaneously, CLCs can shape the structural context in which individuals operate by promoting environmentally sustainable rules and norms, especially when supported by public institutions (Chater & Loewenstein, 2023). In this way, CLCs may help bridge

individual- and system-level interventions, enabling public institutions to facilitate systemic changes that support individuals' adoption of PEBs, while empowering citizens to act autonomously and exert bottom-up influence on their institutional environment (Nielsen et al., 2024; Oettingen & Gollwitzer, 2025).

In the absence of local government participation, expanding the diversity of businesses authorized to accept CLC payments may help these schemes reach a broader audience. A larger network of participating businesses can strengthen individuals' control beliefs by reducing uncertainty about the ability to spend CLC units in everyday consumption. However, broadening professional selection criteria exposes the CLC managing group to identity tensions, as it challenges the values underpinning the scheme (Fare et al., 2024; Magnani & Marais, 2021; Peiro et al., 2025). Selection criteria thus play a central role in shaping CLCs' user composition and the magnitude of their subsequent impacts. This underscores the challenge CLCs face in balancing rigidity and flexibility, as noted by the *MLCC42* coordinator: "*There is a balance to be found: how to include enough actors so that we can get things done, while leaving enough out to filter and transform economic practices.*" (Interview 25).

These insights show that while media such as money can shape human behavior, illustrating the non-neutral nature of money (Ament, 2020), people also have the capacity to adapt these media into means of pursuing their own social lives (Zelizer, 2010). Accordingly, CLCs should be understood as tools designed to influence users' behaviors, while remaining flexible enough for individuals to shape the monetary artifact in accordance with their own values and objectives.

7. Conclusion

This paper employed a mixed-methods design to assess the causal effects of the *Lien* CLC on individual-level environmental outcomes. To our knowledge, it is the first study that empirically assesses the environmental impacts of a CLC. Furthermore, it provides the first counterfactual dataset for analyzing such effects.

Drawing on the TPB, our results show that CLC use is shaped by self-selection mechanisms, influenced by physical proximity to the circulation area, pre-existing environmental awareness and knowledge, and established local and green consumption practices. These findings highlight the role of behavioral, normative, and especially control beliefs in



explaining CLC adoption. Because individuals who voluntarily use the CLC are already engaged in relatively environmentally friendly consumption patterns, the additional effects of CLC participation appear moderate. This result is consistent with previous works in ecological economics, suggesting that, in many cases, CLCs merely replace the unit of account in which some local transactions are denominated rather than transforming underlying production and consumption structures (Michel & Hudon, 2015; Revelli, 2026).

Furthermore, our analysis extends this conclusion. By focusing on individual users and drawing on behavioral economics and the sociology of money, we demonstrate that CLCs can influence consumption patterns even among already environmentally aware individuals. In particular, CLC users appear to exhibit a higher demand for environmentally sustainable food products than non-users. The influence of CLCs on greening consumption patterns appears stronger when users are compelled to hold more CLC units than they would have voluntarily converted. These findings challenge the view of money as a neutral medium of exchange and suggest that the design and spending rules of money can shape consumption choices, even when its nominal value remains unchanged. In this respect, our results provide empirical evidence to discuss the ecological monetary theory (Ament, 2020).

Although our results indicate that CLCs may influence individual-level environmental outcomes, these effects are primarily observed among relatively high-income individuals, who can afford the risk of ending the month with only CLC units remaining (Evans, 2009). Future research should therefore examine how CLCs can engage more diverse populations, notably through stronger financial incentives to participate or by extending the spendability of the currency. Moreover, further work could investigate the effects of such CLCs on individuals who are not already environmentally conscious or committed. This research could involve analyzing public transfers or subsidies distributed in CLC units, as well as through the implementation of CLCs in areas characterized by lower levels of environmental awareness, knowledge, and sustainable consumption practices. Finally, larger longitudinal datasets would help strengthen the assessment of causal environmental contributions of CLCs.

8. References

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9. Appendix

a. Questionnaire

Subsection	Question/Detail	Source	Section
Food diet	What is your diet? (Flexitarian, Omnivore, Vegan, Vegetarian)	Kalbar et al., (2016)	Food consumption habits
Food products	Based on your diet, which food products do you consume? (e.g., different types of meat, vegetables, plant-based products, dairy…). For each product: How many times per week do you consume it? Where do you purchase it (address and name of business)? What transportation mode do you use to do so?		
Food preferences	What share of your food consumption is organic? Locally produced? How much food do you waste?		
Housing	What type of housing do you live in? What is your energy source? How many appliances do you own (by type)?		Housing and transportation habits
Vehicle	Do you own a vehicle? If so: What are its characteristics (date of first registration, model, fuel type)? Do you carpool? Use it for commuting? If so, how often?		
Vacation	In 2024, where did you travel by plane (excluding work-related trips)? How many flights did you take?		
Other purchases	How much do you spend per month on personal products (e.g., electronics, clothing, cosmetics…)? What factors influence your purchasing decisions? Do you buy mostly new or second-hand? Online or in-store?		
Already adopted PEBs	How often do you practice the following behaviors: waste sorting, switching off lights, reducing water use, composting, growing vegetables)? Are you a member of any associations?	Despotovic et al. (2021), Lange & Dewitte (2019)	PEBs
Adoption of new PEBs	Would you adopt the following behaviors: use a CLC accepted only in environmentally friendly businesses, participate in a waste collection if rewarded/voluntarily, join an environmental conservation association, participate in a community garden?		
Subjective Environmental knowledge	Do you agree/disagree with these statements regarding human/environment interactions? (E.g., "Technology will always make Earth livable", "Humans abuse the environment", "The so-called 'ecological crisis' is overstated", "If events continue on this trajectory, we will experience a major ecological disaster", …)		Environmental perceptions
Objective Environmental knowledge	What is the estimated increase in global temperature due to human activity since the pre-industrial period? (Options ranging from "0°C-0.5°C" to ">2.5°C".		
Connection with nature	From 1 to 5, how connected to nature do you feel? 		
Environmental awareness	On a scale from 1 (not sensitive to environmental issues) to 7 (very sensitive), where do you position yourself?		
Socio-demographic characteristics	Are you a *Lien* user? What is your sex, age, household composition, income, and address?		Personal information

Table 1A: Detail of the questionnaire

b. Qualitative data description

N°	Date	Gender	Reason for selection	Duration
1	03/11/25	Male	Non-user respondent to the questionnaire	14:11
2	03/11/25	Female	User respondent to the questionnaire	26:34
3	04/11/25	Male	Non-user respondent to the questionnaire	25:45
4	06/11/25	Male	Non-user respondent to the questionnaire	15:33
5	06/11/25	Female	User respondent to the questionnaire and former employee of MLCC42	22:25
6	24/11/25	Male	Non-user respondent to the questionnaire	20:04
7	24/11/25	Female	User respondent to the questionnaire	17:58
8	24/11/25	Male	User respondent to the questionnaire	13:06
9	25/11/25	Male	Non-user respondent to the questionnaire	18:49
10	28/11/25	Male	User respondent to the questionnaire	35:13
11	28/11/25	Male	User respondent to the questionnaire and member of MLCC42 administrative board	44:15
12	01/12/25	Female	User respondent to the questionnaire	90:18
13	12/12/25	Male	Non-user respondent to the questionnaire	22:50
14	23/12/25	Male	User respondent to the questionnaire, member of MLCC42 administrative board, and director of the ERE 43 energy cooperative	64:02
15	07/01/26	Female	Former employee and former member of MLCC42 administrative board	33:43
16	12/01/26	Female	Member of the MLCC42 administrative board	75:27
17	14/01/26	Female	User respondent to the questionnaire and former member of MLCC42 administrative board	36:16
18	20/01/26	Female	User respondent to the questionnaire	22:09
19	20/01/26	Male	User respondent to the questionnaire and former member of MLCC42 administrative board	52:25
20	26/01/26	Female	User respondent to the questionnaire and volunteer in the MLCC42 association	11:06
21	26/01/26	Female	Non-user respondent to the questionnaire	17:45
22	26/01/26	Female	User respondent to the questionnaire	11:41
23	26/01/26	Female	Non-user respondent to the questionnaire	14:31
24	26/01/26	Male	User respondent to the questionnaire	12:26
25	27/01/26	Male	Coordinator of the *Lien* development, only current employee of MLCC42 and member of its administrative board.	100:51
26	27/01/26	Male	User respondent to the questionnaire	11:40
27	30/01/26	Female	User respondent to the questionnaire	14:46
28	04/02/26	Male	User respondent to the questionnaire	17:36
29	11/02/26	Female	Non-user respondent to the questionnaire	18:16
30	13/02/26	Female	User respondent to the questionnaire	22:29

Table 2A: Interview sample (November 2025-February 2026)

	Non-interviewees (mean)	Interviewees (mean)	*T-Test* (p-value)
Female	.4390244	.4814815	.7355731
u_2000	.2926829	.2592593	.7679407
More_bac_3	.4878049	.5555556	.5909871
Rural_dept	.3414634	.3703704	.8106491
Most_bio	.5853659	.6666667	.5069381
Most_local	.6097561	.7407407	.2707047
Worker	.5365854	.6296296	.4553097
House	.5365854	.6666667	.2932198
Age	54.21951	52.25926	.6355383
Alone	.2926829	.2592593	.7679407
Prox_mlc	.5365854	.5925926	.6548628
Prod_vege_per_week	6.97561	6.814815	.895991
Meat_per_week	4.439024	4.037037	.6105593
Connection with nature	3.634146	3.888889	.213444
Environmental knowledge	.3170732	.4074074	.4531577
Environmental awareness	6.170732	6.423077	.256031
N	41	27	68

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

T-Test results indicate that CLC users are more likely to be women and hold a three-year post-baccalaureate degree. These patterns are consistent with the sociodemographic profiles of other CLCs users (Reyns, 2024), supporting the representativeness of our sample. The significant difference observed in *rural_dept* variable is a consequence of our sampling strategy, which we account for in our models.

Table 3A: Descriptive statistics – Interviewees and non-interviewees

c. Quantitative data description

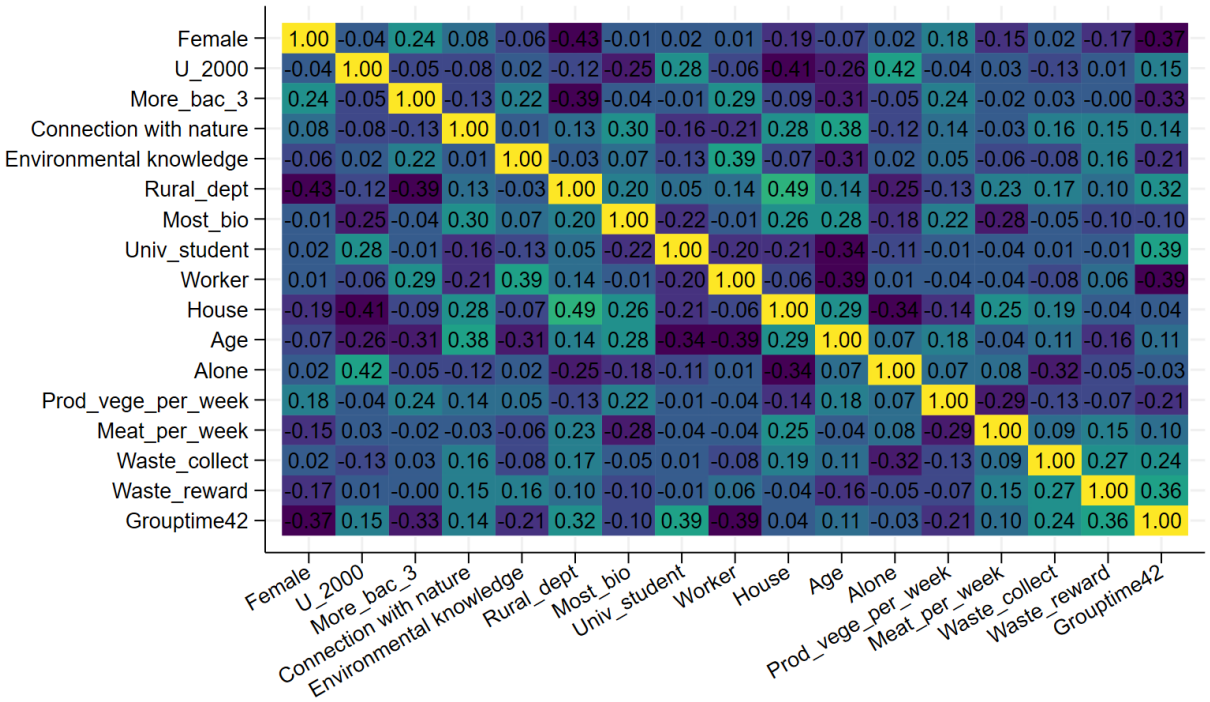


Figure 1A: Correlation matrix

	Non-user (mean)	User (mean)	*T-Test* (p-value)
Female (1 if the respondent is a woman)	.2580645	.6216216	.0023083***
u_2000 (1 if the respondent reports monthly earnings below €2000)	.2258065	.3243243	.3747141
More_bac_3 (1 if the respondent holds a 3-year degree after the baccalaureate or more)	.2580645	.7297297	.0000525***
Rural_dept (1 if lives in a rural department)	.6129032	.1351351	.0000156***
Most_bio (1 if reports consuming more than 50% organic products in their total food consumption)	.6451613	.5945946	.6746938
Most_local (1 if reports consuming more than 50% local products in their total food consumption)	.5483871	.7567568	.0722938*
Worker (1 if the respondent is neither retired nor unemployed)	.516129	.6216216	.3885512
House (1 if the respondent lives in a house)	.6451613	.5405405	.3901783
Age (Respondent age)	57.09677	50.37838	.0949867*
Alone (1 if the respondent being the sole member of their household)	.2258065	.3243243	.3747141
Prox_mlc (1 if the respondent lives in the same municipality as an affiliated CLC food business)	.3870968	.7027027	.0085347***
Prod_vege_per_week (Self-reported number of meals with plant-based products per week)	4.83871	8.648649	.0010252***
Meat_per_week (Self-reported number of meals with meat per week)	5.193548	3.513514	.0274738**
Connection with nature (Appendix 1)	3.709677	3.756757	.815978
Environmental knowledge (Appendix 1)	.3225806	.3783784	.6376094
Environmental awareness (Appendix 1)	6.290323	6.25	.8533852
N	31	37	68

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

T-Test results indicate that CLC users are more likely to be women and hold a three-year post-baccalaureate degree. These patterns are consistent with the sociodemographic profiles of other CLCs users (Reyns, 2024), supporting the representativeness of our sample. The significant difference observed in *rural_dept* variable is a consequence of our sampling strategy, which we account for in our models.

Table 4A: Descriptive statistics – Users and non-users

d. Propensity score matching (PSM)

	(1) PBA	(2) Meat	(3) Organic share	(4) Local share	(5) Environmental knowledge	(6) Environmental awareness
ATE						
Users vs Non-users	4.949***	-1.872	0.051	0.051	0.000	0.454
	(1.511)	(1.189)	(0.192)	(0.192)	(0.181)	(0.432)
Observations	39	39	39	39	39	39

$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 5A: PSM – Average Treatment Effect within the common support region

As our study is based on a natural experiment, we conduct robustness checks to ensure that imbalances in baseline covariates do not drive the estimated effects associated with CLC use. In particular, we use propensity score matching (PSM) to verify that the effects reported in Table 1 are not attributable to observable differences between users and non-users. We begin by estimating propensity scores - i.e., the probability of being a CLC user conditional on a set of pre-treatment covariates unlikely to be influenced by CLC participation – using a binary logistic regression model (Rosenbaum & Rubin, 1983) :

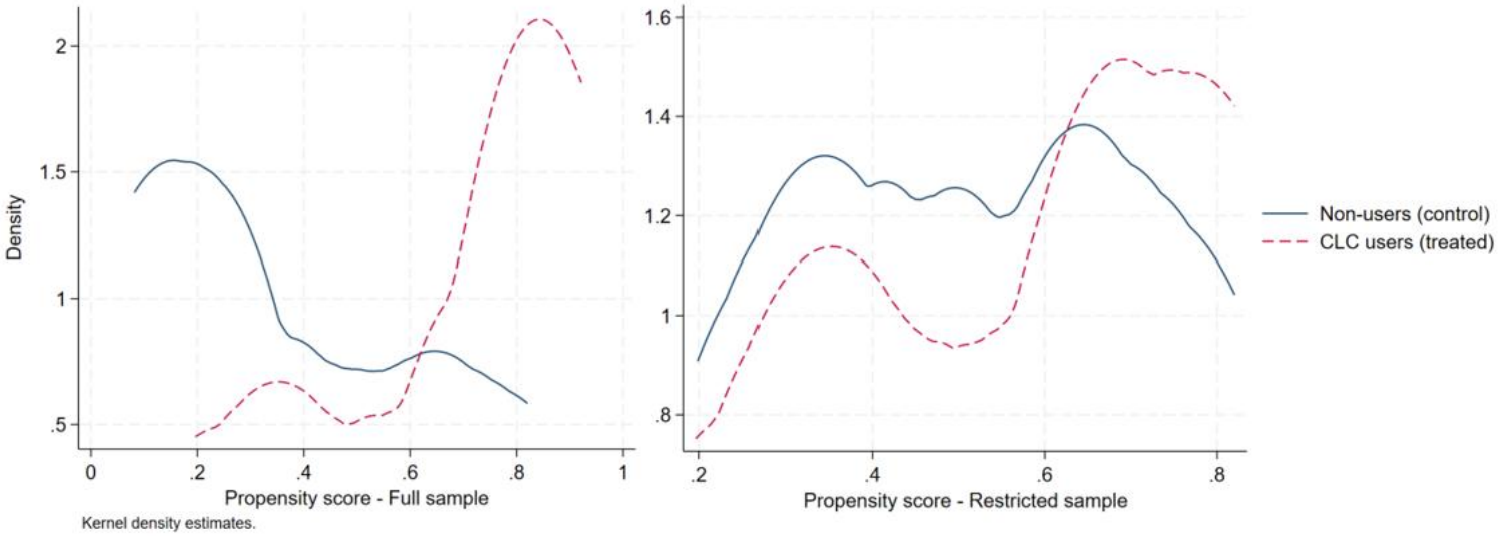
$$\text{User} = \frac{1}{1 + e^{-(\beta 0 + \beta 1 * \text{female} + \beta 2 * \text{more_bac_3} + \beta 4 * \text{rural_dept} + \beta 5 * \text{prox_mlc} + \beta 6 * \text{age})}}$$

To avoid over-parameterization of the model, we restrict the specification to covariates that significantly differ between users and non-users (Table 3A; Caliendo & Kopeinig, 2008). The selected variables are those that most strongly predict CLC participation and are likely exogenous to the treatment. We then estimate the average treatment effect (ATE) using one-to-one nearest-neighbor matching. Although this approach reduces the sample size and thus the statistical power, we prefer it to matching with replacement, which may assign excessive weight to a small number of observations and influence the results (Pirracchio et al., 2012).

Because the full sample includes groups with a near-zero probability of receiving the treatment (Figure 2A, Left panel; observations with propensity scores below 0.2), and

therefore lack valid counterparts in the treated group, the common support assumption appears to be violated. To address this issue, we restrict the sample to observations within the region of common support, ensuring consistent matching (Figure 2A). Within this restricted sample, each control individual is matched to a treated individual with the closest propensity score, thereby limiting self-selection bias arising from observable pre-treatment characteristics. While this procedure improves match quality, it reduces the effective sample size. Given this limitation, we use PSM as a robustness check rather than as a primary identification strategy. Nevertheless, the approach remains informative, as matching estimators have been shown to remain consistent and exhibit low bias even in relatively small samples (Pirracchio et al., 2012).

Therefore, this approach provides no evidence of self-selection bias, as the estimated effects on plant-based product consumption, the share of organic products in total consumption, environmental awareness, and environmental knowledge remain unchanged. Conversely, the estimated effect on the number of meat-based meals per week is no longer statistically significant - likely due to the exclusion of influential observations (Table 1) - while the effect on the share of local products in total consumption becomes statistically significant. These findings suggest that the results of regression (2) in Table 1 are robust. The estimates related to meat consumption appear to be driven by a small number of influential observations. Finally, the positive effect of CLC use on the share of local products consumed is consistent with our qualitative evidence indicating that self-constrained users tend to increase their consumption of local products. Although the use of PSM strengthens the credibility of our results, the estimated ATE should be interpreted with caution. In particular, restricting the sample to the region of common support reduces the effective sample size.



e. ***Figure 2A: Propensity score distribution before matching in the full sample (left, N=68) and the restricted common support sample (right, N=40).***

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IDENTIFICATION AND CHARACTERISATION OF GREEN CURRENCIES IN BRAZIL: AN EXPLORATORY STUDY

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Abstract

Community currencies have increasingly been associated with sustainability transitions; however, their environmental implications remain underexplored. In recent years, “green currencies” have emerged as initiatives connecting environmental practices, such as waste management and recycling, with local economic incentives and community engagement. Despite their growing relevance, these initiatives remain conceptually underdeveloped and empirically fragmented in the literature. This study aims to identify and characterize green currency initiatives in Brazil by analysing their operational mechanisms, institutional arrangements, governance configurations, and socio-environmental impacts. A qualitative multiple case study approach was adopted, examining two Brazilian initiatives with more than five years of operation. Data collection combined document analysis and semi-structured interviews, while thematic analysis supported by NVivo was used to identify patterns and variations across the cases. The findings reveal that green currencies operate through heterogeneous socio-institutional configurations shaped by different origins and

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governance arrangements. The analysis identified two dominant configurations: a hybrid-institutional model and a public-operational model. The results indicate that the origin of the initiatives strongly influences their operational orientation, institutional articulation, public policy integration, and socio-environmental emphasis. In addition, the study demonstrates that green currencies function not only as alternative exchange systems but also as socio-environmental governance instruments capable of influencing behavioural change, supporting circular economy practices, and strengthening local sustainability dynamics. Based on these findings, the study develops a comparative analytical approach integrating environmental, operational, institutional, and social dimensions for the analysis of green currencies. The article contributes to the literature by advancing the understanding of green currencies as niche-level socio-institutional innovations and by providing empirical evidence from the Brazilian context.

Keywords: Green currencies, Sustainability Transitions, Local economic development, socio-environmental innovation

1. Introduction

In the context of sustainability transitions, new forms of economic organization have emerged as alternatives to conventional monetary systems. Among these initiatives, community currencies stand out, as they are designed to complement official currencies and address socio-economic challenges at the local level (Seyfang & Longhurst, 2013; Didier, 2022). These initiatives encompass a wide variety of formats, including social currencies, local currencies, and exchange systems (Blanc, 2020; Seyfang & Longhurst, 2013). In recent years, they have been increasingly associated with sustainability transitions, particularly as instruments for promoting local development and behavioral change.

However, despite their potential, the contribution of community currencies to environmental sustainability remains limited and fragmented. Existing studies indicate that, although these systems can support social and economic objectives, their environmental impacts are rarely assessed systematically, which limits the ability to draw robust conclusions about their effectiveness (Michel & Hudon, 2015). Moreover, only a small number of initiatives explicitly incorporate environmental objectives, suggesting that the ecological dimension still occupies a marginal position within the broader field (Seyfang & Longhurst, 2013). By

promoting the reintegration of waste into production cycles and encouraging local economic circuits, these initiatives also align with the principles of the circular economy, understood as a model focused on waste reduction, material circulation, and the regeneration of natural systems (Ellen MacArthur Foundation, 2026). In this sense, green currencies can be interpreted as territorial mechanisms that contribute to operationalizing these principles at the local level.

Despite their innovative character, these initiatives remain conceptually underdeveloped and empirically fragmented in the literature. There is a lack of analytical frameworks capable of capturing their specific characteristics, as well as a limited understanding of how they operate across different institutional contexts (Diniz et al., 2024; Revelli, 2025). This gap is particularly relevant in the Brazilian context, where several green currency initiatives have been implemented in recent years, often associated with public policies and community-based socio-environmental programs. Nevertheless, these initiatives have not been systematically and comparatively analysed. In light of this, this study seeks to answer the following research question: how have green currencies been conceived and operationalized in the Brazilian context?

To address this question, the article aims to identify and characterize green currency initiatives by analysing their operational mechanisms, institutional arrangements, and socio-environmental impacts. The analysis focuses on initiatives with at least five years of implementation, in order to consider cases with a higher degree of institutional and operational maturity. The study contributes to the literature by developing an analytical approach for understanding green currencies and by identifying different configurations based on empirical evidence.

2. Literature review

This section reviews the literature on community currencies as alternative monetary arrangements, their role in sustainability transitions, and the conceptualization of money as a social and institutional construct.

2.1 Complementary currency

Community and complementary currencies refer to a diverse set of alternative exchange systems that operate alongside national currencies, typically within specific territorial or social contexts (Seyfang & Longhurst, 2013; Blanc, 2020). These systems are based on

collective agreements and are designed not to replace official money, but to fulfil functions often neglected by conventional monetary systems, such as fostering local economic development, strengthening social ties, and promoting financial inclusion (Lietaer, 2002; Diniz et al., 2024). Different models of community currencies reflect variations in objectives and operational mechanisms. Time banks, for instance, use hours of labour as the unit of account, promoting reciprocity and community engagement through non-convertible exchanges of services (Seyfang, 2001; Blanc, 2013).

Complementary or social currencies circulate locally alongside national currencies, enabling the exchange of goods and services within defined communities and supporting local economic activity (Stepnicka, 2023). Local exchange trading systems (LETS) and similar networks operate through mutual credit systems, where transactions are recorded within the network and money functions primarily as a medium of exchange rather than a store of value (Lee et al., 2004). These variations reflect the experimental nature of community currencies as institutional innovations that explore alternative forms of economic coordination at the local level. More recently, community currencies have been increasingly associated with sustainability transitions, particularly as niche-level innovations that experiment with alternative socio-economic practices and institutional arrangements. These systems can create new incentive structures and governance configurations that encourage more sustainable forms of production and consumption (Seyfang, 2006; Seyfang & Longhurst, 2013).

Within the sustainability transitions literature, socio-technical change is understood as a multi-level process involving interactions between niche innovations, dominant regimes, and broader landscape dynamics (Geels, 2002). These transitions are complex and multidimensional, encompassing technological, institutional, market, and cultural elements that co-evolve over time (Geels, 2011). Such systems tend to be stabilized by lock-in mechanisms, including established infrastructures, institutional arrangements, and socially embedded practices, which hinder systemic change. Moreover, sustainability transitions are inherently political, as they involve contested visions, power relations, and governance challenges (Smith & Stirling, 2010). Within this theoretical framework, community currencies can be interpreted as niche innovations that seek to introduce alternative economic logics and practices, potentially contributing to the reconfiguration of dominant socio-economic regimes.

2.2 Money as a social and institutional construct

Money can be understood not as a neutral economic instrument, but as a socially constructed institution, constituted by relations of credit, trust, and legitimacy, embedded within broader social and institutional structures (Ingham, 1996). By incorporating new arrangements of governance and participation, social currencies highlight this socially constructed nature of money and its potential for institutional and political transformation (Barinaga et al., 2026). Experiences with social currencies indicate that the way money is organized influences local socio-economic dynamics, particularly in mutual credit systems, where money is created in the very act of transaction between participants (Blanc, 2013). In this sense, by making the processes of monetary creation and circulation more visible, these arrangements can enhance participants' understanding of how money functions, contributing to the transformation of social relations and the strengthening of cooperative practices (Barinaga, 2025).

At a broader scale, recent literature in ecological finance suggests that monetary and financial systems actively shape economic trajectories by defining the criteria for credit and liquidity allocation. From this perspective, financial processes should not be understood as neutral mechanisms, as they have economic, political, and social implications and influence the organization of economic activity (Christophers, 2015). Consequently, monetary and financial policies reflect institutional arrangements that prioritize certain objectives (traditionally financial ones) over socio-environmental goals (traditionally financial ones) over socio-environmental goals (Lagoarde-Ségot & Revelli, 2023).

2.3 Community currencies as policy and governance instruments

From a governance perspective, the design of social currencies can be understood as part of broader transition processes, in which monetary systems are intentionally structured to support alternative socio-economic configurations. In this context, these initiatives can be seen as institutional arrangements aimed at reconfiguring economic coordination and strengthening local autonomy and civic participation (Orzi, 2015). Complementary currencies may emerge from different types of origins, commonly distinguished as exogenous and endogenous. Exogenous initiatives are promoted by external actors, such as governments or organizations, whereas endogenous initiatives arise from processes driven by the community itself (Blanc, 2011). This distinction aligns with the notion that economic actions are embedded in social relations (Granovetter, 1985), as endogenous initiatives tend

to reflect locally grounded dynamics based on trust and participation. However, many contemporary experiences combine elements of these dynamics, resulting in hybrid arrangements characterized by the articulation of multiple actors and shared governance structures (Barinaga et al., 2026). This differentiation is analytically relevant, as the origin of the initiative influences governance arrangements, levels of institutionalization, and patterns of participation, shaping how community currencies are conceived and operationalized (Seyfang, 2000).

In addition, community currencies imply the redefinition of social relations and governance rules associated with monetary systems, often being organized around collective action. This feature allows such initiatives, in certain contexts, to function as public policy instruments, particularly when implemented by local authorities to incentivize desirable behaviors (Barinaga et al., 2021). From a governance perspective, monetary authorities can actively shape credit allocation by conditioning liquidity provision to sustainability outcomes, thereby influencing the direction of investment and economic activity (Lagoarde-Ségot & Revelli, 2023). In this context, community banks and social currencies can be understood as innovative operational arrangements for public policy implementation, particularly in the domains of social protection and local development (Silva & Pereira, 2023). Furthermore, recent studies highlight that digital municipal currencies not only operate as local governance instruments but also enable broader systemic transformation processes across municipalities. By combining a standardized monetary infrastructure with flexibility in policy design, these instruments allow local governments to adapt welfare and development strategies to their specific socio-economic contexts while facilitating trans-local diffusion and replication (Barinaga et al., 2026). In this sense, community currencies transcend their local scope, functioning as scalable governance tools capable of supporting multi-level policy innovation and systemic change.

2.4 Community currencies and sustainability transitions

From this perspective, community currencies can be understood as niche-level innovations that seek to experiment with alternative economic arrangements and sustainability-oriented practices. However, the environmental dimension of these initiatives remains relatively underexplored in the literature. Existing studies suggest that, although these systems may contribute to sustainability, their environmental impacts are rarely assessed systematically, which limits the ability to draw robust conclusions about their effectiveness (Michel &

Hudon, 2015). Moreover, only a limited number of initiatives explicitly incorporate environmental objectives, indicating that ecological concerns still occupy a marginal position within the broader field (Seyfang & Longhurst, 2013). Recent research also highlights the lack of consolidated analytical frameworks and evaluation methodologies capable of capturing the environmental contributions of these systems (Diniz et al., 2024; Revelli, 2025). This gap is particularly relevant in light of the emergence of new initiatives explicitly designed to integrate environmental practices with local economic incentives.

Green currencies represent one of these emerging configurations, understood as community-based monetary systems that link environmental practices (such as waste management and sustainable consumption) to local economic incentives (Diniz et al., 2024; Seyfang, 2006). These initiatives typically operate by rewarding environmentally desirable behaviors (such as waste separation, recycling, and sustainable consumption) through locally circulating monetary units. In many cases, participants exchange recyclable materials for units of local currency, which can then be used in registered businesses, while the collected materials are sold to recycling companies to financially sustain the system (França et al., 2020; Mello et al., 2022). This mechanism simultaneously promotes waste management, income supplementation, and local economic circulation.

Beyond waste-exchange schemes, some green currency systems are designed to influence broader consumption patterns by encouraging environmentally responsible choices, such as the use of public transportation, the purchase of local or organic products, and the adoption of energy-efficient practices (Seyfang, 2006). In addition to environmental objectives, these initiatives often pursue broader socio-economic goals, including the promotion of solidarity-based economies and the strengthening of local cooperation networks (Orzi, 2015). Many experiences are also closely linked to public policies and local governance structures, combining institutional support with community engagement.

2.5 Analytical gaps and research contribution

Despite these advances, green currencies remain conceptually underdeveloped and empirically fragmented in the literature (Diniz et al., 2024; Revelli, 2025). Existing studies tend to focus on broader categories of community currencies or on isolated case studies, without offering systematic comparative analyses or robust conceptual frameworks (Seyfang & Longhurst, 2013; Blanc, 2020).

This limitation can be understood in light of approaches that conceptualize money not merely as an economic instrument, but as a social and political institution that organizes practices, values, and forms of economic coordination (Barinaga, 2021). From this perspective, community currencies (and green currencies in particular) should not be analysed solely in terms of their operational mechanisms, but also in relation to the institutional arrangements and social dynamics that shape their circulation and effects. However, although this approach opens new analytical possibilities, there remains a lack of models capable of systematically integrating the environmental, economic, and institutional dimensions of these initiatives (Seyfang, 2006; Michel & Hudon, 2015).

Furthermore, empirical evidence on social currencies in the Brazilian context indicates that these systems operate through complex institutional arrangements, often articulated with public policies and subject to governance dynamics and operational constraints that vary according to local contexts (Silva & Pereira, 2023). These characteristics reinforce the need for more comprehensive analytical models capable of capturing the diversity of configurations and their socio-environmental impacts.

3. Methodology

This study adopts a qualitative and exploratory multiple case study approach (Yin, 2014; Eisenhardt, 1989), combining documentary analysis with targeted semi-structured interviews. Given the still underexplored nature of green currencies, the use of multiple documentary sources enabled the reconstruction of operational mechanisms, governance arrangements, and socio-environmental dynamics across the analysed initiatives. This strategy is suitable for investigating phenomena that remain underexplored in the literature, such as green currencies, enabling an in-depth understanding of their mechanisms, institutional arrangements, and operational dynamics in real-world contexts. Furthermore, the use of multiple cases allows for comparisons across different experiences, contributing to the identification of patterns, variations, and distinct configurations, as well as to the development of analytical propositions and a comparative analytical approach (Eisenhardt, 1989).

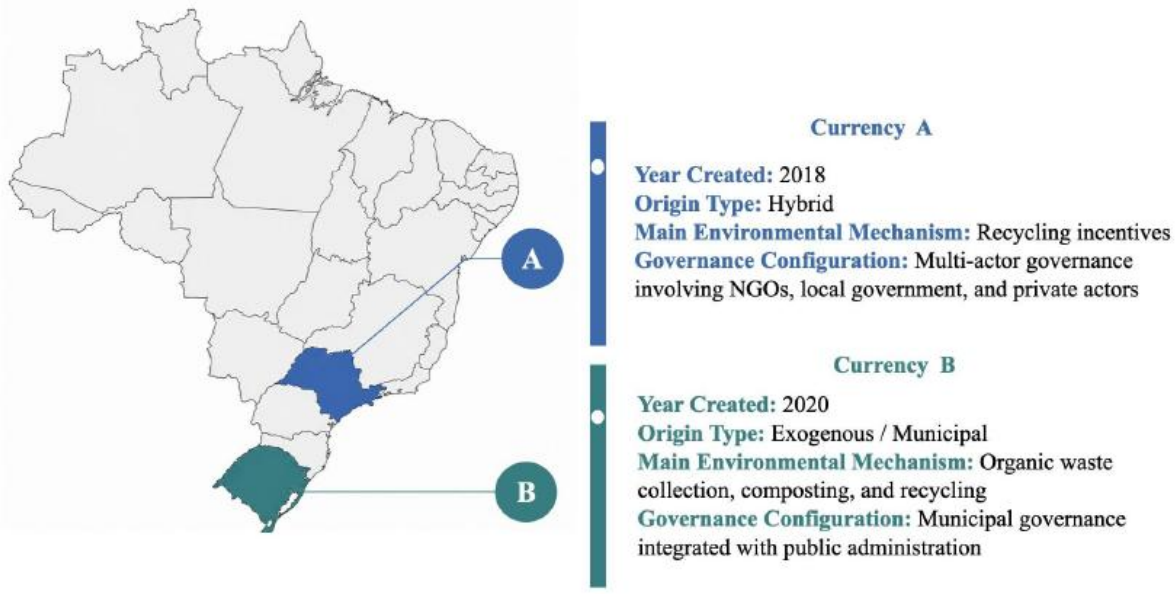
3.1 Case selection

The cases were selected through purposive sampling, aiming to capture the diversity of socio-environmental currency configurations in Brazil. Specific criteria guided the selection

process, including: (i) the existence of green currency initiatives with explicit socio-environmental objectives; (ii) a minimum of five years of operation, ensuring greater institutional maturity and data availability; and (iii) access to information and key actors involved in the implementation and management of the initiatives.

Based on these criteria, two representative cases were selected from different Brazilian regions, enabling the analysis of distinct institutional arrangements, operational mechanisms, and territorial contexts. To preserve analytical standardization and avoid the overexposure of specific initiatives, the cases are presented anonymously as Currency A and Currency B. The figure 1 presents the geographical distribution of the selected cases, together with their main institutional and environmental characteristics, including origin type, governance configuration, and core environmental mechanisms.

Figure 1: Geographical distribution and comparative characteristics of the analysed socio-environmental currency initiatives in Brazil.



Source: Authors (2026)

3.2 Data collection

Data collection combined extensive documentary analysis with semi-structured interviews in order to ensure analytical triangulation and contextual depth. Documentary sources

included institutional documents, legislation, technical reports, project materials, news articles, television reports, academic publications, and official materials related to the analysed initiatives. These materials enabled the reconstruction of the historical development, operational mechanisms, governance arrangements, and socio-environmental objectives of the green currencies.

Semi-structured interviews were subsequently conducted with actors directly involved in the initiatives, including founders, public managers, project coordinators, and currency users. The interviews were conducted remotely, with an average duration of 35 minutes, and were subsequently transcribed for analysis. The interviews aimed primarily to complement documentary information, clarify operational dynamics, and capture perceptions regarding the functioning, governance arrangements, and socio-environmental impacts of the initiatives. The distribution of empirical sources used in the research is presented in Table 2.

Table 2: Distribution of empirical sources by analysed case

Case	Interviews	Laws	TV Reports	Press Reports	Academic Articles	Official Documents	Field Visit	Total Documents
A	5	1	2	3	2	1	1	15
B	4	2	5	1	1	2	0	15
Total	9	3	7	4	3	3	1	30

Source: Authors (2026)

The iterative coding process and the triangulation of multiple data sources contributed to increasing the reliability and internal consistency of the analysis.

3.3 Data Analysis

Data were analysed using thematic analysis, supported by the NVivo software, which enabled the organization, coding, and systematization of the empirical material. The analytical process followed an iterative approach, combining deductive and inductive strategies.

Initially, analytical dimensions were defined based on the literature, including: (i) environmental, related to ecological practices and incentives; (ii) economic-operational, referring to mechanisms of functioning, circulation, and value generation; and (iii) institutional-governance, associated with institutional arrangements, involved actors, and forms of coordination. Additionally, the origin of the initiatives (endogenous, exogenous, or hybrid) was considered as a relevant analytical dimension for understanding differences across cases.

Data coding in NVivo was guided by an initial set of categories and key terms derived from the literature, including, among others: waste management, recycling, sustainable consumption, local economy, income generation, governance, participation, public policy, institutional arrangement, incentives, behavior change, and environmental practices. These terms guided the identification of relevant excerpts in documents and interviews, enabling the systematic organization of data into thematic nodes.

Subsequently, open coding was conducted, allowing for the identification of emergent categories and the refinement of previously established dimensions. The analysis involved both within-case examination and cross-case comparison, enabling the identification of patterns, differences, and recurring elements across the analysed experiences.

3.4 Research limitations

This study presents some limitations that should be considered when interpreting the results. First, the research is based on a limited number of cases which, although suitable for an in-depth qualitative analysis, restricts the generalization of the findings to other green currency experiences and territorial contexts. In addition, the purposive sampling strategy may introduce biases related to data availability and access to institutional actors.

Another limitation concerns the exploratory nature of the study. Rather than statistically testing causal relationships, the research seeks to identify patterns, institutional configurations, and analytical dimensions associated with green currency initiatives. Furthermore, the study focuses primarily on environmental, operational, and governance dimensions, which may not fully capture long-term economic impacts or broader political dynamics associated with these systems.

Despite these limitations, the study contributes by advancing the empirical understanding of green currencies, proposing a comparative analytical approach, and identifying different governance configurations based on real-world experiences in the Brazilian context.

4. Results

This section presents the comparative analysis of the two green currency initiatives investigated in this study: Currency A and Currency B. The findings are organized according to the analytical dimensions established during the coding process, including environmental, economic-operational, institutional-governance, and social dimensions. The coding process enabled the identification of patterns and variations across cases to identify patterns, variations, and dominant characteristics across the cases. The comparative analysis reveals important differences in the configuration and operational orientation of the two green currency initiatives. Although both cases share common characteristics related to local economic circulation and governance structures, the coding patterns indicate distinct emphases across the initiatives.

Currency A presented stronger institutional articulation, particularly regarding institutional arrangements and integration with public policies. This suggests a configuration characterized by greater coordination among actors and more robust institutional support mechanisms. In addition, Currency A demonstrated stronger references associated with social impact, indicating a greater emphasis on community-oriented social dynamics.

Currency B, in turn, demonstrated a more pronounced environmental and operational orientation, with higher concentrations of references related to waste management and operational mechanisms. These findings suggest a configuration more strongly connected to environmental practices and operational implementation processes.

Overall, the findings indicate that green currencies do not constitute homogeneous initiatives, but rather operate through different combinations of environmental, operational, institutional, and social dimensions. These variations reinforce the importance of considering governance arrangements, operational structures, and local contexts in the analysis of green currency systems.

4.1 Environmental dimension

The environmental dimension emerged as one of the central components across the analysed green currency initiatives, particularly regarding waste management practices, environmental awareness, and local sustainability dynamics. Although both cases incorporated socio-environmental objectives, important differences were identified in terms of operational focus and environmental orientation.

Currency B presented the strongest environmental emphasis among the analysed cases, with a higher concentration of references related to waste management. The initiative demonstrated a strong focus on encouraging recycling practices through incentive mechanisms linked to the circulation of the local currency. Evidence from interviews and institutional materials indicated that the system contributed to increasing community engagement in waste separation practices and environmental awareness.

In addition, Currency B demonstrated operational mechanisms associated with recycling processes and the reintegration of waste into local productive dynamics, reinforcing principles associated with the circular economy. The case also revealed connections between environmental practices, community participation, and local awareness initiatives.

In contrast, although Currency A also incorporated environmental objectives, the environmental dimension appeared less central when compared to Currency B. The initiative demonstrated stronger emphasis on institutional articulation, governance structures, and social dimensions, while environmental practices were more indirectly connected to the functioning of the currency system.

Across both cases, the findings suggest that green currencies operate not only as economic exchange mechanisms but also as instruments capable of influencing environmental practices and promoting local sustainability transitions. The results reinforce the idea that sustainability transitions depend not only on technological or infrastructural solutions but also on social engagement and changes in everyday practices. In this sense, the analysed initiatives illustrate how local monetary systems may contribute to circular economy dynamics by encouraging recycling practices, waste separation, and the circulation of resources within local economic systems.

4.2 Economic and operational dimension

The economic and operational dimension revealed important differences regarding the functioning, circulation mechanisms, and operational structures of the analysed green currency initiatives. Although both cases were associated with local economic incentives and waste exchange dynamics, the initiatives demonstrated distinct operational configurations and different levels of institutional complexity.

Currency B presented the strongest operational orientation among the analysed cases, with the highest concentration of references associated with operational mechanisms and integration with public policies. The initiative demonstrated a highly structured operational system involving waste collection, sorting processes, redistribution mechanisms, and the circulation of local currency units across different sectors of the municipality. Institutional materials and interviews indicated the existence of formalized operational procedures and integration with municipal administrative structures, reinforcing the central role of operational coordination in the functioning of the system.

Currency A also demonstrated strong economic and operational dimensions, particularly regarding local economic circulation and institutional coordination. The initiative showed significant articulation between local actors, commercial establishments, and social participation mechanisms, contributing to the strengthening of local economic dynamics. In addition, the case presented evidence related to institutional support mechanisms and local coordination arrangements, suggesting a relatively stable operational structure.

One interviewee highlighted the role of the initiative in strengthening local commercial networks:

> *"It is a form of marketing while also helping the environment." (Interviewee 6)*

Overall, the findings indicate that green currencies function not only as symbolic sustainability initiatives but also as operational systems that organize material flows, structure exchange mechanisms, and stimulate local economic activity. The results suggest that the effectiveness and continuity of these initiatives depend not only on environmental engagement but also on the existence of operational capacities, institutional support, and mechanisms capable of sustaining local circulation dynamics over time. In this sense, the analysed cases reinforce the relevance of operational processes in enabling circular economy practices and supporting local sustainability transitions.

4.3 Institutional and governance dimensions

The institutional and governance dimension revealed important differences in terms of coordination mechanisms, institutional support, and public policy integration across the analysed initiatives. Although both cases demonstrated institutional articulation, the findings indicate distinct governance configurations and different levels of public sector involvement.

Currency A demonstrated stronger institutional articulation, particularly regarding institutional arrangements and coordination mechanisms involving multiple actors. The initiative emerged through a hybrid configuration involving a non-governmental organization, private sector actors, and support from the local government. This origin appears to have contributed to the development of a more collaborative and institutionally articulated governance structure. The findings also indicate stronger connections with social participation mechanisms and local coordination dynamics.

Currency B, in turn, demonstrated a higher degree of institutionalization and stronger integration with formal public management structures. The initiative presented formal coordination mechanisms, operational support from municipal structures, and significant integration with public policies. The findings suggest that this institutional configuration contributed to the development of a more operationally structured governance arrangement, particularly regarding waste management practices and local circulation mechanisms.

This institutional integration is evidenced in the legal framework regulating the initiative:

> *"Article 4 - The Green social currency shall be produced, numbered, and registered by the Executive Branch through the Municipal Secretariat for the Environment." (Law excerpt 3)*

Overall, the findings indicate that governance arrangements play a central role in shaping the operational capacity, institutional stability, and sustainability of green currency initiatives. The results suggest that different institutional configurations may influence not only the level of public policy integration but also the ability of local currency systems to coordinate actors, organize exchange mechanisms, and sustain socio-environmental practices over time. In this sense, the analysed cases reinforce the relevance of governance structures and institutional support in enabling local sustainability transitions.

Taken together, the findings suggest that the origin of green currency initiatives directly influences their governance configurations, coordination mechanisms, operational structures, and levels of institutionalization. In this sense, the analysed cases demonstrate that green currencies do not operate homogeneously, but rather develop through distinct institutional arrangements shaped by the actors involved in their creation, coordination, and maintenance.

5. Discussions

The findings reinforce recent literature suggesting that community currencies should not be understood as homogeneous monetary arrangements, but rather as diverse socio-institutional configurations shaped by distinct governance structures, operational mechanisms, and socio-environmental priorities (Blanc, 2020; Barinaga et al., 2026). While previous studies have frequently approached complementary currencies as broad categories of local exchange systems, the comparative analysis developed in this study demonstrates that green currencies may assume substantially different configurations depending on their institutional origins and governance arrangements.

The analysed cases revealed two distinct institutional configurations. Currency A demonstrated a hybrid governance arrangement characterized by multi-actor collaboration, institutional articulation, and stronger integration between civil society organizations, local actors, and municipal support structures. In contrast, Currency B demonstrated a more operationally structured and public-led configuration, with stronger integration with formal public management structures and public policy mechanisms. These differences suggest that the environmental, operational, institutional, and social dimensions of green currencies are closely associated with the actors involved in their creation, coordination, and maintenance.

The findings also contribute to debates regarding governance configurations in community currency systems (Blanc, 2011). The stronger operational coordination and public policy integration identified in Currency B suggest that public-led configurations may facilitate institutionalization, operational scaling, and governance capacity. At the same time, Currency A reinforces arguments that hybrid governance arrangements may strengthen institutional collaboration, local participation, and socio-economic articulation. This finding aligns with recent literature suggesting that contemporary community currencies

increasingly operate through hybrid governance structures involving public authorities, civil society organizations, and private actors (Barinaga et al., 2026).

From a sustainability transitions perspective, the analysed initiatives can be understood as niche-level socio-institutional innovations experimenting with alternative forms of economic coordination and environmental governance (Geels, 2002; Seyfang & Longhurst, 2013). Rather than functioning solely as local exchange systems, the findings indicate that green currencies may operate as governance instruments capable of influencing environmental practices, organizing material flows, and supporting circular economy dynamics. The cases analysed reinforce the argument that sustainability transitions depend not only on technological innovation, but also on institutional experimentation, governance capacity, and social engagement.

This study contributes to the literature by proposing a comparative analytical approach capable of integrating environmental, operational, institutional, and social dimensions of green currency initiatives. Empirically, the research advances understanding of Brazilian green currency experiences, a field that remains relatively underexplored in international literature. From a policy perspective, the findings suggest that green currencies may function as flexible governance instruments capable of articulating local economic development, environmental management, and community participation. However, the effectiveness and continuity of such initiatives appear to depend on institutional capacities, governance arrangements, and operational sustainability over time.

6. Conclusions

This study investigated two Brazilian green currency initiatives through a comparative qualitative analysis based on environmental, operational, institutional, and social dimensions. The findings demonstrate that green currencies should not be understood as homogeneous systems, but rather as heterogeneous socio-institutional configurations shaped by distinct governance arrangements, operational structures, and forms of institutional articulation.

The comparative analysis identified two dominant institutional configurations across the analysed cases: a hybrid governance configuration (Currency A) and a public-operational configuration (Currency B). These differences suggest that the origin of the initiatives strongly influences their governance dynamics, operational capacities, levels of

institutionalization, and socio-environmental orientations. The results also reinforce the relevance of green currencies as socio-environmental governance instruments capable of connecting local economic circulation with environmental practices, community participation, and circular economy dynamics. Beyond functioning as alternative exchange mechanisms, the analysed initiatives demonstrated the capacity to organize material flows, support waste management practices, and stimulate sustainability-oriented local dynamics.

From a theoretical perspective, this study contributes to the literature by proposing a comparative analytical approach capable of integrating environmental, institutional, operational, and social dimensions in the analysis of green currencies. The findings also contribute to sustainability transitions literature by demonstrating how local monetary arrangements may function as niche-level socio-institutional innovations connected to broader processes of environmental governance and socio-economic transformation. Despite these contributions, the study presents some limitations. First, the analysis focused on two Brazilian cases, which limits the generalizability of the findings to other socio-economic and institutional contexts. Second, the study relied predominantly on qualitative materials and coding analysis, which does not allow the direct measurement of long-term environmental, economic, and social impacts.

Future studies could expand the comparative scope by investigating recently created green currency initiatives, particularly those developed during the last two years, allowing the identification of emerging governance models, digital operational arrangements, and new sustainability strategies. Comparative international studies may also contribute to understanding how different institutional and policy contexts shape the development and effectiveness of green currencies across countries. Furthermore, future research could incorporate longitudinal approaches and quantitative indicators to evaluate environmental impacts, local economic effects, and governance dynamics over time. Taken together, the findings reinforce that green currencies represent an emerging and dynamic field of socio-environmental innovation, combining monetary experimentation, local governance, and sustainability-oriented practices within distinct institutional configurations.

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THE PROMISE OF A BETTER LIFE – VARIETIES OF COMMUNITY CURRENCIES IN THE STATE OF RIO DE JANEIRO[1]

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Abstract

Worldwide, community currency (CC) initiatives present highly diverse institutional designs and business models, and Brazil is no exception. The country has a long-standing tradition of CCs with more than 150 cases, analogue and increasingly in a hybrid or digitally-only form. More recently, a distinct pattern has emerged, with neighbouring municipalities implementing digital CCs through top-down, municipality-led initiatives for government-to-person (G2P) payments aimed at increasing the outreach of social transfers to entitled households. This paper focuses on four of these experiences, all implemented in cities in the state of Rio de Janeiro: Mumbuca (in the city of Maricá, in 2013), Araribóia (city of Niterói, in 2021), Saquá (city of Saquarema, in 2022), and Macaíba (city of Macaé, in 2023). The main purpose of this study is to review the four case studies with community currencies as the preferred means by municipalities for social-cash transfer programmes to target beneficiaries within their jurisdiction. We identify similarities and differences and make these experiences available also to a broader, non-Portuguese audience. Methodologically, the paper adopts a comparative case study

[1] We thank the participants for the discussion, their comments and suggestions. The information presented in this paper has been compiled to the best of our knowledge, and any remaining errors are, of course, our own.

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approach. It draws on qualitative data from (i) document analysis (municipal regulations, program guidelines, institutional reports, and publicly available materials) and (ii) process tracing of key design and implementation decisions across the four cases. The analysis is structured around three core dimensions that are recurrent in the CC literature and central to operational continuity over time: (1) organizational aspects; (2) governance and ownership; and (3) currency management. Preliminary findings suggest significant variation across the four cases, with Mumbuca emerging as the most robust experience in terms of sustainability and dissemination, while more recent initiatives exhibit greater institutional and operational fragilities. The paper concludes by identifying key vulnerabilities and proposing policy and design adjustments aimed at strengthening the long-term sustainability of the four cases analysed.

Keywords: Community currencies, convertibility, credit line, digitalization, entitlement, governance, oil, ownership; sustainability, Rio de Janeiro

JEL: B59, E41, E51, E64, G21, 018

1. Introduction

Community currency (CC) initiatives around the world differ considerably in their institutional designs and business models. Brazil is no exception. The country has a long tradition of CCs, with more than 150 cases, analogue and increasingly in a hybrid or digitally-only form.

More recently, a distinct pattern has gained relevance in Brazil: digital CCs created by municipalities and used for government-to-person (G2P) payments. These initiatives are generally implemented through a top-down approach and use community currencies to distribute social cash transfers to eligible households. At the same time, by restricting the circulation of these resources to the municipality, they seek to support local businesses and stimulate the local economy.

This paper focuses on four such experiences, all located in the state of Rio de Janeiro: Mumbuca currency, introduced in the city of Maricá in 2013; Araribóia, introduced in Niterói in 2021; Saquá, introduced in Saquarema in 2022; and Macaíba, introduced in Macaé in 2023.

The main purpose of this study is to review the four case studies with community currencies as the preferred means by municipalities for social-cash transfer programmes to target beneficiaries within their jurisdiction. The research question guiding our analysis is to what extent can we identify similarities and differences in the institutional design of the four community currencies. We also examine whether Maricá, the most long-standing community currency, serves as a blueprint for the other three case studies or whether context-specific implementation choices dominate this recent pattern of community currency launches in the Rio de Janeiro area.

To address this question, the paper uses a cross-case analysis. There are several approaches to evaluate these experiences, inter alia an empirical and quantitative analysis. However, the available data in general is limited and the data which is actually available would not be significant enough due to the very short-term lifetime of Niterói, Saquá and Macaíba. This is a research avenue only for the future, when all community currencies run at least 5 years. Hence, for the time being we apply a qualitative approach based on the framework of Metzger et al. (2023) and focus on the institutional design with the following three dimensions: (1) organizational aspects; (2) governance and ownership; (3) currency management.

The analysis is based on a desk study drawing on academic literature, municipal regulations, program guidelines, institutional reports, news sources, and other publicly available materials. While there is already a larger body of academic research on Mumbuca[4] and some on Araribóia[5], the literature on Saquá (Mauriel, 2025; Faria et al., 2026) and Macaíba (Mauriel, 2025); Figueiredo & Ney, 2026) remains scarce due to their rather recent launching. Moreover, relatively little information is publicly disclosed by the respective municipalities and when yes, it is often only available in Portuguese. Accordingly, with the qualitative review of the four community currencies in the Rio de Janeiro area, we intend to make these experiences available also to a broader, non-Portuguese audience.

The analysis reveals both similarities and differences across the four cases. Two common vulnerabilities are political dependence and reliance on oil royalties for funding. One difference relates to who is allowed to use the currencies in each municipality. In

[4]Araujo et al., 2026; Balakrishnan et al., 2024; Britto et al., 2022; Diniz et al., 2026; Faria et al., 2020; Faria et al., 2022; Faria et al., 2026; Gonzalez et al., 2020; Oliveira et al., 2022; Silva & Rigo, 2025.
[5] Britto et al., 2022; Faria et al., 2026; Oliveira et al., 2022; Silva & Rigo, 2025.

Niterói, Saquarema, and Macaé, only beneficiaries can receive and use the currencies, whereas Maricá does not impose this restriction. The cases also differ in their approaches to credit provision. In Maricá, Mumbuca Bank offers microcredit lines; in Niterói, public calls are used to provide financing to small businesses, while in Saquarema and Macaé there are plans to introduce credit lines, but no evidence of their implementation was identified by the time this paper was completed. Overall, the analysis shows that Mumbuca stands out as the most consolidated of the four experiences, despite the vulnerabilities identified above.

This paper is divided into four sections. The next section introduces the methodology and explains the three dimensions used in the cross-case analysis. Section 3 presents the desk study of the four cases, examining each community currency according to the three dimensions described in Section 2, followed by the results of the cross-case analysis. Section 4 presents the final considerations.

2. Methodology

Following the framework of Metzger et al. (2023), this chapter lays out the methodology of the following desk study. The paper utilizes a cross-case analysis to address the research question to what extent the institutional design of CCs in the Rio Area varies and how context-specific implementations drive success or failure for these case studies. We will compare the case studies along the three domains: (1) organisational aspects; (2) governance and ownership; and (3) currency management.

(1) Organizational aspects

The framework starts with a section about organizational aspects, which describe fundamental design decisions by municipalities and sometimes the issuing bank That includes the name, the introduction date of the digital CC, the preparation period to introduce the CC, its organizers, and the CC's objective. These are provided for informative reasons and are rather descriptive. The number of the total population and users is displayed; the two numbers compared show the dissemination and acceptance of the CC within the municipality. Lastly, the table identifies the specific CC type and uses Blanc's (2011) generational classification. Since we consider exclusively digital implementations, we also identify the used technology. Therefore, we follow Diniz et al.'s (2019) technological taxonomy. The last two categories can be scored with the help of the classification within the respective taxonomies.

Table 1: Organizational aspects

Name	State the CC's name. (Descriptive)
Objective	Specific or officially stated aim or goal of the CC.
Digital introduction date	State the point in time when the digital CC was introduced.
Preparation period	If applicable, state how long it took the project to introduce the digital variant.
Organizer/inventor	Name the actor who developed and introduced the CC.
Number of population	State the most current available number of population of the municipality.
Number of users	State the most current available number of users.
Community currency type	Name the CC type and classify it after Blanc (2011).
Technology[6]	Shortly describe the technology used to operate the CC and classify it after Diniz et al. (2019).

Source: Own compilation.

(2) Governance and ownership

Next, we identify factors crucial to governance and ownership. We start with the question of who is allowed into the system. Some CCs allow only socially excluded and vulnerable groups, others only businesses or volunteers and community activists into the community (and some everyone who actually wishes to join and use it). We split this question into three separate categories. First, who is entitled to access the system? This is a ternary category that distinguishes businesses, individuals, or both. Second, who is accepting the CC? Once again, this is a binary decision having either only businesses accepting the CC or also individuals. We then consider the scope of use of the CC, identifying what types of payments and transactions it can be used for. Lastly, we identify how members are allowed into the system. This process is called onboarding. We differentiate this into a continuum from standardized to fairly standardized to non-systematic and briefly describe the underlying process. Subsequently, we identify if limits are set within the system. That relates to either geographic or content limits. Then, we provide descriptive information on who maintains the system and describe the maintenance dimension, whether the system is organized top-down or bottom-up (Gómez 2012, p. 88). We also examine how each CC system is funded, identifying its

[6] This certainly could constitute a section of its own. As a general overview, Baharmand et al. (2021, p. 5) provide an excellent schematic overview for blockchain projects in the development cooperation and humanitarian aid sector. Farroukh and Metzger (forthcoming) share the experience of a blockchain-based CC in Cameroon.

main sources of funding and indicating whether the operation of the CC is self-sufficient. Finally, we clarify if payments can be accessed centrally or decentrally (Nooke and Zeller 2019, p. 12).

Table 2: Governance and ownership

Entitlement	Who is allowed to use the CC? (Businesses vs. specific gropus vs. everyone)
Acceptance	Who in the community accepts the CC? (Businesses vs. everyone)
Scope of Acceptance/Use cases	What can the CC be used to pay for?
Onboarding	How are new users onboarded to the system? (Standardized vs. fairly standardized vs. non-systematic)
Geographical limits	Identify whether there exist geographical limits. (Yes vs. No)
Content limits	Identify whether there is a content-wise limitation of the CC. (Yes vs. No)
Maintenance – who	Identify who maintains the CC system.
Maintenance – how	Identify how the system is maintained (Top-down vs. Bottom-up).
Funding	What sources of funding support the CC system?
Access to payments	How can users access their accounts and payments? (Central vs. Decentral)

Source: Own compilation.

(3) Currency management

Lastly, we examine factors in currency management with a focus on convertibility, fees, and the economic functioning of the CC. The CCIA (2015, pp. 99–115) calls those the key features of a CC which are critical for its survival and its sustainability. First, questions around convertibility are investigated, i.e., is the CC convertible, which can be answered binarily. Additionally, we analyse factors connected to the convertibility, such as the existence of an underwriter, its potential guaran and backing, as well as the final value determination of the CC and the number of CCs in circulation (numeric) (CCIA 2015, pp. 99–109).

Secondly, questions about fees existent within the system are investigated. Therefore, we display the category of fees and describe their nature. Additionally, we show if demurrage and seigniorage exist within binary categories. Lastly, we examine with a category if any fees are used to support the community within which the respective CC is operating (CCIA 2015, pp. 109–113; Nooke and Zeller 2019, p. 7).

Thirdly, we examine each case regarding the functions of money. We first identify the amount every participant receives and if this amount is fixed or flexible. Then, we assess the extent to which CC fulfils the four functions of money: (1) *unit of account*, providing a standardised measure for pricing goods and services, comparing prices, and denominating contracts; (2) *medium of exchange*, facilitating transactions in goods and services and reducing transaction costs; (3) *store of value*, allowing nominal wealth to be stored and accumulated; and (4) *standard of deferred payment*, serving as the unit in which credit contracts and repayment obligations are denominated.

Generally, CCs take over only partially typical money functions. The overwhelming majority of existing CCs links the value of the CC to the legal tender. Accordingly, it is the legal tender which serves as the *unit of account* and takes over this function. In the four cases of the Rio de Janeiro area, all CCs are set equal to one reais. All CCs are used as a means of payment and are thus taking over the *medium of exchange* function. Only very few CC frameworks allow the CC to be used as a *store of value* or a *medium of deferred payments*. Some of the CCs even punish users who prefer to keep a balance in their account with a penalty fee (demurrage). If the institutional design excludes that the CC cannot be used as means of contract fulfilment for credits and accordingly not be used for savings, already structurally weakens the self-sustaining process of the CC. Finally, we examine if the CC design provides for a purchaser of last resort.

Table 3: Currency management

Convertibility	Is the CC convertible? (Yes vs. No)
Underwriter	Does an underwriter for the CC exist, and if yes, who is it?
Underwriter's guarantee	If there is an underwriter, what does (s)he guarantees?
Value of the CC	How is the value of the CC determined, and who decides about it?
Backing	Is the CC backed by legal tender or commodities?
Circulating number of the CC	Who decides about the circulating amount, and what is the amount?
Fees	Identify fees tied to the CC and state their purpose.
- **Seigniorage**	Identify whether a seigniorage exists and, in case, state for what it is used.
- **Demurrage**	Identify whether demurrage exists.
Community contributions	Explicitly identify if there are community contributions of the CC apart from potential fees.
CC amount	Identify the units of the CC received by the members of the network.

Functions of money	Medium of exchange, store of value, unit of account, standard of deferred payment.
Earning	State whether users can earn in the CC.
Purchaser of last resort	Are there places that always accept the CC on demand?
Credit lines	Does the CC system offer credit lines, and if yes, under what conditions?

Source: Own compilation.

3. Desk study: the four Brazilian cases in the Rio de Janeiro Area

In Brazil, community currencies (CCs) are generally linked to the creation of a community bank, which is usually responsible for issuing and managing the currency within a specific and geographically limited locality. Another distinguishing characteristic concerns the organisation or better institution who creates the CC: the community itself or the municipality. In the former case, the initiative is bottom-up and the currency is commonly referred to as a "social currency," as exemplified by the Palmas currency, created in 2002 by a residents' association in the Conjunto Palmeira neighbourhood (Pereira et al., 2011). In the latter case, when the municipality is responsible for its creation, it constitutes a top-down initiative, and the CC is classified as a "municipal currency" or "municipal social currency".

Despite these differences, both models share common features: their circulation is intended to promote local development, address socio-economic inequalities, and they are circumscribed to a specific territory. In most cases, these currencies are backed and operate at one-to-one parity with the Brazilian real (BRL). This represents the majority of CC experiences in Brazil. Backed CCs are less challenged by a lack of acceptance as those residents and businesses which are participating on a voluntary basis in the CC always have the option to check-out and regain legal tender. In a non-backed CC this is not possible; once receiving the CC in exchange of goods and services, including work, it is the receiver's risk to find someone who will accept the CC for his or her purchases. On the other hand, multiplier effects are biggest with an unbacked CC.

In the following section, we focus on four cases to examine to what extent the institutional design of CCs in the Rio Area varies: CC Mumbuca (introduced in the city of Maricá in 2013), CC Araribóia (introduced in city of Niterói in 2021), CC Saquá (introduced in city of Saquarema in 2022), and CC Macaíba (introduced in city of Macaé in 2023). We selected these cases because they represent and replicate a new pattern of community

currencies: CCs serve municipalities to target beneficiaries for their social-cash transfer programmes within their jurisdiction. At the end of the section, we present a table summarizing the main characteristics of each case, based on the methodology outlined in the previous section. In the annex you find a synopsis of the four CCs.

Before proceeding, it is worth noting a methodological limitation of this study. The analysis of the currencies discussed below draws on academic literature in English and, predominantly, Portuguese, as well as official reports and news sources (also in Portuguese). However, publicly available academic research and quantitative data on these currencies remain scarce, which limits the scope and depth of the analysis.

3.1. Mumbuca (city of Maricá)

In 2013, the Municipal Law No. 2,448/2013 (Maricá, 2013) created the Mumbuca currency and the People's Community Bank of Maricá (also known as Mumbuca Bank) as part of a municipal basic income policy in the city of Maricá. Under this framework, the municipality would pay social benefits to the local population in Mumbuca currency, with payments administered by Mumbuca bank. In 2017, the bank gained autonomy and began to be managed by a community association (Silva & Pereira, 2022), no longer functioning as a direct operational arm of the municipality, although it still administers the payment of social benefits.

From 2013 to 2017, benefit payments in Mumbuca were made through a magnetic card, similar to a prepaid card. After four years in operation in 2017, benefits began to also be paid through the E-Dinheiro app[7], a platform owned by the Instituto E-Dinheiro and developed by MoneyCloud (Faria et al., 2020), which enabled payments, transfers, and other basic banking services in the Mumbuca currency (Silva and Pereira, 2022). However, the prepaid cards could, and still can, be used as a form of payment in the Mumbuca currency.

From 2017 to September 2025, the Municipality of Maricá transferred funds in Brazilian reais to Instituto E-Dinheiro, which, together with the Mumbuca Bank, carried out the

[7] The E-Dinheiro platform was developed by Instituto Banco da Periferia (later renamed Instituto E-Dinheiro) in collaboration with MoneyCloud in 2016 (Almeida et al., 2023). As mentioned in the text,initially, Maricá's social currency system operated through magnetic cards. In 2017, the municipality signed a collaboration agreement with Instituto E-Dinheiro to support the management of Banco Mumbuca and the payment of benefit with the platform E-Dinheiro. This platform was launched in Maricá in December 2017 and became operational in early 2018 (Cernev, 2019; Almeida et al., 2023).

corresponding transfers to beneficiaries in Mumbuca (Faria et al., 2026). After September 2025, Instituto E-Dinheiro ceased to participate in this arrangement, and the funds began to be managed exclusively by Mumbuca Bank on behalf of the municipality (Jorge, 2025). In this context, the E-Dinheiro app was also replaced by a new application carrying the same name as the currency, "Mumbuca" (Prefeitura de Maricá, 2025a, 2025b).

The municipality of Maricá, like the other cities analysed in this paper, receives oil royalties from the federal government, enabling the municipality to finance and sustain social benefit payments in Mumbuca (Balakrishnan et al., 2024). As a result, Mumbuca presents a case in which the community currency system is deeply integrated with and extensively used by a public authority. By December 2025, around 71,000 residents (nearly 33% of the city's population) were receiving monthly social benefits in Mumbuca (Prefeitura de Maricá, 2025b). It is currently the largest community currency operation in Brazil, with approximately 133,000 accounts at Mumbuca Bank, a figure that includes both beneficiaries, non-beneficiaries and businesses (Prefeitura de Maricá, 2024).

In addition to the basic income program, the municipality also established the Mumbuca Future Program (Programa Mumbuca Futuro), which provides benefits in Mumbuca currency. The program aims to reduce school dropout rates and support social and professional inclusion (Prefeitura de Maricá, 2025c). Municipal public servants also receive certain benefits in Mumbuca, including food allowances and year-end bonuses (Prefeitura de Maricá, 2025b; 2025e).

Another distinguishing feature is that residents of Maricá can access different microcredit lines from Mumbuca Bank under varying conditions, including both low-interest and interest-free loans. These loans are denominated and disbursed in Brazilian reais rather than in the Mumbuca community currency[8] (Banco Mumbuca, 2025a). The funds used to finance these credit lines come from the transaction fees charged on payments made with Mumbuca. There are no public data available on the evolution of non-performing loans. In addition, there is no public information available how precisely loans are being assigned to potential borrowers, whom we assume are numerous given the interest-free feature of the loans.

[8] Banco Mumbuca previously offered loans in Mumbuca (Gama et al., 2021). However, the bank's current website lists loan amounts only in Brazilian reais (R$), without specifying when or whether disbursements in Mumbuca were discontinued. The reasons for this apparent change require further investigation.

A further characteristic is that beneficiaries are not allowed to convert Mumbuca into Brazilian reais. Commercial establishments that accept payments in Mumbuca, however, may exchange the currency for reais upon payment of a service fee. Under the previous E-Dinheiro system, non-beneficiaries and accredited local business were entitled to buy, access, and use Mumbuca (for example, they could obtain credit lines in Mumbuca) (Almeida et al, 2023)). However, no official sources confirm if they can still do so under the current system.

Payments in Mumbuca are primarily accepted by local businesses, including restaurants, pharmacies, and supermarkets. However, the currency cannot be used to pay utility bills or local taxes. Hence, the municipality which originally launched and issued Mumbuca, does not accept the community currency itself for its revenues. This lack of acceptance by the creator of the CC certainly undermines confidence into the Mumbuca itself and limits its acceptance by non-beneficiaries and local businesses and challenges its sustainability. Data available suggests that a high proportion of local businesses convert their Mumbuca revenues back into reais.

In addition, larger businesses, such as supermarket chains, often convert Mumbuca into Brazilian reais instead of recirculating it within the local economy, which may reduce its local circulation effects (Diniz et al., 2026).

Table 4: Mumbuca overview

Organizational aspects	
Name	Mumbuca
Objective	Banking the unbanked, provide subsidies efficiently, incentivize local development, financial inclusion.
Digital introduction date	2018
Preparation period	2013, magnetic cards
Organizer/inventor	Brazilian Network of Community Banks (bought from MoneyCloud), People's Community Bank of Maricá & Municipality of Maricá
Total population	216,000 (as of 2026)
Number of users	71,000 receive social benefits in Mumbuca; 133,000 hold accounts at Mumbuca Bank, including both beneficiaries and accredited local businesses (Prefeitura de Maricá, 2024, 2025c).
CC type	Fiat-backed CC, Blanc (2011): G3
Technology	App & card & SMS/USSD + conventional bank ledger system (Mumbuca platform) Proprietary DCC Platform

Governance & Ownership	
Entitlement	Social benefit recipients. Note 1: accredited local businesses can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. Note 2: under the previous E-Dinheiro system, non-beneficiaries and accredited local business were entitled to buy, access, and use Mumbuca (for example, they could obtain credit lines in Mumbuca) (Almeida et al, 2023)). However, no official sources confirm if they can still do so under the current system.
Acceptance	Accredited local businesses (see notes for entitlement)
Scope of Acceptance/Use cases	Accepted by local businesses, but not for utility bill or local tax payments.
Onboarding	Standardized for businesses: Must get accredited at a central location by Mumbuca Bank. Non-systematic for users: Different ways, e.g., download & register in “Mumbuca App”
Geographical limits	Yes, Municipality of Maricá
Content limits	Yes, the CC cannot be used to pay taxes and is generally restricted to purchases of goods and services from accredited local businesses.
Maintenance – who	Mumbuca Bank, which started as a municipal bank. It gained autonomy in 2017 and now the Bank is managed by an NGO (Associação Banco Comunitário Popular de Maricá) (Pereira e Silva, 2022).
Maintenance – how	Mumbuca started as a top-down initiative, but now has some bottom-up elements, since the bank is managed by an NGO. However, it still depends heavily on municipal funding
Funding	Oil royalties (Gonzalez et al. 2020; Balakrishnan et al., 2024)
Access to payments	Decentral: App, USSD/SMS & Central: branch office, local staff
Currency management	
Convertibility	Yes, usually against a fee. However, Mumbucas received through the municipal cash transfer programme cannot be converted into Brazilian reais. Businesses can convert Mumbuca into reais.
Underwriter	Mumbuca Bank
Underwriter’s guarantee	Conversion to BRL
Value of the CC	1:1 peg to BRL, established by Maricá’s Municipal Law No. 2,641/2015 (Maricá, 2015))
Backing	Yes, Brazilian real (BRL).
Circulating number of the CC	Dynamic: The Municipality & Mumbuca Bank determine the amount through social benefits paid & granted credits.

Fees	With the old arrangement (E-Dinheiro app), local businesses were charged a 2% transaction fee on each sale made in Mumbucas. An additional 1% fee applied when merchants converted Mumbucas into Brazilian reais after the fifth day of the month. Conversions made between the first and fifth days were free of charge. With the new app ("Mumbuca") we could not locate how much they are charging.
- Seigniorage	No
- Demurrage	No
Community contributions	Yes, profits are reinvested in the community or used for new credit lines[9].
CC amount per beneficiary	230 Mumbucas
Functions of money	Medium of exchange
Earning	No
Purchaser of last resort	Yes, the Mumbuca Bank.
Credit line	Yes, Mumbuca Bank offers microcredit in Brazilian reais, financed by the fees charged for converting Mumbuca into BRL.

Source: Own compilation based on Ansorena et al. (2021); Balakrishnan et al. (2024); Banco Mumbuca (2025); Blanc (2011); Diniz et al. (2019, 2023); Faria et al. (2020); Gonzalez et al. (2020); Maricá (2025); Pereira e Silva (2022); Prefeitura de Maricá (2024, 2025c, 2025d, 2025e, 2025f, 2025i), worldpopulationreview.com.

3.2. Arariboia (city of Niterói)

The creation of the Arariboia community currency was also a top-down initiative led by the Municipality of Niterói and established by Municipal Law No. 3,621 in 202 (Niterói, 2021). The law also established the municipal bank that would manage the currency, Arariboia Bank. Although it is referred to as a bank, in practice it functions as an operational arm of the municipality, similar to the role played by Mumbuca Bank in Maricá until 2017, and has no further functions than issuing Arariboia and distributing the cash-out-social transfers in form of the local CC.

Instituto E-Dinheiro and the E-Dinheiro app have been present since the creation of the Arariboia currency. As in Maricá, the municipality transfers public resources to a dedicated fund managed by Instituto E-Dinheiro, which is also responsible for operating Arariboia Bank (Faria et al., 2026). Beneficiaries may receive the Arariboia community

[9] The bank's revenues have been used to support microcredit and community projects (Cernev, 2019; Banco Mumbuca, 2025b). However, the decision-making process governing the allocation of these resources, as well as the proportion directed to each activity, remains unclear.

currency either through magnetic cards or via the E-Dinheiro mobile application (Niterói, n.d.; Instituto E-Dinheiro, n.d.).

Unlike Maricá, Arariboia Bank does not provide loan facilities to account holders. To foster local entrepreneurship, the Municipality of Niterói has instead adopted an alternative approach by issuing public calls for proposals to finance the social economy. To date, three such calls have been launched between 2023 and 2025; the municipality has provided in each call R$ 4 million for initiatives, collectives and associations (Prefeitura de Niterói, 2025a).

The Arariboia currency shares several features with Mumbuca. Beneficiaries are not allowed to convert the currency into Brazilian reais, while commercial establishments may do so upon payment of a fee. Unlike in Maricá, however, access to the Arariboia currency is restricted to beneficiaries, as non-beneficiaries are not allowed to hold or use the currency, particularly because it is exclusively linked to a public income-transfer policy. Accordingly, the sustainability of the CC depends structurally by design on the local government only – as any other social policy of the municipality. This differs from the experience of Maricá, where Mumbuca Bank operates as a more autonomous entity and provides additional financial services beyond the management of the CC.

Arariboia is primarily accepted by local businesses (restaurants, pharmacies, and supermarkets) but cannot be used to pay utility bills or local taxes. Brandão and Carlos (2025) analysed the circulation of the currency between January 2022 and December 2023 and found that most Arariboia transactions took place in large supermarket chains, which belong to national and international champions. Under these circumstances the economic and social impact of the CC on local businesses is very limited and multiplier effects are rare. While this may be a positive indicator of improved food security for beneficiary households, it may also limit the circulation of resources among small local businesses and within more impoverished neighbourhoods of Niterói (one of the objectives of the CC's creation).

Table 5: Arariboia overview

Organizational aspects	
Name	Arariboia
Objective	Reduce social inequality through income transfers to low-income and extremely poor families; promote local economic development.

Digital introduction date	Launch in 2021, with official start in 2022
Preparation period	N/A
Organizer/inventor	Instituto E-Dinheiro and Municipality of Niterói
Population	520,000 (as of 2026)
Number of users	50,000 individuals receive social benefits in Niterói (Year: 2025) (Prefeitura de Niterói, 2025b). Around 8,000 accredited local businesses and service providers (Prefeitura de Niterói, 2025c).
Complementary currency type	Fiat-backed CC, Blanc (2011): G3
Technology	App & card & SMS/USSD + conventional bank ledger system (E-Dinheiro platform), Diniz et al. (2019): Proprietary DCC Platform
Governance & Ownership	
Entitlement	Social benefit recipients (non-beneficiaries are officially excluded). Note: accredited local businesses cannot purchase the CC but can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. This means they are not entitled to the CC, but they do have access to it, although with some restrictions.
Acceptance	Accredited local businesses
Scope of Acceptance/Use cases	Accepted by local businesses, but not for utility bill or local tax payments.
Onboarding	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Arariboia Bank / E-Dinheiro;
Geographical limits	Yes, municipality of Niterói
Content limits	Yes, the CC cannot be used to pay taxes and is generally restricted to purchases of goods and services from accredited local businesses.
Maintenance – who	Municipality of Niterói (the Arariboia bank functions as an operational arm of the municipality)
Maintenance – how	Top-down
Funding	Oil royalties
Access to payments	Decentral: App, USSD/SMS & Central: branch office, local staff
Currency management	
Convertibility	Yes, usually against a fee. However, only businesses can convert Arariboia into Brazilian reais; those who received benefits in Arariboia cannot.
Underwriter	Municipality of Niterói
Underwriter's guarantee	Conversion to BRL
Value of the CC	1:1 peg to BRL (established by Niterói's Municipal Law No. 3,621/2021 (Niterói, 2021))
Backing	Yes, Brazilian real (BRL).

Circulating number of the CC	Dynamic: The Municipality determines the amount through social benefits paid.
Fees	2% fee on each transaction conducted using the CC[10] (Instituto E-Dinheiro, n.d.).
- Seigniorage	No
- Demurrage	No
Community contributions	Yes, profits are reinvested in the community or used in public calls for proposals to finance local entrepreneurship[11] (Prefeitura de Niterói, 2025a)
CC amount per beneficiary	345 Arariboias (Prefeitura de Niterói, 2025b)
Functions of money	Medium of exchange
Earning	No.
Purchaser of last resort	Yes, the Arariboia bank.
Credit line	No. Instead, the municipality opens public calls for proposals to finance local entrepreneurship (Prefeitura de Niterói, 2025a)

Source: Own compilation based on Blanc (2011); Diniz et al. (2019); Instituto E-Dinheiro (n.d.); Niterói (2021); Prefeitura de Niterói (2025b, 2025c), worldpopulationreview.com.

3.3. Saquá (city of Saquarema)

Following the model of the Mumbuca and Arariboia currencies, the Municipality of Saquarema implemented the Saquá currency and Saquá Bank through Municipal Law No. 2,189/2022 (Saquarema, 2022b).

Saquarema's model is very similar to that of the Arariboia currency: Instituto E-Dinheiro and the E-Dinheiro app have been present since the creation of the currency; the municipality transfers public resources to a dedicated fund managed by Instituto E-Dinheiro, which is also responsible for operating Saquá Bank (Faria et al., 2026). Beneficiaries may receive the Saquá community currency either through magnetic cards or via the E-Dinheiro mobile application (Instituto E-Dinheiro Saquarema, n.d.).

[10] Under Articles 4 and 5 of Niterói Municipal Decree No. 14,928/2022, a 2% administrative fee is charged on each transaction involving the Arariboia currency. The revenues collected are managed by the entity responsible for Banco Arariboia and may be used to finance collective employment and income-generating initiatives, solidarity economy infrastructure, community development activities, training, promotional materials, and participation in relevant events (Niterói, 2023). The decree also provides for the possibility of financing a municipal microcredit programme, although this has not been implemented in practice. Instead, the municipality has relied on public calls for proposals to support local initiatives (Prefeitura de Niterói, 2025a).

[11] See footnote 10.

Individuals who receive social benefits in the Saquá currency are not allowed to convert the currency into Brazilian reais, while commercial establishments may do so upon payment of a fee. As in Niterói, access to the Saquá currency is restricted to beneficiaries, as non-beneficiaries are not allowed to hold or use the Saquá currency. Thus, the same restrictions to a self-sustained and sustainable evolution as for Arariboia apply also to Saquá. The currency is primarily accepted by local businesses (such as restaurants, pharmacies, schools, and supermarkets), but cannot be used to pay utility bills or local taxes. And again, in contrast to local businesses, the municipality which created the Arariboia does not accept it.

In addition to income transfers, the municipality also provides a benefit in Saquá aimed at encouraging school attendance, through a policy called “Moeda Educa Saquá” (Prefeitura de Saquarema, 2023).

Saquá Bank does not currently provide microcredit lines, as observed in Maricá, nor does it offer public calls or programs aimed at fostering entrepreneurship, as in Niterói. Nevertheless, the agreement between Instituto E-Dinheiro and the Municipality of Saquarema includes provisions for the future creation of credit lines (Saquarema, 2022c). To date, however, no public information has been made available regarding the reasons for the non-implementation of these measures.

Table 6: Saquá overview

Organizational aspects	
Name	Saquá
Objective	Reduce social inequality through income transfers to low-income and extremely poor families; promote local economic development.
Digital introduction date	2022
Preparation period	N/A
Organizer/inventor	E-Dinheiro and Municipality of Saquarema
Population	97,000 (as of 2026)
Number of users	N/A
Complementary currency type	Fiat-backed CC, Blanc (2011): G3
Technology	App & card & SMS/USSD + conventional bank ledger system (E-Dinheiro platform), Diniz et al. (2019): Proprietary DCC Platform
Governance & Ownership	
Entitlement	Social benefit recipients (non-beneficiaries are officially excluded).

	Note: accredited local businesses cannot purchase the CC but can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. This means they are not entitled to the CC, but they do have access to it, although with some restrictions.
Acceptance	Accredited local businesses
Scope of Acceptance/Use cases	Accepted by local businesses, but not for utility bill or local tax payments.
Onboarding	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Saquá Bank/ E-Dinheiro;
Geographical limits	Yes, municipality of Saquarema
Content limits	Yes, the CC cannot be used to pay taxes and is generally restricted to purchases of goods and services from accredited local businesses.
Maintenance – who	Municipality of Saquarema (the Saquá bank functions as an operational arm of the municipality)
Maintenance – how	Top-down
Funding	Oil royalties
Access to payments	Decentral: App, USSD/SMS & Central: branch office, local staff
Currency management	
Convertibility	Yes, usually against a fee. However, only businesses can convert Saquá into Brazilian reais; those who received benefits in Saquá cannot.
Underwriter	Municipality of Saquarema
Underwriter's guarantee	Conversion to BRL
Value of the CC	1:1 peg to BRL (established by Law No. 2,189/2022 (Saquarema, 2022b)
Backing	Yes, Brazilian real (BRL).
Circulating number of the CC	Dynamic: The Municipality determines the amount through social benefits paid.
Fees	2% fee on each transaction conducted using the social currency. 1% fee on conversions from Saquá to Brazilian reais. An additional 1% fee is applied when merchants converted Mumbucas into Brazilian reais after the fifth day of the month. Conversions made between the first and fifth days are free of charge (Instituto E-Dinheiro Saquarema, n.d.).
- Seigniorage	No
- Demurrage	No
Community contributions	N/A
CC amount per beneficiary	400 Saquás (Saquarema, 2026)
Functions of money	Medium of exchange
Earning	No.
Purchaser of last resort	Yes, the Saquá bank.

Credit line	No (There is a legal provision for the creation of credit lines in the Saquá currency (Saquarema, 2022c), but there is no indication that this has been implemented).

Source: Own compilation based on Blanc (2011); Diniz et al. (2019);; Instituto E-Dinheiro Saquarema (n.d.); Saquarema, (2022a, 2022b, 2022c, 2026); worldopulationreview.com.

3.4. Macaíba (city of Macaé)

Inspired by the previous models, the Municipality of Macaé implemented the Macaíba currency and Macaíba Bank through Municipal Law No. 5,075/2023 (Macaé, 2023), adopting similar institutional and operational features. Instituto E-Dinheiro and the E-Dinheiro app have been present since the creation of the currency; the municipality transfers public resources to a dedicated fund managed by Instituto E-Dinheiro, which is also responsible for operating Macaíba Bank. Beneficiaries may receive the Macaíba community currency either through magnetic cards or via the E-Dinheiro mobile application (Prefeitura de Macaé, n.d.).

As in the three previous experiences, individuals who receive social benefits in Macaíba are not allowed to convert it into Brazilian reais, while commercial establishments may do so upon payment of a fee. Access to the Macaíba currency is restricted to beneficiaries, as non-beneficiaries are not allowed to hold or use the currency, because it is exclusively linked to a public income-transfer policy. Unlike the experience of Maricá, Macaíba Bank also functions as an institutional arm for the Municipality of Macaé.

Similar to the cases of Mumbuca and Saquá, payments in Macaíba are primarily accepted by local businesses (such as restaurants, pharmacies, schools, and supermarkets), but cannot be used to pay utility bills or local taxes. So, also the municipality of Macaé refuses to accept the currency its launched.

However, a distinguishing feature of Macaíba currency is its territorial segmentation within the municipality. Beneficiaries are assigned to specific areas and can use the currency only at accredited establishments located within their designated area. Thus, although Macaíba operates at the municipal level, its circulation is formally restricted to specific parts of Macaé (Prefeitura de Macaé, n.d.).

Regarding fees, the city of Macaé presents a slight variation compared to other experiences. An administrative fee is charged to participating merchants, ranging from

2% to 5%[12], depending on the establishment's revenue in Macaíba, rather than the fixed 2% rate observed in Niterói and Saquarema. The higher the revenue of merchants, the higher are the fees. The progressive fee scheme reduces the financial strain on smaller local businesses, while at the same time more prosperous merchants, probably with a bigger market share, have to contribute a share to the running of Macaíba. According to the municipality, the proceeds from this fee are intended to be reinvested in the Municipal Fund and earmarked for a future "Fair Credit Policy," aimed at providing loans to merchants to support business development (Prefeitura de Macaé, n.d.). Although microcredit has not yet been implemented, its future introduction appears to be an explicit policy objective (Prefeitura de Macaé, n.d.). Finally, merchants are also subject to fees for converting Macaíba into Brazilian reais. Once again, beneficiaries are not permitted to convert the CC into Brazilian reais (Prefeitura de Macaé, n.d.).

Table 7: Macaíba overview

Organizational aspects	
Name	Macaíba
Objective	Reduce social inequality through income transfers to low-income and extremely poor families; promote local economic development.
Digital introduction date	2023
Preparation period	N/A
Organizer/inventor	E-Dinheiro and Municipality of Macaé
Population	267,000 (as of 2026)
Number of users	31,000 beneficiaries (Year: 2025, Prefeitura de Macaé, 2025) and 1,800 accredited local businesses (Prefeitura de Macaé, 2026)
Complementary currency type	Fiat-backed CC, Blanc (2011): G3
Technology	App & card & SMS/USSD + conventional bank ledger system (e-Dinheiro platform), Diniz et al. (2019): Proprietary DCC Platform
Governance & Ownership	
Entitlement	Social benefit recipients (non-beneficiaries are officially excluded). Note: accredited local businesses cannot purchase the CC but can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. This means they are not entitled to the CC, but they do have access to it, although with some restrictions.

[12] Businesses with earnings of up to 200,000 Macaíbas will pay a 2% fee, while those with earnings exceeding 200,000 Macaíbas will pay a 5% fee (Prefeitura de Macaé, n.d.).

Acceptance	Accredited local businesses
Scope of Acceptance/Use cases	Accepted by local businesses, but not for utility bill or local tax payments.
Onboarding	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Macaíba Bank / E-Dinheiro;
Geographical limits	Yes, municipality of Macaé. However, the currency is territorially segmented within Macaé: beneficiaries can use Macaíba only at accredited establishments within their designated area. (Prefeitura de Macaé, n.d.).
Content limits	Yes, the CC cannot be used to pay taxes and is generally restricted to purchases of goods and services from accredited local businesses.
Maintenance – who	Municipality of Macaé; the Macaíba bank functions as an operational arm of the municipality.
Maintenance – how	Top-down
Funding	Oil royalties
Access to payments	Decentral: App, USSD/SMS & Central: branch office, local staff
Currency management	
Convertibility	Yes, usually against a fee. However, only businesses can convert Macaíba into Brazilian reais; those who received benefits in Macaíba cannot.
Underwriter	Municipality of Macaé
Underwriter's guarantee	Conversion to BRL
Value of the CC	1:1 peg to BRL (established by Law No. 5,075/2023 (Macaé, 2023))
Backing	Yes, Brazilian real (BRL).
Circulating number of the CC	Dynamic: The Municipality determines the amount through social benefits paid & granted credits.
Fees	2% to 5% fee on each transaction conducted using the CC. The percentage will vary depending on the establishment's revenue (the higher its revenue, the higher is the fee). Businesses with earnings of up to 200,000 Macaíbas will pay a 2% fee, while those with earnings exceeding 200,000 Macaíbas will pay a 5% fee (Prefeitura de Macaé, n.d.).
- Seigniorage	No
- Demurrage	No
Community contributions	N/A
CC amount per beneficiary	Variable according to household composition: 150 Macaíbas for the head of household, an additional 150 for the spouse, and 75 for each dependent aged 0–17 (up to three dependents). Eligible dependents with disabilities receive an additional 100 Macaíbas (Prefeitura de Macaé, n.d.).
Functions of money	Medium of exchange
Earning	No.

Purchaser of last resort	Yes, the Macaíba bank.
Credit line	No. There is a legal provision for the creation of credit lines in the Macaíba currency, but this has not yet been implemented.

Source: Own compilation based on Blanc (2011); Diniz et al. (2019), Macaé (2023); Prefeitura de Macaé (n.d., 2025, 2026), worldpopulationriview.com.

3.5. Comparative Findings and Discussion

The main objective of this paper is to review the four case studies with community currencies as the preferred means by municipalities for social-cash transfer programmes to target beneficiaries within their respective jurisdiction in the Rio de Janeiro area, Due to a lack of comprehensive public data, we focused on the institutional design of the four CCs and analysed to what extent it varies across the cases and supports or rather restricts its sustainability (for a comprehensive comparative overview, see Table 8 in the Appendix).

The cross-case analysis reveals both similarities and differences across the institutional design of the four currencies. The more recent experiences (Araribioia, Saquá and Macaíba) were largely inspired by the model previously implemented in the city of Maricá, which established a blueprint for other CCs in the Rio de Janeiro area.

Organizational aspects

All four initiatives combine social and economic objectives, using the CCs to distribute municipal benefits while seeking to promote local economic development. Mumbuca was the first of the four currencies to be introduced and initially operated only through magnetic cards, before start using the E-Dinheiro platform in 2018[13]. Currently, both methods are available, allowing users to make transactions either through the Mumbuca app or with a magnetic card. Araribioia, Saquá, and Macaíba were introduced later and adopted this combined model from the outset. While Mumbuca currently operates through its own platform (the “Mumbuca app”, because, as mentioned before, they stopped using the E-Dinheiro platform in November 2025.), the other three currencies use the E-Dinheiro platform.

There are considerable differences in scale. Mumbuca has the largest and most diverse user base, with around 71,000 social benefit recipients and approximately 133,000

[13] See footnote 7.

accounts, including beneficiaries, non-beneficiaries and registered establishments (Prefeitura de Maricá, 2024, 2025c). Arariboia has around 50,000 beneficiaries and approximately 8,000 accredited establishments (Prefeitura de Niterói, 2025b, 2025c), while Macaíba has around 31,000 beneficiaries and 1,800 accredited establishments (Prefeitura de Macaé, 2025, 2026). Comparable information is not available for Saquá. These figures should, however, be interpreted cautiously, as the available data refers to different years and sometimes measure different categories of users, hence the data is comparable to a limited extent. However, if we compare the numbers for users and local businesses with the respective population, the data shows that Mumbuca is the CC in the Rio de Janeiro area with the broadest dissemination and coverage. Besides the longer operation time for Mumbuca, the major reasons for the broader dissemination and acceptance across the population are the design features allowing everybody participate, including holding balances in deposits, to a limited extent savings accounts and receiving loans in Mumbuca.

Governance and ownership

The four cases are strongly connected to municipal governments, but Mumbuca differs in terms of its current governance structure. Arariboia, Saquá, and Macaíba follow a top-down model in which their respective community banks operate as arms of the municipal governments restricted to managing the social cash-transfers and delivering them to the eligible beneficiaries. Mumbuca was also initially established through a top-down process, but Mumbuca Bank later gained some level of autonomy and is currently managed by a community association. The table therefore classifies its current structure as bottom-up, although the currency remains closely connected to municipal social policies.

All four cases remain highly dependent on the oil revenues and the municipal governments deciding that a part of the oil revenues is used to fund social policy which they would be able to afford without the oil revenues. The former reveals a dependency on the exploitation of non-renewable energy resources, while the latter creates a common political vulnerability, as their continuity depends to a considerable extent on continued political support and on the priorities of local administrations. In the short to medium run, a change in government or in policy priorities could therefore affect the continuity or design of these initiatives. This vulnerability is reinforced by their funding structure. All four municipalities rely on oil royalties to finance their CC schemes,

creating an additional dependency on a source of revenue that is external to the currency systems themselves.

Hence, in the long run, either the end of exploitation or the final exhaustion of the oil sources of the coast will put an end to the generous social policy. Without making their community currencies more self-sufficient and less dependent on annual injection, the CCs will not be able survive. This suggests that the restrictions imposed by the design (lack of acceptance of the respective CC by the municipality as such, lack of access to the CC for non-beneficiaries, exclusion or punishment of holding accounts and loans in the respective CC) could be reconsidered. Alternatively, municipalities need to find another money maker which could subsidise the solidarity economy in the years after oil.

An important difference concerns who can participate in the systems. In Niterói, Saquarema, and Macaé, entitlement is restricted to social benefit recipients, although accredited local businesses can also access and use the currencies by accepting payments from beneficiaries and spending them at other accredited businesses (Niterói, 2021; Saquarema, 2022; Macaé, 2023). Under the previous E-Dinheiro system, Mumbuca was more accessible, as non-beneficiary residents could also use the currency, including through microcredit programmes (Almeida et al, 2023). However, it is unclear whether this is still possible under the current system, as no official sources confirm it. This broader access may also help explain why Mumbuca has been more widely used and accepted by local residents.

All four currencies have geographical restrictions, as they can only be used at accredited establishments within their respective municipalities. However, Macaíba differs from the other three cases because it introduces an additional territorial restriction within the municipality. Beneficiaries are assigned to specific areas and can use the currency only at accredited establishments located within their designated area (Prefeitura de Macaé, n.d.). Thus, while Mumbuca, Arariboia, and Saquá can circulate throughout their respective municipalities, Macaíba's circulation is formally restricted to specific areas within the city of Macaé.

Access to payments, however, combines decentralized digital channels, such as apps and SMS/USSD, with physical access through branch offices and local staff.

Currency management

Currency management presents a high degree of similarity across the four cases. All four currencies are backed by Brazilian reais and maintain a 1:1 peg to the BRL (Maricá, 2015; Niterói, 2021; Saquarema, 2022; Macaé, 2023). Beneficiaries cannot convert the social benefits they receive into BRL, whereas accredited businesses can do so, generally subject to fees (Instituto E-Dinheiro, n.d.). Mumbuca again differs because non-beneficiaries may acquire Mumbucas and subsequently convert them back into reais (a fee still applies). None of the four currencies applies seigniorage or demurrage[14].

The cases differ more clearly in the amounts distributed and in the financial mechanisms associated with the currencies. Mumbuca provides a fixed benefit of 230 Mumbucas, while non-beneficiaries can voluntarily acquire other amounts. Arariboia (Prefeitura de Niterói, 2025b) and Saquá (Saquarema, 2026) provide fixed amounts of 345 and 400 units, respectively. Macaíba adopts a different model, with the amount varying according to household composition (Prefeitura de Macaé, n.d.). However, the different rules to assign amounts to beneficiaries and disburse them do not impact the operation or running of the CC as such. Multiplier effects depend on (i) how much in total will be injected into the local economy. On the one hand, it is the municipality deciding about the total amount they are prepared to spend on social cash-transfers via the CC; on the other hand, it is the beneficiaries who decide to what extent they substitute purchases formerly undertaken in reais with the cash transfers in the CC. The leakage effects finally determine to what extent the CC activates a multiplier effect (Farroukh et al., forthcoming). As we do not have any robust data, we cannot assess the actual leakage by beneficiaries. (2) how many of the citizens are additionally allowed into the system. Those residents and businesses who are using the CC for their purchases instead of using reais, bring additional demand denominated in the respective local CC.

The approaches to credit differ strongly and for multiplier effects and sustainability effects decisively. Mumbuca Bank offers microcredit in Brazilian reais, financed by fees charged on the conversion of Mumbuca into Brazilian reais (Banco Mumbuca, 2025a),

[14] Although we did not identify any seigniorage or demurrage mechanisms in any of the currencies, it is worth noting that the regulations governing the social currencies Maricá (2026), Saquarema (2022a), and Macaé (2023) provide for the blocking of beneficiaries' accounts or cards after 90 days of inactivity. In Maricá, the regulation also explicitly requires that unused benefit funds be returned to the municipality. Niterói is the only municipality where no equivalent legal provision was identified.

while Niterói uses public calls for proposals to finance local entrepreneurship (Prefeitura de Niterói, 2025a). Saquarema and Macaé have legal provisions allowing for credit lines, but these mechanisms had not been implemented at the time of the analysis.

4 Final considerations

This paper compared four municipality-led digital community currencies in the state of Rio de Janeiro, examining their organisational aspects, governance and ownership, and currency management. The analysis shows that, although the four initiatives share several characteristics, important differences can be found in their institutional design and implementation. Mumbuca, as the most long-running CC four cases, differs from the other currencies in several respects, including its governance arrangements, broader access, and provision of microcredit.

The comparison also identifies restrictions and vulnerabilities that may affect the continuity of these initiatives. Despite differences in governance, all four cases remain strongly connected to municipal governments and dependent on continued political support. Their reliance on oil royalties represents an additional vulnerability, as the financial sustainability of the schemes depends on a source of revenue external to the CC systems themselves. The restrictions imposed by the design (lack of acceptance of the respective CC by the municipality as such, lack of access to the CC for non-beneficiaries, exclusion or punishment of holding accounts and loans in the respective CC) have a self-harming effect on the CC and undermine the sustainability of the respective CCs. As a first step, all municipalities should accept the CC which they launched and (let) distribute themselves.

An important limitation of this study concerns the availability of data. Although there is a more consolidated body of literature on Maricá, as well as some studies on Niterói, publicly available data on these experiences remain limited, particularly in the cases of Macaé and Saquarema. This makes a more in-depth analysis difficult, especially regarding the social and economic impacts of the four currencies on their respective territories, inter alia the actual acceptance by participants, the leakage effects and multiplier effects. More systematic data collection and disclosure by municipalities would therefore be important to support further research.

From a methodological perspective, the study also highlights the value of developing a more holistic framework for comparing CC experiences. Considering organizational, governance, and currency-management dimensions together makes it possible to identify both common patterns and context-specific differences

Finally, considering the growing number of municipality-led CC initiatives in Brazil, a broader mapping of these experiences could provide a clearer picture of how this model is spreading and changing over time. Such a mapping could also allow both existing and new initiatives to learn from the successes and vulnerabilities of previous experiences. It could further contribute to the academic understanding of community currencies and to the design of more resilient initiatives in the future.

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Appendix

Table 8: Comprehensive comparative overview

Element / City	Maricá	Niterói	Saquarema	Macaé
Organizational aspects				
Name	**Mumbuca**	**Arariboia**	**Saquá**	**Macaíba**
Objective	Banking the unbanked, provide subsidies efficiently, incentivize local development, financial inclusion.	Reduce social inequality through income transfers to low-income and extremely poor families; promote local economic development.		
Digital introduction date	2018	Launch in 2021, with official start at 2022	2022	2023
Preparation period	2013, magnetic cards	N/A		
Organizer/inventor	Brazilian Network of Community Banks (bought from MoneyCloud), People's Community Bank of Maricá & Municipality of Maricá	Instituto E-Dinheiro and Municipality of Niterói	E-Dinheiro and Municipality of Saquarema	E-Dinheiro and Municipality of Macaé
Population	216,000 (as of 2026)	520,000 (as of 2026)	97,000 (as of 2026)	267,000 (as of 2026)



Number of users	71,000 receive social benefits in Mumbuca; 133,000 hold accounts at Mumbuca Bank, including both beneficiaries and registered establishments (Prefeitura de Maricá, 2024, 2025c).	50,000 individuals receives social benefits in Niterói (Year: 2025) (Prefeitura de Niterói, 2025b). Around 8,000 accredited commercial establishments and service providers (Prefeitura de Niterói, 2025c).	N/A	31,000 beneficiaries (Year: 2025, Prefeitura de Macaé, 2025) and 1,800 local establishments (Prefeitura de Macaé, 2026)
CC type	Fiat-backed CC, Blanc (2011): G3			
Technology	App & card & SMS/USSD + conventional bank ledger system (Mumbuca platform) Proprietary DCC Platform	App & card & SMS/USSD + conventional bank ledger system (E-Dinheiro platform), Diniz et al. (2019): Proprietary DCC Platform		
Governance & Ownership				
Entitlement	Social benefit recipients. Note 1: accredited local businesses can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. Note 2: under the previous E-Dinheiro system, non-beneficiaries and accredited local business were entitled to buy, access, and use Mumbuca (for example, they could obtain credit lines in Mumbuca) (Almeida et	Social benefit recipients (non-beneficiaries are officially excluded). Note: accredited local businesses cannot purchase the CC but can spend CCs received from customers at other accredited businesses or convert them into Brazilian reais. This means they are not entitled to the CC, but they do have access to it, although with some restrictions.		



	al, 2023)). However, no official sources confirm if they can still do so under the current system.			
Acceptance	Accredited local businesses (for Mumbuca, see notes for entitlement)			
Scope of Acceptance/Use cases	Accepted by local businesses, but not for utility bill or local tax payments.			
Onboarding	Standardized for businesses: Must get accredited at a central location by Mumbuca Bank. Non-systematic for users: Different ways, e.g., download & register in "Mumbuca App"	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Arariboia Bank / E-Dinheiro;	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Saquá Bank/ E-Dinheiro;	Standardized for businesses and social benefit recipients: Must get accredited at a central location by Macaíba Bank/ E-Dinheiro;
Geographical limits	Yes, municipality of Marica	Yes, municipality of Niterói	Yes, municipality of Saquarema	Yes, municipality of Macaé. However, the currency is territorially segmented within Macaé: beneficiaries can use Macaíba only at accredited establishments within their designated area. (Prefeitura de Macaé, n.d.).
Content limits	Yes, The CC cannot be used to pay taxes and is generally restricted to purchases of goods and services from accredited local businesses.			
Maintenance – who	Mumbuca Bank (started as a municipal bank, it later gained autonomy and is now the Bank is managed by an NGO (Associação Banco Comunitário Popular de Maricá)(Pereira e Silva, 2022).	Municipality of Niterói (the Arariboia bank functions as an operational arm of the municipality)	Municipality of Saquarema (the Saquá bank functions as an operational arm of the municipality)	Municipality of Macaé (the Macaíba bank functions as an operational arm of the municipality)



Maintenance – how	Mumbuca started as a top-down initiative, but now has some bottom-up elements, since the bank is managed by an NGO. However, it still depends heavily on municipal funding.	Top-down		
Funding	Oil royalties			
Access to payments	Decentral: App, USSD/SMS & Central: branch office, local staff			
Currency management				
Convertibility	Yes, usually against a fee. However, Mumbucas received through the municipal cash transfer programme cannot be converted into Brazilian reais. .	Yes, usually against a fee.However, only businesses can convert Arariboia into Brazilian reais; those who received benefits in Arariboia cannot.	Yes, usually against a fee. However, only businesses can convert Saquá into Brazilian reais; those who received benefits in Saquá cannot.	Yes, usually against a fee. However, only businesses can convert Macaíba into Brazilian reais; those who received benefits in Macaíba cannot.
Underwriter	Mumbuca Bank	Municipality of Niterói	Municipality of Saquarema	Municipality of Macaé
Underwriter's guarantee	Conversion to BRL			
Value of the CC	1:1 peg to BRL, established by Maricá's Municipal Law No. 2,641/2015 (Maricá, 2015))	1:1 peg to BRL (established by Niterói's Municipal Law No. 3,621/2021 (Niterói, 2021))	1:1 peg to BRL (established by Law No. 2,189/2022 (Saquarema, 2022)	1:1 peg to BRL (established by Law No. 5,075/2023 (Macaé, 2023))
Backing	Yes, Brazilian real (BRL).			
Circulating number of the CC	Dynamic: The Municipality & Mumbuca Bank determine the amount through social benefits paid & granted credits.	Dynamic: The Municipality determines the amount through social benefits paid.		



Fees	With the old arrangement (E-Dinheiro app), local businesses were charged a 2% transaction fee on each sale made in Mumbucas. An additional 1% fee applied when merchants converted Mumbucas into Brazilian reais after the fifth day of the month. Conversions made between the first and fifth days were free of charge. With the new app ("Mumbuca") we could not locate how much they are charging..	2% fee on each transaction conducted using the CC[1] (Instituto E-Dinheiro, n.d.).	2% fee on each transaction conducted using the social currency. 1% fee on conversions from Saquá to Brazilian reais. An additional 1% fee is applied when merchants converted Mumbucas into Brazilian reais after the fifth day of the month. Conversions made between the first and fifth days are free of charge (Instituto E-Dinheiro Saquarema, n.d.).	2% to 5% fee on each transaction conducted using the CC. The percentage will vary depending on the establishment's revenue (the higher its revenue, the higher is the fee). Businesses with earnings of up to 200,000 Macaíbas will pay a 2% fee, while those with earnings exceeding 200,000 Macaíbas will pay a 5% fee (Prefeitura de Macaé, n.d.).
• **Seigniorage** • **Demurrage**	No			
Community contributions	Yes, profits are reinvested in the community or used for new credit lines[2].	Yes, profits are reinvested in the community or used in public calls for proposals to finance local	N/A	

[1] Under Articles 4 and 5 of Niterói Municipal Decree No. 14,928/2022, a 2% administrative fee is charged on each transaction involving the Arariboia currency. The revenues collected are managed by the entity responsible for Banco Arariboia and may be used to finance collective employment and income-generating initiatives, solidarity economy infrastructure, community development activities, training, promotional materials, and participation in relevant events (Niterói, 2023). The decree also provides for the possibility of financing a municipal microcredit programme, although this has not been implemented in practice. Instead, the municipality has relied on public calls for proposals to support local initiatives (Prefeitura de Niterói, 2025a).

[2] The bank's revenues have been used to support microcredit and community projects (Cernev, 2019; Banco Mumbuca, 2025b). However, the decision-making process governing the allocation of these resources, as well as the proportion directed to each activity, remains unclear.

		entrepreneurship[3] (Prefeitura de Niterói, 2025a)		
CC amount per beneficiary	230 Mumbucas..	345 Arariboias (Prefeitura de Niterói, 2025)	400 Saquás (Saquarema, 2026)	Variable according to household composition: 150 Macaíbas for the head of household, an additional 150 for the spouse, and 75 for each dependent aged 0–17 (up to three dependents). Eligible dependents with disabilities receive an additional 100 Macaíbas (Prefeitura de Macaé, n.d.).
Functions of money	Medium of exchange.	Medium of exchange	Medium of exchange	Medium of exchange
Earning	No			
Purchaser of last resort	Yes, the Mumbuca Bank.	Yes, the Arariboia Bank.	Yes, the Saquá Bank.	Yes, the Macaíba Bank.
Credit line	Yes, Mumbuca Bank offers microcredit in Brazilian reais, financed by the fees charged for converting Mumbuca into BRL.	No. Instead, the municipality opens public calls for proposals to finance local entrepreneurship (Prefeitura de Niterói, 2025a)	No (There is a legal provision for the creation of credit lines in the Saquá currency, but there is no indication that this has been implemented (Saquarema, 2022c)).	No (There is a legal provision for the creation of credit lines in the Macaíba currency, but this has not yet been implemented).

[3] See footnote 15.

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COMPLEMENTARY CURRENCIES, LOCAL ENTREPRENEURSHIP, AND CIRCULAR PRACTICES: EVIDENCE FROM PLACE-BASED ECONOMIC INSTITUTIONS IN BRAZIL

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Abstract

This study aims to examine how green social currencies influence entrepreneurial dynamics in the Brazilian context. The research adopts a qualitative multiple case study approach based on the analysis of two Brazilian municipalities that implemented green social currencies associated with recycling, organic waste management, and local economic circulation. Data collection combined 12 semi-structured interviews with public managers, founders, entrepreneurs, community leaders, and local actors, as well as documentary analysis of institutional reports, municipal legislation, and official materials. The findings suggest that complementary currencies contribute less to the creation of new ventures and more to strengthening local entrepreneurial ecosystems. Across the cases analyzed, the currencies stimulated local consumption, expanded customer circulation, strengthened local fairs and commercialization networks, increased the visibility of businesses that supported the local currency, and promoted the mobilization of local resources. The results also indicate that these systems operate as territorially embedded socio-technical infrastructures connecting local economic development, sustainability practices, and circular economy practices. The study contributes to advancing the understanding of complementary currencies as mechanisms capable of strengthening local entrepreneurial

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ecosystems while also providing practical implications for policymakers and practitioners interested in alternative economic models and local sustainability strategies.

Keywords: Complementary currencies, Local entrepreneurship, Circular economy, Socio-technical infrastructures, Local economic development

1. Introduction

Complementary currencies have been proposed as instruments capable of strengthening local economies by retaining the circulation of resources within specific territories and stimulating the activity of small businesses. By operating through geographically bounded monetary circuits, these systems aim to reduce financial "leakages" and enhance the local income multiplier effect, encouraging the exchange of goods and services among actors within the same territory (Seyfang & Longhurst, 2013; Blanc, 2011). In this sense, it is argued that such initiatives can not only increase liquidity in contexts of financial constraint but also reconfigure local economic dynamics by directing purchasing power toward territorially embedded markets.

According to Barinaga and Zapata Campos (2024), in Kenya, the Eco-pesa currency was implemented in informal settlements with the aim of simultaneously addressing environmental and employment challenges, stimulating local resource circulation and the hiring of labor for activities such as waste collection. Empirical results indicate that, after two months of implementation, approximately 80% of the monitored businesses reported increases in both the number of customers and income, with an average growth of 22%, along with the expansion of local employment and increased savings capacity among residents. Despite these positive results, limitations related to the currency's backing model and its convertibility highlighted challenges regarding the system's sustainability and continuity.

Despite these findings, the literature has predominantly focused on the effects of complementary currencies on local economic development and social cohesion (Seyfang & Longhurst, 2013; Michel & Hudon, 2015), devoting less attention to their role in shaping entrepreneurial dynamics. In particular, there is still limited evidence on how these monetary systems may act as external enablers of entrepreneurial action, in the sense proposed by Davidsson (2015), influencing resource allocation, market participation, and

business practices at the local level. Furthermore, the potential of these initiatives to foster practices associated with the circular economy remains underexplored, especially in territorially embedded contexts. As a result, the intersection between complementary currencies, local entrepreneurship, and circular economy dynamics remains fragmented and insufficiently developed in the literature.

Additionally, an exploratory search conducted in the Scopus and Web of Science databases, covering the last ten years and combining terms related to complementary currencies, circular economy, and entrepreneurship, revealed a very limited number of studies that integrate these three dimensions simultaneously. This finding reinforces the fragmentation of the literature and highlights the lack of approaches that systematically articulate the role of complementary currencies in promoting entrepreneurship within circular economy-oriented contexts.

Against this background, this study seeks to answer the following research question: how do complementary currencies stimulate local entrepreneurship in the Brazilian context? To address this question, the study analyzes two cities that have adopted green currencies, which, in addition to promoting sustainable practices within the territory, aim to strengthen local entrepreneurship.The expected contribution is to provide comparative insights that may support future studies on complementary currencies, entrepreneurship, and circular economy practices. The analysis is based on a combination of primary and secondary data. The article is structured as follows: Section 2 presents the literature review; Section 3 describes the methodology; Section 4 presents the results; Section 5 discusses the findings; and Section 6 concludes the study.

2. Literature review

This section reviews the literature on complementary currencies, local entrepreneurship, and circular economy to establish the analytical foundations of the study. It first examines complementary currencies as territorially bounded monetary systems and their role in local economic dynamics. It then explores their relationship with local economic development and entrepreneurial action, highlighting existing gaps. Finally, it addresses their potential to foster circular economy practices, emphasizing the limited integration between these research streams.

2.1 Complementary currencies as local economic infrastructures

Complementary currencies can be understood not only as alternative monetary arrangements but also as localized economic infrastructures that actively shape market organization and resource flows within specific territories (Seyfang, 2006). From a socio-technical perspective, money itself can be conceptualized as an infrastructure that mediates exchanges and coordinates economic activity (Barinaga & Zapata Campos, 2024). In this sense, these currencies operate as community-based infrastructures, functioning as socio-technical arrangements that facilitate the circulation of goods and services while organizing people and resources within geographically bounded circuits (Barinaga & Zapata Campos, 2024; Blanc et al., 2025; Seyfang & Longhurst, 2013).

Their effectiveness depends on the collective trust that sustains their acceptance, in line with the conception of money as an institutional fact (Petz, 2022). Moreover, they may perform functions of economic resilience by acting as complementary mechanisms to the official monetary system (Lietaer, 2002). This perspective aligns with the literature that defines complementary currencies as territorially embedded systems aimed at increasing the local economic multiplier, supporting small businesses, and reducing monetary leakages (Seyfang & Longhurst, 2013; Blanc, 2011). By reinforcing internal circulation and strengthening exchange networks, these systems contribute to the structuring of local economic ecosystems and can be understood as territorially constructed forms of economic organization (Lee, 2004).

Additionally, complementary currencies can be interpreted as monetary innovations (Place et al., 2021) and as “parallel infrastructures” designed to support more sustainable patterns of production and consumption (Michel & Hudon, 2015). By stimulating the circulation of resources within local economies and preventing the outflow of wealth, these currencies contribute to economic dynamism at the territorial level. Empirical evidence also suggests that they strengthen micro, small, and medium-sized enterprises by expanding access to new customers and encouraging local exchanges (Stępnicka et al., 2023). However, their economic impact remains limited in scale, suggesting that their potential as drivers of local development and entrepreneurship has not yet been fully realized (Williams, 1996; Lietaer, 2002; Lee et al., 2004).

2.2 Complementary currencies and local economic dynamics

Complementary currencies expand economic activity by connecting networks of individuals and firms, enabling the mobilization of skills and resources outside the conventional economy while strengthening local exchanges (Collom, 2005). In this sense, these systems contribute to economic dynamism by stimulating the circulation of resources within the territory and reducing the outflow of wealth from the community, thereby reinforcing local markets and supporting small businesses (Seyfang & Longhurst, 2013).

Moreover, complementary currencies can be understood as sociotechnical infrastructures that organize flows of resources and economic interactions within territorially bounded contexts (Blanc et al., 2025). In the case of digital municipal currencies, these systems also operate as public policy instruments, fostering local economic activity, expanding monetary agency, and enabling institutional transformations across multiple scales through standardized yet locally adaptable infrastructures (Barinaga et al., 2026).

Empirical evidence reinforces this role by indicating that complementary currencies contribute to activating underutilized resources and stimulating internal economic interactions, particularly by addressing monetary scarcity that constrains exchange in local communities (Williams, 1996). In the context of Kenya, Kiaka et al. (2024) show that these systems enable vulnerable populations to mobilize labor, markets, and local capacities, generating economic activity in contexts where the conventional monetary system presents limitations, while also inducing behavioral adaptations among users.

Despite these advances, the literature still presents important limitations in understanding the mechanisms through which complementary currencies directly influence local economic dynamics. Existing studies have primarily focused on aggregate outcomes, such as local economic development and sustainability, paying less attention to how these mechanisms affect the behavior of economic agents (Seyfang & Longhurst, 2013; Michel & Hudon, 2015). In particular, it remains underexplored what mechanisms drive the influence of these currencies on the development of entrepreneurship at the local level, although there is evidence that they can stimulate local consumption and the creation of community-based enterprises (Rigo, 2020).

2.3 Complementary currencies as enablers of entrepreneurship

Entrepreneurial activity can be understood as the process through which individuals create and exploit opportunities for innovation; however, its realization depends on the existence of favorable systemic conditions and the interaction among interdependent actors within an entrepreneurial ecosystem (Stam, 2015). In this sense, access to resources, networks, and mechanisms of economic coordination plays a central role in enabling entrepreneurial action (Stam, 2015; Granovetter, 1985).

Complementary currencies can be understood not only as alternative means of exchange but also as local sociotechnical infrastructures that enable and structure economic activity within specific territories, being characterized as community-based innovations that emerge from civil society and respond to local needs (Seyfang & Smith, 2007; Seyfang & Longhurst, 2013). By facilitating transactions, mobilizing underutilized resources, and strengthening interaction networks, these currencies contribute to the dynamics and coordination of local entrepreneurial ecosystems (Kuk et al., 2024). Additional evidence suggests that complementary currencies can intensify economic circulation and stimulate local activity, as illustrated by historical experiences such as the Wörgl case (Lietaer, 2001). In resource-constrained contexts, they play a particularly relevant role by enabling the recombination of locally available assets, supporting value creation processes aligned with the notion of bricolage, in which actors build new economic opportunities from existing resources (Baker & Nelson, 2005).

From this perspective, complementary currencies have been widely associated with local economic development and sustainability outcomes (Stępnicka et al., 2023). More recently, the literature has advanced in recognizing these systems as external enablers of entrepreneurship, as they influence resource mobilization, market creation, and entrepreneurial practices (Kuk et al., 2024). However, there is still limited understanding of the specific mechanisms through which these currencies affect entrepreneurial dynamics at the local level, particularly in territorially embedded contexts, as the entrepreneurial processes underlying the creation and operation of such systems remain underexplored in the literature (Meyer, 2020).

2.4 Complementary currencies and circular economy practices

The circular economy can be understood as a regenerative system in which resource input, as well as waste generation, emissions, and energy losses, are minimized through the closing and slowing of material and energy loops. In this context, practices such as reuse, recycling, and remanufacturing become central to the reorganization of production and consumption systems (Geissdoerfer et al., 2017).

The promotion of these practices depends not only on individual decisions but also on the existence of institutional and organizational structures capable of guiding and incentivizing sustainable economic behavior. In this sense, complementary currencies emerge as relevant mechanisms, as they function as sociotechnical infrastructures that shape exchange and consumption patterns at the local level (Seyfang, 2006). By creating alternative systems of provision, these currencies contribute to the incorporation of more sustainable consumption patterns and to the reorganization of economic dynamics on a territorial basis (Seyfang & Longhurst, 2013).

These systems can contribute to strengthening local economies by promoting financial inclusion and reinforcing dynamics based on solidarity and cooperation (Diniz et al., 2016). Furthermore, they can enable practices aligned with the circular economy by encouraging local consumption, reducing the outflow of resources from territories, and facilitating forms of sharing, reuse, and extension of product life cycles through the creation of alternative markets and collaborative consumption arrangements (Seyfang & Longhurst, 2013).

Despite this potential, the implementation of these practices faces significant structural barriers, including financial constraints, lack of market demand, absence of standardization, and institutional restrictions, which hinder their large-scale consolidation (Geissdoerfer et al., 2023). Moreover, although social currencies contribute to strengthening social capital and economic inclusion, their economic impact remains limited due to their small scale and the difficulty of integration with broader economic systems (Michel & Hudon, 2015). In addition, there is a lack of robust empirical evidence regarding their environmental impacts and the effectiveness of these systems in promoting sustainable patterns of production and consumption (Seyfang & Longhurst, 2013).

3. Methodology

This study adopts a qualitative, exploratory, and comparative approach based on the multiple case study method (Eisenhardt, 1989; Yin, 2014). This approach is appropriate for investigating context-dependent social phenomena, allowing an understanding of how green social currencies contribute to local entrepreneurship and circular economy dynamics across different territorial contexts.

3.1 Research design

The research is based on a multiple case study design involving two Brazilian municipalities located in different regions of the country. The comparative perspective allows the identification of similarities and differences regarding the functioning of the initiatives, their governance structures, and their perceived impacts on local entrepreneurship and circular economy practices.

3.2 Case selection

The cases were intentionally selected based on four criteria: (i) the existence of an operational green social currency initiative; (ii) the relationship between the currency and environmental or circular economy practices; (iii) the participation of local economic actors, such as entrepreneurs, farmers, or local businesses; and (iv) the availability of institutional and documentary information regarding the initiatives. The selected cases represent distinct operational models of green social currencies. The first case is characterized by a partnership between local government, private organizations, and local businesses. The second case is based on the integration between organic waste management, local fairs, and family farming activities. The diversity among the cases enabled the exploration of different territorial dynamics and entrepreneurial outcomes associated with the implementation of complementary currencies.

3.3 Data collection

Data collection was conducted through semi-structured interviews and documentary analysis. The primary data consisted of 12 semi-structured interviews conducted with key actors directly involved in the creation, management, or operation of the initiatives. A total of seven interviews were carried out in the municipality associated with Green Social Currency A, and five interviews were conducted in relation to Green Social Currency B. The

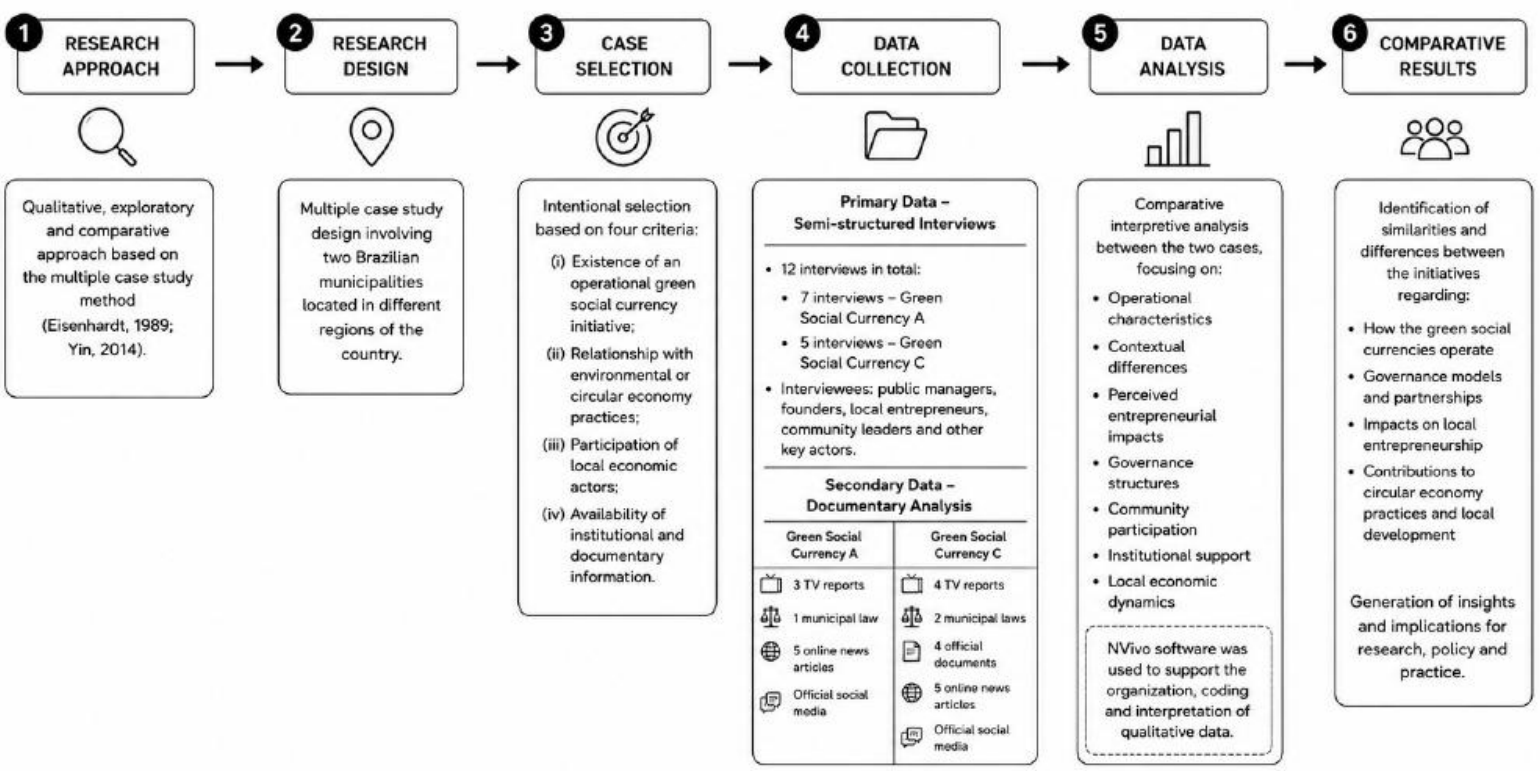
interviewees included public managers, founders of the initiatives, local entrepreneurs, community leaders, and other actors directly connected to the operation and circulation of the currencies.

The interviews sought to understand the operational dynamics of the initiatives, their relationship with local entrepreneurship, and their contributions to local economic circulation and sustainability practices. Secondary data were obtained through documentary analysis. In the case of Green Social Currency A, three television reports, one municipal law, five online news articles, and content published on the initiative's official social media platforms were analyzed. In the case of Green Social Currency B, four television reports, two municipal laws, four official documents, five online news articles, and content published on the official social media platforms of the green social currency were analyzed. These materials contributed to reconstructing the historical development, governance structures, and operational characteristics of the green social currencies, while also complementing the evidence obtained through the interviews.

3.4 Data analysis

The collected data were analyzed through a comparative interpretive analysis between the two selected cases. The analysis focused on identifying operational characteristics, contextual differences, and perceived entrepreneurial impacts associated with the green social currencies. Interview data and documentary sources were jointly examined to identify recurring patterns and distinctions among the initiatives, particularly regarding governance structures, community participation, institutional support, and local economic dynamics. To support the organization, coding, and interpretation of the qualitative data, the NVivo software was used. The tool assisted in the systematization of interviews and analyzed documents, enabling the identification of thematic categories, recurring patterns, and relationships among the different elements observed in the studied cases. Figure 1 presents the methodological flow adopted in this study, including the stages of case selection, data collection, documentary analysis, and comparative data interpretation.

Figure 1: Methodological Framework Step-by-step of the research process Source: Authors (2026)



Source: Authors (2026)

4. Results

This section presents the main findings from the two analyzed cases of green social currencies implemented in Brazilian municipalities. Although the initiatives shared objectives related to environmental sustainability and local economic circulation, important differences were identified regarding governance models, operational dynamics, and entrepreneurial impacts. The following subsections describe the main characteristics and outcomes observed in each case.

4.1 Green Social Currency A

Green Social Currency A was created in 2018 in a municipality located in the state of São Paulo, with approximately 15,000 inhabitants. The initiative resulted from a partnership between the Municipal Government, a non-governmental organization (NGO), and a multinational company. The main objective of the initiative was to stimulate environmental awareness among the population through incentives for recycling and the proper disposal of solid waste. The currency operated through the exchange of recyclable materials for green coins, which could later be used to purchase products in a store linked to the program or converted into vouchers accepted by approximately 47 local businesses from different economic sectors.

Regarding local entrepreneurship, the participation of local businesses in the initiative was mainly associated with the visibility generated by their connection to the socio-environmental project. Participating businesses received a supporter seal from the program, strengthening their image within the local community. According to the interviewed entrepreneurs, the initiative was well accepted by the population, who frequently used the vouchers in participating businesses. In many cases, consumers complemented the voucher value with their own financial resources or purchased additional products, increasing consumption in the participating establishments.

The entrepreneurs' reports also indicated that participation in the initiative contributed to strengthening the symbolic image of businesses within the local community by associating participating establishments with socio-environmental responsibility and sustainability practices. In addition, the vouchers and coins functioned as mechanisms that connected consumers and local businesses, favoring customer loyalty and increasing consumption in participating establishments. As reported by one of the interviewed entrepreneurs,

> "*People would come with a 25 reais voucher, end up spending more, and pay the remaining amount themselves*" (Interviewee 4),

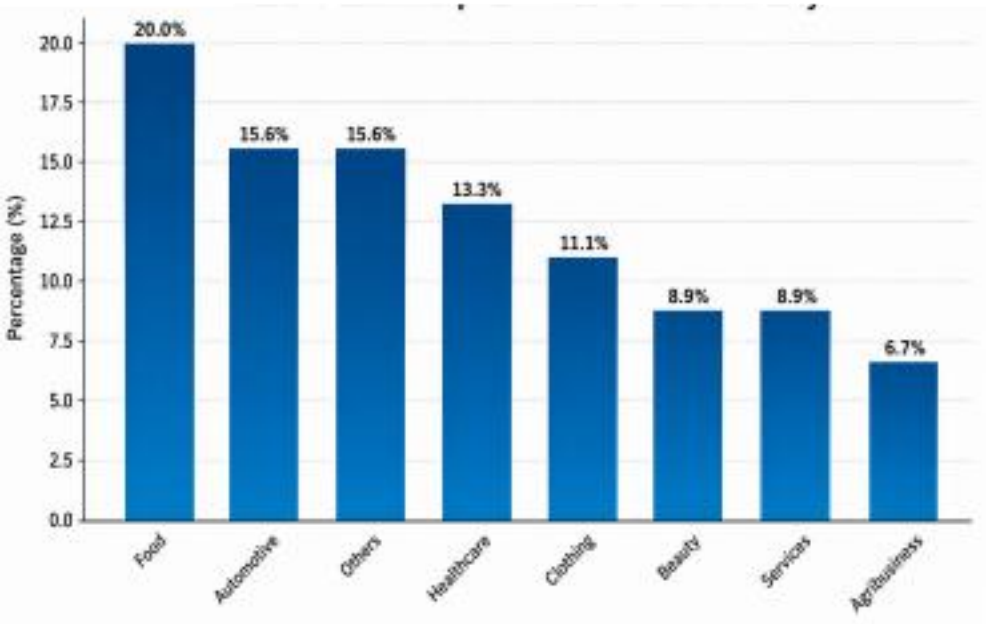
demonstrating that the initiative also stimulated complementary consumption in local businesses.

The findings suggest that the currency operated more strongly in strengthening local economic circulation and stimulating consumption in existing businesses rather than directly creating new ventures. Thus, the observed entrepreneurial impacts were mainly

related to increased customer flow, commercial strengthening, and the dynamization of local sales. The partnership between the program and local entrepreneurs remained active for approximately four years. However, in 2026, the project presented low monetary circulation, with only one central store remaining responsible for exchanging green coins for food products and hygiene items intended for the municipality's solidarity fund.

According to the interviewees, three main factors contributed to the reduction of the currency's dynamics over time: (i) changes in municipal public administration; (ii) the interruption of NGO support, which played a central role in the operation and social mobilization of the program; and (iii) the discontinuation of financial investments made by the multinational company partner. Despite its current limitations, the project still has support through municipal legislation authorizing the municipality to use public resources to replenish the store linked to the program. According to participants' reports, the annual budget currently allocated to the initiative is approximately R$15,000. Graph 1 presents the classification of the types of businesses participating in the project.

Graph 1: Sectors that accepted the Green Social Currency A



Source: Authors (2026)

4.2 Green Social Currency B

Green Social Currency B was created in 2020 in a municipality in the state of Rio Grande do Sul with approximately 50,000 inhabitants. The initiative aimed to develop a circular economy cycle in which residents exchanged organic waste for Green social Currency B. With this currency, residents could purchase products at local farmers' markets, while farmers, in turn, could use the received resources to obtain fertilizer produced from the collected organic waste. In this way, organic waste became part of the backing mechanism of the social currency.

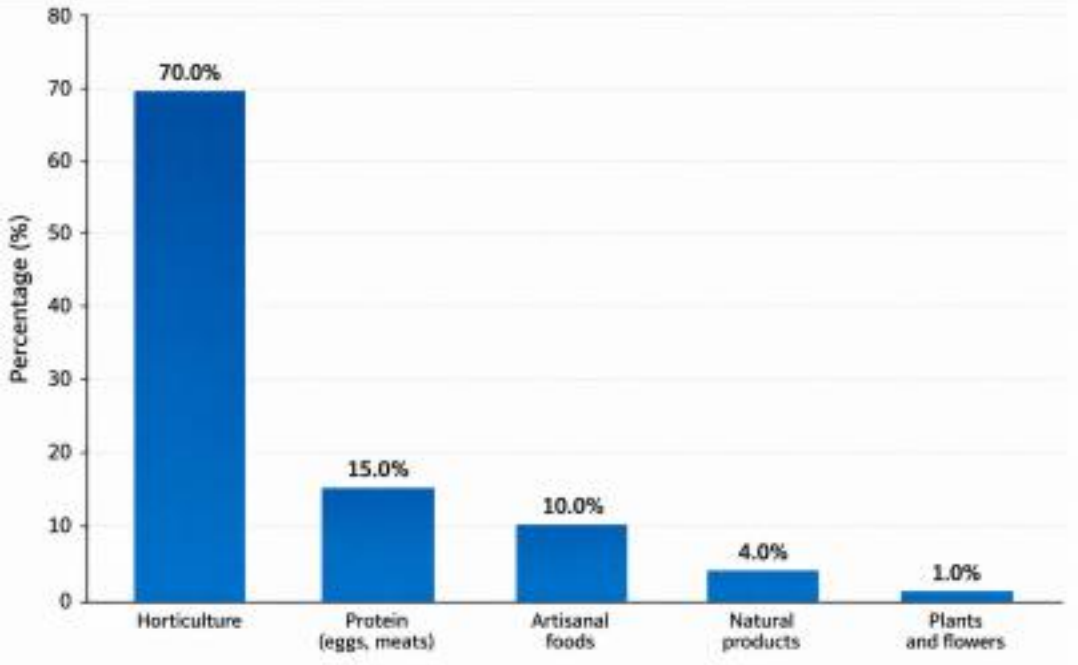
By 2026, approximately 63 farmers accepted Social Currency B across the municipality's three local markets. As reported by one of the interviewees, the initiative:

> "*Creates a more sustainable economic dynamic, where the product returns to the community itself.*" (Interviewee 10)

The reports indicate that the social currency also contributed to increasing the visibility and economic inclusion of family farmers in the municipality, strengthening local markets and encouraging new commercialization opportunities for small producers. According to the interviewees, before the implementation of the social currency, local markets had low participation and limited relevance within the municipality. Following the creation of Green social Currency B, an increase in public engagement and the strengthening of local markets was observed, expanding the participation of family farmers and stimulating the commercialization of local products.

After two years of project implementation, the city government developed a second social currency focused on exchanging recyclable materials for public benefits and services, such as tickets for events, sports activities, and the use of the municipal rotating parking system. Later, in 2026, the municipality also created the city's popular bank, expanding initiatives related to complementary currencies and local economic development. As shown in Graph 2, it is possible to observe the distribution of products commercialized at the farmers' market.

Graph 2: Products that most accept the Green social currency B



Source: Authors (2026)

4.3 Comparative overview of the cases

Although the two initiatives share common characteristics related to environmental sustainability and local economic circulation, important differences were identified regarding governance structures, operational dynamics, and entrepreneurial impacts. Table 1 presents a comparative overview of the main characteristics identified across the analyzed cases.

Table 1 - Comparative characteristics and entrepreneurial impacts of the analyzed green social currencies

Characteristics	Green Social Currency A	Green Social Currency B
State	São Paulo	Rio Grande do Sul
Population	15,000	50,000
Year created	2018	2020
Main environmental focus	Recycling	Organic waste / Recycling
Governance model	Public-private partnership	Municipal initiative
Main entrepreneurial mechanism	Local consumption stimulation	Local fairs and family farming
Number of businesses/farmers involved	47 businesses	63 small farmers
Currency backing mechanism	No formal backing mechanism	Organic waste/adubo
Main entrepreneurial impact	Increased sales and customer flow	Expansion of local commercialization
Main limitation	Changes in public administration and reduction of institutional support	Dependence on municipal coordination

Source: Authors (2026)

5. Discussions

The results demonstrate that green social currencies operate as territorial mechanisms capable of strengthening local economic circulation, stimulating circular economy practices, and supporting entrepreneurial dynamics across different contexts. The analyzed cases indicate that these initiatives contribute less to the creation of new businesses and more to the strengthening of existing local entrepreneurial ecosystems through the expansion of local consumption, increased commercial visibility, the strengthening of local fairs and commercialization networks, and the reinforcement of local exchange dynamics.

Furthermore, the findings reinforce the literature that understands complementary currencies as territorially embedded socio-technical infrastructures (Seyfang, 2006; Barinaga & Zapata Campos, 2024), capable of connecting environmental practices, economic circulation, and local development. The results also demonstrate that the continuity of these initiatives depends heavily on governance structures, institutional support, and community participation, confirming previous discussions regarding the sustainability and scalability challenges of complementary currencies (Michel & Hudon, 2015; Seyfang & Longhurst, 2013).

6. Conclusions

The results of this study demonstrate that complementary currencies stimulate local entrepreneurship in the Brazilian context mainly through the strengthening of territorial economic circulation, the expansion of local exchange networks, and the mobilization of economic resources associated with circular economy practices. Rather than directly generating new businesses, the analyzed cases indicate that these initiatives primarily contribute to strengthening existing entrepreneurial ecosystems by stimulating local consumption, increasing the visibility of small businesses and family farmers, strengthening local fairs and commercialization networks, and promoting new forms of economic interaction among communities, entrepreneurs, and local producers.

The findings also demonstrate that green social currencies may operate as territorially embedded sociotechnical infrastructures capable of connecting sustainability, waste management, and local economic development. In this sense, the analyzed models revealed that complementary currencies may assume different functions depending on their governance arrangements, circulation mechanisms, and levels of community participation. While some initiatives showed greater institutional dependence and vulnerability to political changes, others demonstrated stronger integration with circular economy practices and local commercialization dynamics.

From a theoretical perspective, the study contributes to expanding the understanding of the mechanisms through which complementary currencies influence local entrepreneurial dynamics, a topic that remains underexplored in the literature. The results suggest that these initiatives operate primarily as mechanisms for strengthening local economic networks, territorial coordination, and the circulation of resources within communities.

The study also highlights important gaps in the literature regarding the relationship between complementary currencies, entrepreneurship, and circular economy practices. Future studies should further explore these intersections, particularly through longitudinal and comparative analyses involving green social currencies with more than five years of operation, allowing a deeper understanding of their long-term entrepreneurial and territorial impacts.

As limitations, the study focused on two specific cases and relied primarily on interviews and documentary analysis. Future research could conduct field studies involving in-person visits to the analyzed localities, expand the number of interviews with different actors involved in the initiatives, and develop analytical frameworks capable of systematizing the main mechanisms through which complementary currencies influence local entrepreneurship and circular economy practices across different territorial contexts.

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REDE ALEGRIAS: BETWEEN A DEPENDENCY SPIRAL AND REINFORCING CAPACITY IN A DIGITAL COMMUNITY BANK IN PARATY, BRAZIL

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Abstract

Community development banks that operate digital social currencies extend financial inclusion to producers, traders, and service providers who depend on local circulation and have limited access to conventional banking. This paper asks how community bank governance, social currency circulation, and digital infrastructure interact as a solidarity-economy initiative consolidates as a digital community bank.

The paper draws on an instrumental qualitative case study of Rede Alegrias, a solidarity-economy network operating a digital social currency on the e-Dinheiro platform in Paraty, Rio de Janeiro. Findings are organized into three aggregate dimensions, each combining

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tensions and potentials. Centralized and Dependent Governance: coordination concentrated in a single figure and dependence on external funding coexist with elected leadership and reporting exceeding what funders formally require. Restricted Circulation: a narrow set of transactions and establishments coexists with grassroots projects sustaining the currency's everyday use. Contested Solidarity Infrastructure: friction in registering and using the currency and limited transparency over platform records coexist with workarounds built to compensate for what the platform does not provide.

The paper proposes a framework of three interlocking propositions linking these three dimensions. A Dependency Spiral (P1) describes how responses compensating for a tension in governance, circulation, or infrastructure transfer and reinforce dependency in another. Reinforcing Capacity (P2) describes how capacities developed within governance, circulation, or infrastructure extend into the others, generating cumulative collective capacity. Movement (P3) names the organizational work sustaining Reinforcing Capacity against the Dependency Spiral, particularly between moments of external urgency.

The paper contributes to research on community currencies and solidarity finance by shifting attention from the presence of constraints or capacities to the mechanisms through which they become mutually reinforcing over time, offering community banks sharing a digital platform a way of tracking whether that interval builds capacity or reinforces dependency.

Keywords: Digital community banks; Social currencies; Solidarity economy; Governance; Digital infrastructure

1. Introduction

Community development banks that operate digital social currencies support local production and consumption, and provide credit for small producers, traders, and service providers whose activities depend on continuous local circulation and limited access to conventional banking (Singer, 2009; Soares, 2006). Since Banco Palmas issued Brazil's first social currency and later digitalized it as e-Dinheiro, this shared technical infrastructure has extended similar arrangements to dozens of community banks and municipal programs across the country (Cernev & Proença, 2016; Cernev & Diniz, 2020). Research on this platform documents how digitalization distributes administrative responsibilities among

community banks, technology providers, and municipal partners (Cernev & Diniz, 2020), how currency concentrates once digitalization opens registration to establishments beyond small producers (Pupo, 2022), and how a shared, externally governed infrastructure now ranks among the most complex problems community banks face (Faria et al., 2026).

The literature on social currencies examines governance, circulation, and digital infrastructure largely through two approaches: comparisons across a population of community banks at a given moment (Faria et al., 2026), and transaction-level analyses that trace aggregate patterns of circulation across a platform (Diniz et al., 2026). Both vantage points reveal how these dimensions operate at scale, but neither traces how they interact within a single small-scale community bank as its operation develops over time. A tension in one domain can transfer the original constraint into a different domain. Examining governance, circulation, and infrastructure as they interact within one bank's own trajectory makes this kind of transfer visible, along with the corresponding possibility that capacities built in one domain accumulate into the others. Thus, this study asks: *how do governance, circulation, and infrastructure interact as a solidarity-economy initiative consolidates as a digital community bank?*

To answer this question, this paper takes the case of Rede Alegrias (roughly translated 'Network of Joys'), a solidarity-economy project in Paraty, Rio de Janeiro. The analysis identifies three second-order themes within each domain, paired tensions and potentials organized into aggregate dimensions: Centralized and Dependent Governance, Restricted Circulation, and Contested Solidarity Infrastructure. The main contribution of this paper is a framework describing these two reinforcement cycles: a Dependency Spiral, in which localized tensions are transferred across the three domains and progressively reinforce one another, and a Reinforcing Capacity cycle, in which capacities developed within one domain extend into the other, cumulatively strengthening the Alegrias' collective capacity. The framework further identifies Movement as the deliberate organizational work required to sustain the project's continuation, balancing between these two cycles.

By examining these interactions within a single community bank, the study contributes to research on community currencies and solidarity finance by shifting attention from the presence of particular constraints or capabilities to the mechanisms through which they become mutually reinforcing over time. The case of Rede Alegrias therefore provides both an

empirically grounded account of the consolidation of a digital community bank and an analytical framework that can be examined in other digital community banks.

2. Literature Review

The Solidarity Economy concept refers to arrangements that organize production, exchange, consumption, and finance through cooperation, reciprocity, collective responsibility, and social objectives (Soares, 2006). Community development banks constitute a form of solidarity arrangement organized around a delimited territory, combining productive microcredit, consumption credit, social currencies, and community projects to build and strengthen sustainable relationships among local production, commerce, services, and consumption (Singer, 2009; Soares, 2006). We propose to study the sustainment of this arrangement by analyzing three interdependent dimensions: governance, circulation, and infrastructure.

2.1 Governance

Community banks operate as network-based, associative arrangements whose financial services keep wealth in continuous circulation within a delimited territory, oriented toward generating decent work and income through the principles of solidarity economy (Cernev & Proença, 2016). Banco Palmas was the first to combine two functions that had previously operated separately in Brazil's experience of solidarity finance: productive microcredit aimed at expanding small businesses, and exchange clubs organized around a bounded membership. This combination has since been replicated across the network of Brazilian community banks that followed its model (Cernev & Proença, 2016; Singer, 2009; Soares, 2006).

Governing this arrangement rests on self-management, cooperation, and valuing the people who participate (Barinaga, 2019; Cernev & Proença, 2016): members meet in assembly to decide on the rules governing the organization's operation and to elect its leadership, whose authority remains subordinate to that collective decision (Meyer, 2020; Singer, 2009). Soares (2006) ties this kind of practice to collective autonomy itself, defined as the material and organizational conditions that allow all members equal participation in the decisions that concern them.

This decision-making structure can be described along a continuum, from centralized, where a single authority decides top-down, to decentralized, where decisions follow

bottom-up, democratic participation. Community banks grounded in solidarity finance tend toward this second, shared end of the continuum (Diniz et al., 2024). This same structure governs the currency alongside credit, projects, partnerships, and the platform a bank comes to depend on, treating the currency as one instrument among several (Diniz et al., 2024).

Hernandes et al. (2018) add that this collective, associative character extends into the negotiations a community bank conducts with technology providers and users as it consolidates a digital platform, making that consolidation itself a negotiated, collective process. Faria et al. (2026) trace changes in autonomy and financial sustainability among community development banks operating shared digital-currency platforms across several municipalities. Financial sustainability strengthened for at least one bank once digitalization introduced a share of platform fees returning to the community, while autonomy remained challenged by dependence on local government, partner institutions, and the technology providers behind the platform itself.

2.2 Social Currency Circulation

The circulation of social currencies takes different forms across social and community currency experiences (Soares, 2006). Social currency's effects depend most directly on what happens once it enters circulation: money that stays within the local network sustains local commerce and production, whereas money that concentrates or leaves the territory does not (Cernev & Proença, 2016). Circulation, like governance, depends on the trust of all participants place in the currency and in the bank that administers it (Soares, 2006). The Sardex circuit, a mutual-credit system for small and medium enterprises in Sardinia, shows this trust can also grow the other way: members transacting with one another nurtured reciprocity and mutual responsibility over time, a process the currency's design activated but that depended on the social interaction taking place among members as they used it (Dini & Kioupkiolis, 2019). Importantly, the experience of Sardex nearly ended in 2026. Its effort to expand to become a country-wide provider of digital currencies, spurred on by the personal ambitions of its group of founders and one of its main corporate investors (CDP Venture Capital SGR), led to a debt crisis. Sardex survived thanks to a major restructuring that involved a return to its roots as a specifically local (i.e., only operating on Sardinia) B-2-B digital currency operator (Crowe 2026). This experience essentially confirmed two crucially important points: community-ownership of a digital currency provider is paramount in order

to avoid its degeneration into a regular for-profit business; and, second, trust, accountability and operational effectiveness are almost always strongest at the local level.

Social currencies issued by Brazilian community banks increasingly circulate on the shared digital platforms E-Dinheiro. On this platform, a merchant pays a fee on each transaction, split between the community bank and the national network that maintains the platform (Pupo, 2022). Faria et al. (2026) describe how these accumulated fees can constitute a community fund, administered by the bank itself, financing the bank's own activities and low-interest microcredit for local businesses.

Circulation can also work against the same territorial development it is meant to serve, since once registration opens to any interested establishment, the composition of the accepting network can change the direction the currency flows. Studying the Mumbuca currency in Maricá, where this opening took place once the currency digitalized, Pupo (2022) found that large-volume establishments, including outlets of a chain with more than a hundred stores in the state, accounted for seventy-six percent of the number of purchases and close to five times the purchase volume of smaller, locally rooted establishments over the period studied; the amount received represented a small fraction of these establishments' total monthly sales, and they routinely exchanged it back into reais at the community bank, limiting recirculation. Analyzing more than three million transactions in the same currency, Diniz et al. (2026) report a Gini coefficient of 0.80 for the distribution of revenue among receiving businesses, with the largest twenty percent of recipients accounting for 82.4 percent of total payments received; these largest recipients recirculated only seven percent of the currency they received, compared with more than two hundred percent recirculated by the smallest recipients.

The currency can also stop circulating without losing its legitimacy. In the Palmas case, Rigo and França Filho (2017) distinguish between acceptance, a standing declaration by commerce owners that they are willing to take the currency as payment, and actual use, meaning the currency is received in a transaction. Commerce owners kept declaring their acceptance of Palmas even after years without being paid in it, and this declared acceptance remained widespread across the network as the volume and frequency of transactions in the currency declined. The authors interpret this persistence as tied to a symbolic attachment: holding onto the idea of belonging to a neighborhood with its own currency (Rigo & França Filho, 2017). In sum, circulation can generate revenue, sustain local

commerce, and, in principle, reinforce its own growth: the founders of Banco Palmas described this as a self-reinforcing pattern, in which greater acceptance among merchants draws more residents to acquire the currency, and greater use among residents draws more merchants to accept it (Singer, 2009). Whether that reinforcement takes hold depends on how the currency is designed, on the incentives built into that design, such as a penalty against hoarding an idle balance (Soares, 2006), and on the trust participants place in the currency and in the bank administering it (Rigo & França Filho, 2017).

2.3 Infrastructure

Based on Diniz, Siqueira and van Heck (2019), who studied twenty-two digital community currency platforms across countries, we understand infrastructure here as the technical system, hardware, software, and the rules embedded in them, through which a currency is issued, recorded, moved, and made available to whoever holds it. In Brazil, this system took shape first around E-Dinheiro, a platform that grew out of Banco Palmas' own currency before extending to other community banks and to municipal social-currency programs (Cernev & Diniz, 2020; Pupo, 2022). A digital platform can bring significant benefits to a social currency. It can substantially lower the cost of running the currency (Cernev & Diniz, 2020). Once accredited and registered on the platform, a merchant receives a point-of-sale device and, at the end of each month, payment for the transactions recorded, with a percentage retained to cover the cost of operating the system (Cernev & Proença, 2016).

A platform infrastructure can also connect a currency to services beyond payment between individuals, such as supporting account management, transaction records, and integration with credit and public programs (Diniz et al., 2019). Infrastructure can also generate the data a paper currency never produced: Diniz et al. (2026) trace more than three million transaction records from a digital community-currency platform to show how funds circulate spatially and among different types of establishments. And it can broaden participation beyond in-person exchange: the Sardex circuit runs its mutual-credit system for small and medium enterprises entirely through an electronic platform, allowing members across Sardinia to trade with one another without meeting face to face (Dini & Kioupkiolis, 2019).

A platform also brings challenges that paper currency does not carry. Control over it does not always sit with the community using it: when the technology company running E-Dinheiro withdrew from the project over insufficient financial returns, more than twenty

community banks that had adopted the platform by 2016 depended on a continuity that was, at that point, outside their own control (Cernev & Diniz, 2020). Even the Sardex circuit, which its own founders designed and operated, faces the technical challenge of migrating from a centralized system to a blockchain-based one in order to make governance of the circuit less dependent on a single operator (Dini & Kioupkiolis, 2019). And digitalization does not by itself guarantee the community feeling a currency depends on: Diniz, Siqueira and van Heck (2019) find this risk recurring across the platforms they studied, regardless of how the technology itself is designed.

Therefore, infrastructure is the technical system that makes a currency's issuance, movement, and record possible, and what it delivers to a community bank runs in both directions. It can lower the cost of operating a currency, extend what that currency connects to, credit lines, public programs, transaction data no paper currency produced, and reach participants beyond face-to-face exchange. At the same time, it can place control of the currency's own continuity partly outside the hands of whoever administers it, a condition that persists even when the platform's own founders designed and operated it but choose to do so as if it were a profit/growth-maximizing entity (such as in the case of Sardex).

3. Case and Methodology

3.1 Research strategy and case background

This research adopts an instrumental case study (Stake, 1995) as its research strategy. The case, Rede Alegrias, in Paraty, Rio de Janeiro, comprises the community bank, the association responsible for its governance, its core operational team, participating users and businesses, and a portfolio of projects, together with the digital social currency Alegrias these projects share as an instrument of exchange, also called Alegrias. Hereafter, we shorten Rede Alegrias to Alegrias when referring to the network as a whole. The primary interest in Alegrias lies less in the network's own particularities and more in what it can illuminate about the constitutive dilemmas of digital social currencies in solidarity-economy and informality contexts (Hart, 1973; ILO, 2002, 2013). Research participants combine formal and informal income sources, and the network grew within this broader informal setting, drawing members already engaged in small-scale production, trade, and service provision.

Alegrias is located in Paraty, a coastal municipality in the state of Rio de Janeiro whose local economy combines artisanal fishing, family farming, and community-based tourism, each shaped by significant natural and cultural resources alongside persistent constraints, limited infrastructure for processing and commercialization, restricted access to credit, and dependence on tourism seasonality (Theodoro et al., 2024). Tourism creates income opportunities for many residents and also produces seasonal variation in demand. Much of this activity is small-scale and labor-intensive, organized around personal relationships and local demand.

The research adopts an interpretivist, qualitative perspective. The phenomenon examined, the Alegrias community bank and digital social currency, is treated as a social and historical construction. This perspective is consistent with the social and community currency research that understands money as involving collective choices that extend beyond the technical operation of a payment instrument (Soares, 2006; Dini and Kioupkiolis, 2019).

The Alegrias began in 2018 through relationships connected to *Escola Comunitária Cirandas* (Cirandas Community School), bringing together families, producers, and service providers interested in a local exchange network. Its first currency circulated in printed form, without backing in Brazilian reais, and new members received an initial amount of Alegrias to exchange with other participants. The Covid-19 pandemic altered the conditions under which the Alegrias operated: physical circulation became difficult while interruptions in conventional markets increased the importance of local production and exchange. Alegrias adopted the Cyclos platform and continued operating the currency digitally, still without backing, while participants made intensive use of a WhatsApp group to coordinate exchanges.

This period was followed by what the Alegrias' coordinator described as a moment of disillusionment, the experience of trying to sustain an economic circuit among members whose production and consumption needs did not always correspond, while many recurrent expenses still required reais. The creation of Banco Comunitário Alegrias and the migration to e-Dinheiro responded to this experience: the Alegrias adopted a digital currency backed one-to-one by the real, with Saúva (the social-impact arm of an investment fund) providing the funds to convert balances previously recorded in Cyclos. This transition also expanded the organizational work the initiative required, and the Alegrias came to include the community bank alongside projects such as productive microcredit, the Agroecological

Solidarity Kitchen, local fairs, and communication activities, sustained by a small core team and external partnerships.

This trajectory, from an exchange network without backing to a community bank operating a backed digital currency, forms the background against which the findings presented below should be read. The analysis that follows concentrates on the Alegria's current configuration, though participants often referred to earlier moments when describing their present experience.

3.2 Data collection

Data collection took place in two stages. The first stage was carried out in person in Paraty between March and April 2026, and included participant observation, participation in the Alegrias' fairs and events, and semi-structured interviews. The second stage, conducted remotely in May 2026, comprised two additional interviews and the collection of secondary documentary materials.

During the first stage, the researcher lived in the city as a temporary resident, moving around and attending fairs, markets, and Alegrias´ events. This mode of presence allowed observations that would be unlikely to emerge from brief visits: the everyday dynamics of mutuality among Alegrias members, and the concrete frictions of registering and joining the platform, experienced directly by the researcher herself.

The field diary recorded observations, informal conversations, impressions, and analytical questions that emerged throughout the stay. Notes were taken in a field notebook and later transcribed, with dates and context preserved. In parallel, the researcher recorded audio reflections while traveling and at the end of each day of fieldwork, material that served as a space for analytical elaboration concurrent with data collection.

Semi-structured interviews were conducted with 28 participants (Table 1) across six groups: the alegrias' team (E01–E05, seven sessions, since E01 was interviewed on three occasions), a former team member (X01), an external consultant (C01), long-standing users and supporters (U01–U07), new entrants (N01–N04), participants with low engagement (P01–P04), and non-users (NU01–NU05).

Most interviews were recorded and later transcribed. When an interview took place quickly at a fair, during participants' working hours, recording was replaced with notebook notes,

with the interviewees' consent. In some cases, the richer conversation occurred before or after the formal recording; these episodes were logged in the diary and treated as field observations.

The researcher also attempted to use the currency as any other participant would, opening an account, obtaining Alegrias social currency, and carrying out transactions. This process was documented in the diary and treated as data on the experience of registration and entry.

In the second stage, two additional interviews were conducted: one with a couple of local entrepreneurs, and one with a representative of Saúva Jataí, the Alegrias' partner organization. Three secondary documentary materials were also collected: the transcript of a public presentation given by the Alegrias' coordinator in August 2023 (DS-Evento), Saúva Jataí's 2025 Annual Impact Report (DS-Relatorio), and an academic article about the Alegrias published in 2024 (DS-Artigo). These materials were used to enrich the description of the case.

Table 1 - Interviews

Code	Profile summary	Group in user map	Business size	Date	Recording	Duration (min)	Notes
C01	External consultant, sociologist, community banks	—	—	08/04/2026	Recorded	68	
E01	Alegrias coordinator, social sciences	Alegrias team member	—	30/03/2026	Field notes	60	
E01b	Alegrias coordinator, social sciences	Alegrias team member	—	02/04/2026	Recorded	80	
E01c	Alegrias coordinator, social sciences	Alegrias team member	—	03/06/2026	Recorded	46	
E02	Researcher/intern, economics student	Alegrias team member	—	31/03/2026	Recorded	56	
E03	Community agent, teacher	Alegrias team member	—	01/04/2026	Recorded	42	
E04	Solidarity Kitchen lead,	Alegrias team member	—	07/04/2026	Recorded	30	
E05	Communications lead, cultural producer	Alegrias team member	—	08/04/2026	Recorded	45	
F01	Funder representative	—	—	—	Recorded	43	
N01	Fair-vendor couple, rural producers	New users and entrants	Micro – rural production (fair)	02/04/2026	Recorded	3	Fair, brief interview

N02	Fair vendor, rural producer	New users and entrants	Micro – rural production (fair)	02/04/2026	Recorded	3	Fair, brief interview
N03	Artisan, sustainable products	New users and entrants	Micro – individual craftwork	05/04/2026	Recorded	6	Fair, brief interview
N04	Couple, bicycle services	New users and entrants	Small – service	—	Recorded	36	
NU01	Fair vendor, spouse of a rural producer	Non-users – aware, uninterested	Micro – rural production (fair)	02/04/2026	Recorded	7	Fair, brief interview
NU02	Self-employed, açaí vendor	Non-users – aware, uninterested	Micro – informal self-employed (açaí cart)	02/04 and 10/04/2026	Field notes	10	2 visits to the fair
NU03	Farmer, rural producer, community leader	Non-users – aware, want to join	Micro/Small – diversified rural production	10/04/2026	Recorded + notes	5	Fair, brief interview
NU04	Rural producer, artisanal sweets	Non-users – aware, want to join	Micro – artisanal rural production	10/04/2026	Field notes	5	Fair, brief interview
NU05	Solidarity-economy agent	Non-users – aware, want to join	—	05/04/2026	Field notes	20	Fair, conversation circle with P02, P03, and NU05
P01	Beekeeper, rural producer	Stopped using / low activity	Micro – rural production (beekeeping)	02/04/2026	Recorded	9	Fair, brief interview
P02	Visual artist, artisan	Stopped using / low activity	Micro – individual craft/art	05/04/2026	Field notes	20	Fair, conversation circle with P02, P03, and NU05
P03	Artisan, Coletivo Somar	Stopped using / low activity	Micro – individual craftwork	05/04/2026	Field notes	20	Fair, conversation circle with P02, P03, and NU05
P04	Fair vendor, rural producer	Stopped using / low activity	Micro – rural production (fair, diversified)	10/04/2026	Field notes	5	Fair, brief interview
U01	Body therapist, self-employed microentrepreneur	Long-standing users and supporters	Micro – self-employed / services	06/04/2026	Recorded	30	
U02	Artisan, microentrepreneur	Long-standing users and supporters	Micro – individual craftwork	05/04/2026	Recorded	12	Fair, brief interview
U03	Entrepreneur, food distribution	Long-standing users and supporters	Micro/Small – food distribution (formally registered)	07/04/2026	Recorded	38	
U04	Service provider, beauty and aesthetics	Long-standing users and supporters	Small – service (individual salon)	06/04/2026	Recorded	15	

U05	Entrepreneur, cleaning products	Long-standing users and supporters	Small/Medium – production and distribution of cleaning supplies	09/04/2026	Recorded	20	
U06	Producer, artisanal seasonings, microentrepreneur	Long-standing users and supporters	Micro/Small – artisanal production (widely distributed brand)	08/04/2026	Recorded	63	
U07	Businessman, fuel	Long-standing users and supporters	Medium – fuel (2 stations)	08/04/2026	Recorded	30	
X01	manager, entrepreneur	Former team member	—	09/04/2026	Recorded	45	

Total (in minutes): 872

3.3 Method of analysis

The analysis followed the abductive process Dubois and Gadde (2002) describe as systematic combining. The movement was one of going back and forth between data, reflection, and literature, with the analytical framework developing, being revised, and being returned to the field throughout the process. This mode of analysis is consistent with the interpretivist perspective adopted and with the nature of the phenomenon investigated, which resists rigid frameworks.

Reflexive thematic analysis (Braun & Clarke, 2019) guided the treatment of empirical material. Rather than treating themes as latent entities to be discovered in the data, reflexive thematic analysis recognizes that themes are constructed by the researcher in dialogue with the material, and that analytical choices reflect epistemological and theoretical positions that should be made explicit.

In the first round of analysis, transcripts were reviewed with attention to actors, network characteristics, institutional design, technological infrastructure, relevant moments in the trajectory, and recurring challenges. Recorded audio reflections and field-diary notes were read in parallel, as material for analytical elaboration. From this material, in dialogue with the literature, codes describing problems, tensions, and potentials began to be grouped into broader categories.

Subsequent interviews and secondary materials were collected to enrich dimensions that had emerged as relevant, and a return to the full data set allowed these categories to be refined. As this process continued, three broader domains emerged around which the categories consistently clustered, closely matching the reading of the literature on governance, circulation, and infrastructure.

To ensure the validity of the analysis, we shared our preliminary findings with Alegrias' coordinator, and her observations were incorporated into this final round of analysis. This movement is constitutive of the approach adopted: abduction presupposes that new evidence can reconfigure earlier interpretations.

4. Findings

Each of the three domains examined below combines two recurring empirical patterns: a tension, evidence of a difficulty, limit, or risk the Alegrias manages, and a potential, evidence of a capacity or resource the Alegrias draws on to counteract that difficulty. The text below refers to these as a tension pole and a potential pole; Tables 2 through 4 present them in full for each domain.

4.1 Governance: Managing and governing the network

We identify three recurring aspects of how Rede Alegrias manages and governs itself within the governance dimension: the size of its core team, a pattern we name Understaffed Team; the concentration of coordination in a single figure, Centralized Coordination; and its dependence on external financing, External Funding Dependence.

(i) *Understaffed Team*. Rede Alegrias operates through a remarkably small core team responsible for the community bank itself, for coordinating the association, managing the digital social currency, maintaining relationships with members and partner organizations, organizing projects such as the Solidarity Kitchen and local fairs, handling communication, and responding to administrative and regulatory demands. Throughout the fieldwork, these responsibilities repeatedly appeared as concentrated in a handful of people who accumulated multiple roles, often performing tasks beyond their formal expertise. The coordinator illustrated the burden through a certification process: "I had to amend the association's bylaws and file the OSCIP application... it has been going back and forth for almost two years" (E01). Interviewees also described manual processing of platform data, limited communication capacity, and the absence of dedicated staff for several activities. At

the same time, the organization continued to function through the team's capacity to improvise, redistribute responsibilities, and retain operational knowledge informally.

We name this pattern as Understaffed Team to describe the way a small group of people sustains a public-facing community bank without the organizational capacity normally required to sustain an operation of that scope. The tension pole names what a small team costs the Alegrias: bureaucratic processes stall for lack of dedicated staff, the platform's own data has to be processed by hand, and communication reaches whoever is already inside the Alegrias' own orbit, without a mapped and segmented audience of its own. The potential pole describes how the same team absorbs that cost: knowledge that would elsewhere sit in a manual or a job description survives here inside individual memory and improvisation, transmitted informally as members with different professional backgrounds take on responsibilities beyond their training when someone else steps back. Understaffed Team is best understood as a mode of organizing in which scarcity and self-sufficiency function as two faces of the same arrangement, one that lets the Alegrias operate at its current scale while leaving little margin to absorb further growth in demand.

(ii) *Centralized Coordination*. Although Rede Alegrias has formal governance mechanisms, much of its coordination remains concentrated in a single central figure. She represents the Alegrias externally, maintains relationships with public agencies and partner organizations, participates in key operational decisions, and provides continuity across the community bank, the association, and its projects. Interviewees frequently described her as the person through whom information, decisions, and external demands circulate. This concentration is also visible in the Alegrias's public identity: external actors often associate Rede Alegrias directly with her leadership, while members rely on her accumulated knowledge and relationships to navigate daily activities and institutional requirements. An external supporter described "management [as] very concentrated, centralized" and linked it to limited territorial engagement with the idea that members are also owners (F01), in the sense of collective self-management central to the solidarity-economy tradition. At the same time, her authority is not formally unrestricted. Leadership positions are elected, decisions may be discussed in open assemblies, financial and circulation data are compiled and published quarterly and annually on the network's website and summarized on social media, and the organization reports to its funder more than is formally requested (F01; E02; Field Notes).

We name this pattern as Centralized Coordination to capture how authority in Rede Alegrias sits with a single figure whose decisions the Alegrias' own formal mechanisms both depend on and constrain. The tension pole names the risk this concentration carries: a project whose public identity, external representation, and daily continuity run through one person is vulnerable to being read, from outside and occasionally from inside, as an extension of her. The potential pole names the devices that keep this concentration accountable: elected positions, open assemblies, quarterly and annual public reporting, and a practice of disclosure to funders that exceeds what is formally required. Centralized Coordination is best understood as an unresolved arrangement between personal leadership and institutional procedure, in which the same features that produce dependence on a single person also allow that dependence to be observed, questioned, and in principle redistributed.

(iii) *External Funding Dependence*. Rede Alegrias finances a substantial part of its projects and instruments through the continued support of an external organization. This support helps cover activities whose operating costs are not fully recovered through the circulation of the social currency or through the revenues generated by the projects themselves. The supporting organization also provides funding under conditions that Rede Alegrias does not independently determine, while the two parties have not established a shared and explicit threshold for determining when a supported initiative should become financially self-sustaining. An external representative questioned the viability of one service because the return “does not pay even 10 percent of that person's time” (F01). Rede Alegrias has sought to reduce this dependence by creating its own fund and securing a municipal grant independently (E04). These resources broaden its funding base but remain insufficient to sustain the Alegrias’ operations as a whole without continued external support.

At the same time, this relationship has not involved direct intervention in the Alegrias’ agenda or daily decisions. The supporting organization has largely relied on the coordinator’s judgment, maintaining oversight through periodic and relatively informal check-ins. This arrangement has allowed Rede Alegrias to retain substantial autonomy in the use of the resources and in the definition of its activities. However, that autonomy rests on the supporter’s continuing willingness to exercise its funding role through trust without close direction.

We name this pattern as External Funding Dependence to describe a financial arrangement in which the Alegrias' projects and instruments remain workable because an outside organization continues to sustain them. The tension pole names this dependence: services the currency is supposed to make possible cost the Alegrias more than they return, project financing sits under conditions the Alegrias does not set, and the criteria for when a project becomes self-sustaining remain unresolved between the two parties; even the Alegrias' own fund and a municipal grant secured on its own account reduce reliance on the supporter without yet amounting to financial autonomy over the operation as a whole. The potential pole names what the same relationship has produced on its own terms: support exercised without an imposed agenda, and a relationship of trust with the Alegrias' coordinator sustained through periodic, light-touch check-ins. That trust is itself bound to the tension it counterbalances: the autonomy it grants holds because the supporter has so far chosen to exercise its funding role this way, an arrangement the Alegrias does not control and could see narrowed if the supporter's own approach to managing its funded projects were to change. External Funding Dependence, in this sense, describes a relation whose current balance between support and direction rests on choices made on the supporter's side as much as on the Alegrias' own.

Table 2 maps these three second-order themes onto the tensions and potentials identified in the data, organizing them under the aggregate dimension of Centralized and Dependent Governance.

Table 2. Aggregate dimension: Centralized and Dependent Governance

Tensions and Potentials	Second-order theme	Aggregate dimension
Tension: Small team relative to the volume of demands; OSCIP registration in a prolonged bureaucratic process; platform data extracted manually; absence of a sociodemographic mapping of members; communication without budget, without audience segmentation, with uneven digital penetration and low engagement in online formats (E01, E02, E03, E05, X01)	Understaffed Team	Centralized and Dependent Governance
Potential: Handover of responsibilities without operational collapse; activation of informal spaces during crisis; accumulated learning across four distinct operational models; complete		

Tensions and Potentials	Second-order theme	Aggregate dimension
documentary record; profiles with training in social sciences, pedagogy, nutrition, and communication; preserved institutional memory; self-taught absorption of technical knowledge (E01, E03, E04, E05, X01)		
Tension: Dependence on the organizational supporter with risk of community distancing; management still concentrated in the coordinator, with risk of being perceived as a personal project; reluctance to voice internal criticism (C01, F01, P03, DS-Relatorio)	Centralized Coordination	
Potential: Associative governance with elections, assemblies, and external audit; quarterly and annual reports published proactively; formal certifications, Public Utility status and CADSOL (E01, E02, C01, F01, DS-Relatorio)		
Tension: Financial sustainability still dependent on the organizational supporter; the Solidarity Kitchen without its own operational self-sufficiency; accounting understanding not yet aligned on what counts as self-sustaining; bill payments costing the team more time than the fee returns; microcredit administered by the organizational supporter, not by the community; microcredit interest rates rose; occasional municipal partnerships, without a public policy integrating the currency (E01, E02, E04, X01, F01, U06)	External funding dependent	
Potential: Financial and strategic support from the organizational supporter without imposing an agenda; a relationship of trust with the Alegrias' coordinator, sustained through periodic, light-touch check-ins (F01)		

4.2 Circulation: Participation and circulation across the network

Analyzing the empirical material, we identify three recurring aspects of how different groups engage with Rede Alegrias and use alegrias social currency within the circulation dimension: how people first come to the currency through personal relationships, a pattern we name Proximity-dependent Engagement; how alegrias move once they enter a household or

business, Limited Circulation; and how projects and partnerships sustain participation beyond individual exchange, Grassroots Project Momentum.

(i) *Proximity-dependent Engagement*. Engagement with Rede Alegrias and its social currency develops primarily through interpersonal relationships embedded in the local community. Participants often learn about the currency from community agents, neighbors, local businesses, or people who already use it. Adoption may follow a conversation, an invitation to participate in a project, or observation that someone nearby has used the currency without difficulty. One new entrant summarized this route simply: “Through [the agent], she encouraged us... it was also through [the agent's] referral” (N01). Community agents mobilize their own relationships and credibility to introduce the currency, explain how it works, and respond to concerns. In this context, interpersonal endorsement performs functions that would otherwise require broader communication or marketing efforts.

This relational process becomes less effective when potential participants lack prior ties to Alegrias. Residents and visitors who approach the currency primarily by comparing it with familiar payment instruments, such as digital banks or Pix (Brazilian national instant payment platform), may see few practical reasons to adopt it. Previous experiences with local currencies that disappeared or failed to deliver their promises may further reinforce skepticism. One non-user compared Alegrias with Argentina's *patacones* and feared “depositing our reserves... in a currency that does not have certain backing” (NU01). For these actors, the currency’s stated social purpose is not necessarily sufficient to overcome concerns about convenience, continuity, and usability.

We name this pattern as Proximity-dependent Engagement to describe how adhesion to Rede Alegrias travels through relationships built around the currency. The tension pole names what this reliance on proximity excludes: residents and visitors who evaluate the currency against more familiar instruments, digital banks, Pix, or memories of past currencies that failed, find little in the concept itself to overcome that comparison. The potential pole names what that same proximity supplies: adhesion moves from person to person, carried by an agent's own network, by the example of a neighbor already using the currency without incident, or by a single conversation that does the work a marketing campaign would otherwise have to do. Proximity-dependent Engagement therefore makes the currency's growth a function of the density and reach of existing relationships. This

condition explains both the Alegrias' capacity to grow inside its own community and its difficulty for actors positioned outside it.

(ii) *Limited Circulation*. Once Alegrias enter a household or business, they tend to move through a relatively narrow set of transactions and participating establishments. Users often receive the currency before having an immediate opportunity to spend it, creating a timing gap between inflow and outflow. The limited acceptance network further restricts movement and produces uneven balance. A fuel business owner reported: “Today, for example, I have 16,000 reais in alegrias... it is more than I can spend in alegrias” (U07). As a result, currency holdings become unevenly distributed across the network, with some high-traffic establishments receiving alegrias more rapidly than they can recirculate them. In some cases, a single business may accumulate a volume of currency greater than that held by the rest of its customers combined.

Despite these constraints, circulation does not cease. A small number of strategically important establishments provide goods and services that members purchase regularly, thereby preserving the currency’s everyday usefulness. New participants also learn established spending routes soon after joining the Alegrias, directing their alegrias toward the same businesses already used by existing members. These recurring practices create a recognizable circulation pattern, but they do not substantially broaden the range of transactions or actors through which the currency moves.

We name this pattern as Limited Circulation to describe how Alegrias move once they enter a household or a business, a movement narrower than Alegrias’ own ambition for it. The tension pole names the mismatch this produces: a restricted set of places to spend the currency, a timing gap between receiving and spending it, and a volume concentrated enough in a handful of larger establishments that a single business can hold more alegrias than the rest of its customers combined. The potential pole names what keeps circulation from collapsing altogether: a small number of key establishments whose participation sustains the currency's everyday usefulness, and a spending pattern new members learn to replicate almost as soon as they register. Limited Circulation is best understood as a structural feature of a currency whose usefulness depends on a small set of high-traffic points, a dependency that sustains circulation in the short term while concentrating the risk of its collapse in a few places.

(iii) *Grassroots Project Momentum*. Rede Alegrias initially structured participation in response to the urgent needs created by the pandemic. As that immediate sense of crisis receded, however, participation became more difficult to sustain through urgency alone. Outreach still depends largely on interested individuals taking the first step, while events tend to attract people who are already familiar with or supportive of the Alegrias ' aims. Field notes record a former participant saying that the Alegrias had been important for exchange during the pandemic, but that some members grew less confident in it after the migration to e-Dinheiro. The same notes register uncertainty about whether that shift reflects declining trust or simply reduced need, now that the pandemic has passed and the local economy has picked up (P02, P03, Field Notes). Consequently, substantial parts of the wider population Alegrias seeks to reach remain outside its activities.

At the same time, Alegrias has converted part of its initial energy into a growing portfolio of projects. Productive microcredit, the Solidarity Kitchen, composting initiatives, and recurring fairs provide concrete and repeatable contexts in which the social currency can be used. The Solidarity Kitchen, for example, increased from approximately 60 to 100 meals over a year (E04). These projects have expanded in scale and scope even as the urgency that initially mobilized participants has diminished. They therefore offer practical reasons for continued engagement that are less dependent on the exceptional circumstances from which the network emerged.

We name this pattern as Grassroots Project Momentum to describe the relationship between the Alegrias' projects and the energy that first brought people to them. The tension pole names what that energy leaves unresolved once the pandemic's urgency recedes: outreach that still waits for the interested party to take the first step, events that tend to draw people already persuaded, leaving much of the wider population the Alegrias hopes to reach still untouched, and a decline in confidence among some earlier participants whose cause, declining trust or simply reduced need after the pandemic, remains unclear (P02, P03, Field Notes). The potential pole names what has been built on that same energy: a portfolio of projects, productive microcredit, the Solidarity Kitchen, composting, recurring fairs, that gives the currency concrete, repeatable uses and has grown in scale even as the initial urgency faded. Grassroots Project Momentum therefore names a transition already underway, from a network sustained by crisis to one that has to generate its own reasons for

continued participation, a transition its projects appear to be sustaining more successfully than its outreach currently does.

Table 3 maps these three second-order themes onto the tensions and potentials identified in the data, organizing them under the aggregate dimension of Restricted Circulation.

Table 3. Aggregate dimension: Restricted Circulation

Tensions and Potentials	Second-order theme	Aggregate dimension
Tension: Competition from Pix and digital banks; registration barriers preventing use by tourists; affective resistance tied to memories of failed, unbacked currencies; perception of institutional fragility relative to traditional banks; the model seen as incompatible with a tourist-facing clientele; the concept of a complementary currency not self-explanatory (E01–E05, U01, U02, NU01, NU02, NU03)	Proximity-dependent engagement	Restricted Circulation
Potential: Communication oriented toward building belonging; organic recruitment through the community agent's personal network; in-person referral as the most effective adhesion mechanism among all new users interviewed; explicit belief in the limits of capitalism and the role of solidarity economies; initial distrust overcome by observing peers; prior experience with social currencies facilitating understanding; conversion of a non-user made possible by a single instance of in-person support (E03, E05, N01–N04, U01, U02, U05, U06, NU01, NU03, NU04)		
Tension: Limited range of registered establishments; circulation volume low relative to the Alegrias' potential; mismatch between receiving and spending; a scale dilemma between personal proximity and growth; risk of concentration in a few larger establishments; field evidence of low adhesion at fairs and at the Solidarity Lunch; a small share of total revenue received in alegrias; accumulated balances without use; a catalog difficult to access within the app (E02–E04, C01, U01, U03–U05, U07, Field Notes)	Limited Circulation	
Potential — Adhesion of key establishments: large-circulation businesses, such as the gas station and the gas distributor, sustaining the currency's liquidity; the argument most cited by users when introducing the Alegrias to someone new; a spontaneous purchasing circuit between this key establishment and local farmers; a spending circuit replicated even for new users (E01, E03, E04, U01, U02, U04–U07, N02)		

Tensions and Potentials	Second-order theme	Aggregate dimension
Tension: Unanswered questions after registration; events attracting an audience already convinced of solidarity economy; goods offered not essential for lower-income populations; passive outreach; a local preference for physical cash; the incentive weakening after the pandemic ended; departures spreading among members connected to partner collectives (N04, P01–P03)	Grassroots Project Momentum	
Potential: Microcredit; bill payments, Alimentos Alegrias, and salaries at Escola Waldorf; reinvestment of 10 percent of fair sales into shared equipment; Feira Alegrias at Praia do Jabaquara, with Café Solidário; Cozinha Solidária Agroecológica, with labor paid entirely in alegrias; the Circuito de Feirinhas expanded to new fairs across the city; Casa Alegrias as a collaborative space; Compostagem Solidária, with the municipal nursery; partnerships with the municipal Secretariats of Agriculture and Culture; growth in the number of members; access to quality products at accessible prices (E01, E03, E04, E05, U01, U03, U04, U06, DS-Relatorio)		

4.3 Infrastructure: Digital platform as the contested infrastructure

Analyzing the empirical material, we identify three recurring aspects of how Rede Alegrias depends on and relates to the e-Dinheiro platform within the infrastructure dimension: the friction involved in registering for and using the currency day to day, a pattern we name Frictioned Adhesion and Everyday Use; the limits on what the platform's own records make visible, Partial Transparency and Accountability; and the constraints on the Alegrias' control over a platform it shares with other community banks, Limited Autonomy over Solidarity Platform.

(i) *Frictioned Adhesion and Everyday Use*. Registering for and using the Alegrias currency requires more effort than the intended user experience suggests. During fieldwork, the researcher could not register without mediation and encountered repeated obstacles even with in-person support, including a telephone number linked to another bank and rejection of a digital driving licence (Field Notes). Enrollment depends on specific equipment and, in practice, on the availability of a single agent able to complete the registration process. Once registered, users may encounter technical instability during transactions, weakening confidence that payments will be completed reliably. Redeeming accumulated alegrias

introduces further difficulties because the process remains manual and time-consuming. For some participants, a single unsuccessful attempt to access the application or complete a transaction is sufficient to interrupt continued use.

Rede Alegrias has developed workarounds to reduce some of these obstacles. A portable point-of-sale system based on QR codes allows vendors to accept the currency without relying exclusively on the application's standard transaction interface. A WhatsApp group functions as an informal marketplace circulated, as one user explained, participants post what they offer there, allowing others to discover available products and services (U05), compensating for the limited visibility provided by the application's own catalog. These arrangements preserve access to the currency's basic functions, but they operate alongside the underlying technical and procedural difficulties.

We name Frictioned Adhesion and Everyday Use to describe the distance between what registering and using the currency is supposed to feel like and what it actually requires. The tension pole names where that distance opens: a registration process that depends on specific equipment and a single available agent, technical instability that erodes confidence in individual transactions, and a redemption process manual and slow enough that some members simply stop trying after their app fails once. The potential pole names the workarounds Alegrias has assembled to close part of that distance: a portable point-of-sale (QR Code) that lets vendors accept the currency, and an informal marketplace that circulates on WhatsApp precisely because the app's own catalog does not surface it. Frictioned Adhesion and Everyday Use is best understood as an accumulation of small frictions the Alegrias has learned to route around, a pattern that keeps the currency usable for those who persist while filtering out those who do not.

(ii) *Partial Transparency and Accountability.* The platform provides Rede Alegrias with access to transactional records, but it does not offer the level of visibility needed for Alegrias to fully monitor, verify, and communicate the movement of its own currency. Reporting and data-export functions remain limited, making it difficult to produce consolidated accounts directly from the system (Field Notes). In one instance, Alegrias was unable to trace a fee remittance within the platform's own records. Individual transactions may also lack a stable and shareable form of proof, leaving screenshots as the only practical evidence available to participants or administrators (E02).

To compensate for these limitations, Rede Alegrias has developed its own data-processing routine. Raw records extracted from the platform are reorganized and systematized internally, allowing the Alegrias to reconstruct its activities, monitor monetary flows, and publish information about its operations. The coordinator considered this reporting unusually refined precisely because "these are not data that e-Dinheiro gives you" (E01). This routine reflects a broader organizational commitment to transparency and public reporting, but it also requires technical and administrative work that the platform was expected to perform or facilitate.

We name Partial Transparency and Accountability to describe what the platform allows the Alegrias to know about its own money and what it does not. The tension pole names the gap: limited reporting and export functions, a fee remittance the Alegrias could not trace within the platform's own records, and transactions that leave no shareable proof beyond a screenshot. The potential pole names how Alegrias values transparency and the publication of records based on a data-processing routine built in-house that turns the platform's raw records into a systematized account of the Alegrias' own activity. Partial Transparency and Accountability therefore describes an accountability Alegrias has had to construct for itself, alongside, and at points against, the accountability the platform itself was supposed to provide.

(iii) *Limited Autonomy over Solidarity Platform*. Rede Alegrias depends on a technical platform whose architecture, maintenance, and development remain outside the Alegrias' direct control. A representative of another network reported deactivating e-Dinheiro in all its community banks after repeated application problems, while observing that "at this moment, we have no option" (C01). Although the platform enables the operation of the digital social currency, Alegrias has limited influence over how quickly technical problems are addressed or how its functions evolve. Requests for support may take considerable time to resolve, while differences between the functions available to community banks and those available to municipalized banks are embedded in the platform's design (U02). The absence of a clear legal framework for community currencies in Brazil further weakens the Alegrias' position when negotiating technical responsibilities, contractual conditions, or changes to the infrastructure.

Within these constraints, Rede Alegrias has developed ways to exercise influence without withdrawing from the relationship on which its operation depends. Its members publicly

identify technical and contractual limitations in institutional meetings, sectoral forums, and policy discussions while continuing to work with the platform provider. Participation in the broader community-banking movement has also expanded the Alegrias' access to collective spaces in which shared platform problems can be articulated. Over time, Rede Alegrias has accumulated contractual and technical knowledge that it has begun to share with other community banks facing similar conditions, turning its own experience of dependency into a resource for collective learning and advocacy.

We name Limited Autonomy over Solidarity Platform to describe how far the Alegrias' own decisions reach into a technical infrastructure it depends on but did not build. The tension pole names the limits of that reach: technical support that moves slowly, a functional gap between community and municipalized banks built into the platform itself, and the absence of a legal framework in Brazil that would give community currencies clearer standing in this relationship. The potential pole names what the Alegrias has built inside those limits: a capacity to name the platform's shortcomings in public and institutional settings without breaking the relationship that sustains it, a position within the broader community-banking movement built through participation in shared forums and policy discussions, and a body of contractual and technical understanding it has begun to pass on to other community banks facing the same constraints. Limited Autonomy over Solidarity Platform therefore describes a form of agency exercised from a position of dependency, in which the Alegrias makes itself heard, within limits, inside a set of platform rules it does not control.

Read together, the platform's everyday friction, its limited transparency, and a governance structure the Alegrias does not control converge on a single condition: Rede Alegrias depends on infrastructure it did not design and cannot fully repair, even as it has built workarounds for some of that friction, its own means of accounting for what the platform does not record, and a real, if partial, voice in shaping how the platform evolves.

Table 4 maps these three second-order themes onto the tensions and potentials identified in the data, organizing them under the aggregate dimension of Contested Solidarity Infrastructure.

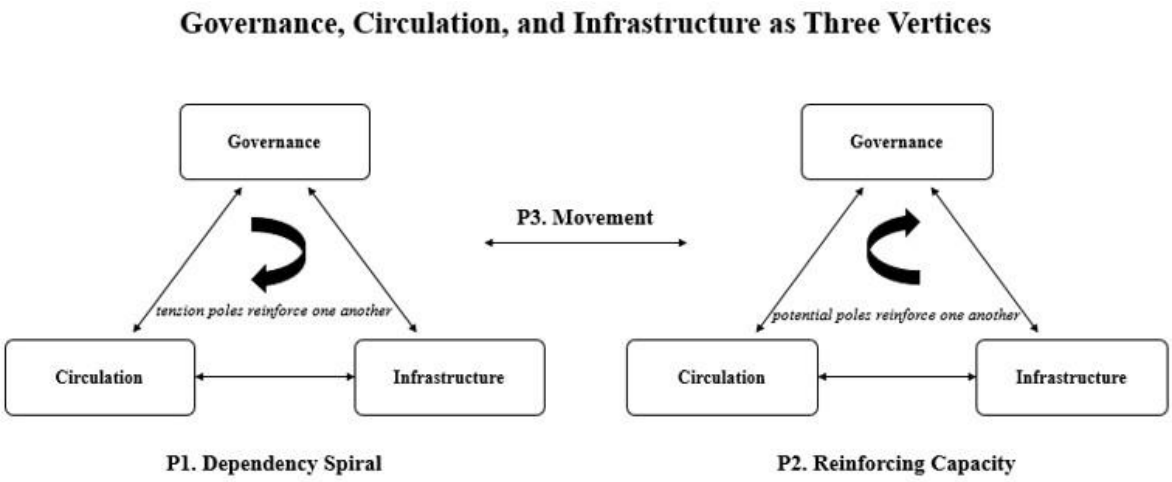
Table 4. Aggregate dimension: Contested Solidarity Infrastructure

Tensions and Potentials	Second-order theme	Aggregate dimension
Tension: Registration barriers requiring specific equipment and a VPN; dependence on a single registration agent; technical instability; limited interoperability; a phone number tied to a single bank; dependence on connectivity; the direct QR-code conversion function removed; manual redemption; passwords and updates creating dependence on the agent; bill payments without date flexibility; registration without subsequent real use; silent abandonment after accumulated barriers; low digital literacy without continuous support (E01–E03, U01, U02, U06, N03, N04, P02–P04, NU04, Diário de Campo)	Frictioned Adhesion and everyday use	Contested Solidarity Infrastructure
Potential: A QR-code totem functioning as a portable point of sale at fairs; a WhatsApp group functioning as an informal marketplace and a channel for discovering where to spend, compensating for the app's catalog gap (E03, E05, U05)		
Tension: Limited reporting and data-export features; a redemption fee remittance not identified in the records; payments without a shareable receipt, only a screenshot (E01, E02, X01, U05, Diário de Campo)	Partial Transparency and accountability	
Potential: An internally built pipeline for extracting and processing platform data; a partnership with UFRRJ researchers who systematize data (E01, E02)		
Tension: Slow technical and methodological support; the incubating partner bank cautioned and shut down; Rede Paulista deactivated e-Dinheiro over the same problems; the absence of a legal framework for community banks limiting investment in the platform; a functional asymmetry between municipalized and community banks (E01, E02, E05, X01, C01, U02)	Limited autonomy over solidarity platform	
Potential: The capacity for critical dialogue with e-Dinheiro, questioning practices with technical argumentation without breaking the relationship; institutional positioning built through participation in community-banking forums, including a seminar marking Banco Palmas's twenty-fifth anniversary and discussions on draft legislation in Brasília; the transfer of this contractual learning to coordinators of other community banks through Rede Paulista (E01, E02, X01, C01)		

5. An Analytical Framework: Two Cycles of Reinforcement

The three domains examined in Section 4, governance, circulation, and infrastructure, each combine a tension pole and a potential pole. This section proposes a framework built on three interlocking propositions according to Figure 1.

Figure 1 – The framework and propositions



The first (P1), a Dependency Spiral, describes how the tension poles of the three domains can reinforce one another. The second (P2), Reinforcing Capacity, describes how the potential poles can reinforce one another instead. The third (P3), which we call Movement, describes the ongoing balancing act between these two directions, the work through which a solidarity-economy project keeps the second cycle active enough to counteract the first, a balance this case suggests may account for the Alegrias' longevity. The three domains function, in this framework, as three vertices of a single structure: governance, circulation, and infrastructure. What varies is the direction in which they reinforce each other at a given moment.

5.1 P1 - A Dependency Spiral

The findings suggest that organizational dependency builds through repeated attempts to compensate for localized constraints. When the tension pole of one vertex is addressed through organizational work that consumes capacities required elsewhere, that work

transfers dependency to a different vertex without resolving it. As these compensatory responses accumulate across governance, circulation, and infrastructure, the three vertices sustain a cycle we call a Dependency Spiral.

For example, friction at the infrastructure vertex limits what governance can know and do with its own resources, since the team must compensate manually for what the platform does not provide, consuming capacity that is already scarce. The compensatory effort required to sustain the infrastructure therefore reduces the organizational capacity available to sustain circulation, because a governance structure stretched thin has less room to cultivate the establishments and relationships circulation depends on. Narrow circulation, in turn, deepens dependence on external funding, since fees and services the currency is meant to generate fall short of covering the Alegrias' own operation, closing the loop back onto governance. Again, the response to one localized limitation produces a new dependency elsewhere in Alegrias. Each vertex, in other words, can deprive the others of precisely the capacity they would need to correct course. The spiral may begin at any of the three vertices and follow different sequences, without requiring a single originating cause. None of the three vertices produced this spiral acting alone, and the Alegrias' own trajectory, six years of continuity across four successive operational models, indicates the spiral has not taken over. Naming it serves a different purpose: it identifies how compensatory responses across the three vertices can progressively reinforce dependency when the potentials that counterbalance localized constraints are not sustained. Rigo and França Filho (2017) document a comparable risk in the Palmas experience, where a wide network of acceptance persisted even as transaction volume declined, showing that legitimacy and circulation can drift apart over time, even in a considerably more consolidated case. Prior research on solidarity currencies has similarly shown that their continuity depends on the sustained articulation of community-centered and technological capacities instead of on the technical artifact alone (Sanches et al., 2025).

The present analysis extends this vision by showing that the organizational work assigned to preserve such articulation can itself transfer and reinforce dependency across governance, circulation, and infrastructure. Left unmanaged, a spiral of this kind offers no self-correcting mechanism internal to the Alegrias, because the responses adopted to preserve immediate operation may consume the capacity required to address underlying dependencies. Its

limiting outcome would be gradual erosion of the organizational conditions required for the project's continuity.

Proposition 1. In digitally mediated solidarity-economy projects, organizational responses that compensate for localized constraints may resolve immediate operational problems while simultaneously absorbing the capacities required elsewhere, thereby transferring and progressively reinforcing dependency across governance, circulation, and infrastructure.

5.2 P2 - Reinforcing Capacity

The findings also reveal a second reinforcing dynamic, one in which locally developed capacities become available to other domains, generating cumulative forms of collective capacity we term Reinforcing Capacity. Capacity built at the governance vertex, an internally developed data pipeline, a team that improvises around what the platform will not provide, extends directly into the infrastructure vertex, where that same capacity supports critical dialogue with the platform and its diffusion to other community banks. The same governance capacity also becomes a resource for circulation, since the tools and legitimacy a well-organized team accumulates make it easier to sustain and expand the projects that keep the currency in use. Circulation, in turn, generates organizational capacities that return to governance: projects that generate visible, recurring benefits reinforce organizational legitimacy that keeps the Alegrias´ associative structures functioning as genuine channels of decision-making. Each vertex generates capacities that become available across the other two, and local strengths accumulate as collective capacities. Like the Dependency Spiral, this reinforcing dynamic may begin at any of the three vertices and proceeds through different sequences.

Rede Alegrias' relationship to its own infrastructure differs from the Sardex case in one respect. In Sardex, the circuit's founders designed the platform's rules, contracts, and algorithms themselves, holding direct authority over its technology (Dini & Kioupkiolis, 2019). Rede Alegrias holds no equivalent design authority over e-Dinheiro, a platform it did not build and does not control; what this case shows is a negotiated engagement with that technology, exercised through critical dialogue and contractual learning. Trust and shared practice accumulating among members appears in both cases: Rede Alegrias's own trajectory echoes Dini and Kioupkiolis's finding that commitment to solidarity-economy values develops through participation itself, built on concrete points of utility encountered along the way. Reinforcing Capacity, in this sense, names the sum of governance,

circulation, and infrastructure potentials the Alegrias accumulates through its own trajectory.

Proposition 2. In a digitally mediated solidarity-economy project, capacities developed within governance, circulation, or infrastructure extend across the other domains, progressively generating and reinforcing collective capacity through participation, relational coordination, and negotiated engagement with technological infrastructure.

5.3 P3 - Movement

Neither cycle runs to completion in the case examined here. We call Movement the ongoing work that keeps the Dependency Spiral from closing by deliberately Reinforcing Capacities across the three vertices, especially during the interval between moments of external urgency. The currency's own relationship to economic cycles offers a partial explanation for why that interval matters, though this relationship varies across the Alegrias' history. Schroeder (2020) argues that some community currencies expand during crisis, since crisis allows better use of otherwise idle capacity when the conventional economy contracts; Rede Alegrias' growth from 50 to 150 families during the Covid-19 pandemic took place under the earlier, non-convertible Cyclos-based currency, consistent with Schroeder's account, but the currency now in use is convertible one-to-one with the Real, a difference that leaves open whether the same countercyclical behavior would recur under a future crisis. Rigo and França Filho (2017) offer a related but distinct observation: that sustaining a currency circuit depends more on its symbolic and political weight than on the satisfaction of immediate needs during periods of economic normalcy. That argument applies independently of convertibility, though it likewise leaves open how the current alegria would behave under renewed urgency.

The fieldwork for this study took place after the pandemic's urgency had receded and after the migration to e-Dinheiro, in a period without the pressure of acute crisis. Absent that pressure to drive adhesion and circulation on its own, the Alegrias' position depends on how it uses the interval. This reframes what consolidation means for a solidarity-economy initiative built on an instrument whose relationship to crisis shifts across its own design changes. The timing of the next period of urgency lies outside Alegrias' control, as does the governance of the platform it depends on. What it can manage is how the interval between such moments is used to actively sustain Reinforcing Capacity, strengthening governance,

deepening grassroots projects, and negotiating platform terms, or whether the tension poles are left to reinforce one another by default.

Proposition 3. In digitally mediated solidarity-economy projects, preventing localized constraints from consolidating into a Dependency Spiral depends on continuous organizational work of Reinforcing Capacity that sustains and reconnects capacities across governance, circulation, and infrastructure over time.

5.4 Discussion: The Frame in Light of the Literature

We advance the three propositions this framework puts forward, a Dependency Spiral, Reinforcing Capacity, and the Movement that mediates between them, as a proposed analytical structure. We discuss that structure against the literature below.

Faria et al. (2026) survey a wider population of community banks sharing the e-Dinheiro platform, naming Rede Alegrias, alongside Banco Preventório in Niterói, among those that continue operating without a municipal partnership, and identify autonomy, proximity, financial sustainability, community mobilization, mediation, and economic democracy as the dimensions digitalization puts under pressure; a statement they report from Banco Palmas' co-founder, describing platform governance as community banks' most complex issue today, corroborates the weight we place on Contested Solidarity Infrastructure. These six dimensions distribute across the three domains we organize as Governance, Circulation, and Infrastructure, suggesting our three-vertex structure condenses a pattern the literature already recognizes. Because Rede Alegrias is one of the banks in that population without a municipal partnership, this case can observe the same six dimensions free of that confound, and its qualitative depth traces how they reinforce one another over time, a dynamic a cross-sectional survey can suggest but not follow.

Pupo (2022) studied the same e-Dinheiro platform in its earlier deployment as Mumbuca, in Maricá, and traced how currency concentrated once the platform opened registration to any establishment beyond the small producers it had originally served. The concentration Pupo documents is considerable: large-volume establishments accounted for seventy-six percent of purchases by number and roughly five times the purchase volume of smaller, locally rooted establishments over the period studied, and the largest recipients exchanged the currency they received back into reais at the community bank, limiting its recirculation. Faria et al. (2026) report a comparable risk for the single-currency municipal model

generally, noting that concentration rises specifically when large businesses accept the currency alongside small producers. Rede Alegrias' own data show a smaller version of this pattern, in the gas station that accumulated sixteen thousand alegrias currency without a clear way to spend them, and in the concentration risk that an external consultant and the same field observations identified in Section 4.2.

The frame proposed in Sections 5.1 and 5.2 builds on three points this literature already establishes: that community banks depend on a shared, externally governed platform (Faria et al., 2026; Cernev & Diniz, 2020), that digital community currencies risk concentrating in large-volume establishments once registration opens beyond small producers (Pupo, 2022), and that the transparency such platforms make possible depends on who controls access to the data they generate (Diniz et al., 2026). Its contribution is the proposition that these conditions reinforce one another through the same three domains, in two opposite directions, and that the interval between the countercyclical peaks Rigo and França Filho (2017) and Schroeder (2020) describe is where a community bank's capacity to counteract that reinforcement becomes visible. Faria and colleagues list the dimensions digitalization affects; Pupo measures the direction currency moves once digitalized; Diniz and colleagues show what platform data can reveal when access to it is unrestricted. We propose a mechanism connecting governance, circulation, and infrastructure into a single structure, and locate the moment at which that mechanism remains open to a bank's own management. Whether this mechanism holds for community banks beyond Rede Alegrias, and whether the interval between urgency peaks can shift currency back toward smaller, locally rooted establishments, are questions this single case can raise but not settle.

Diniz et al. (2026) show what becomes analytically possible when a digital community-currency platform's transaction records are available at scale: more than three million records let the authors trace how funds move spatially and across establishment types, information a paper currency could never have generated. Rede Alegrias' own experience with Partial Transparency and Accountability shows the same kind of platform delivering a much narrower version of that possibility: reporting and export functions remain limited enough that the team has had to build its own pipeline to reconstruct, by hand, a fraction of what Diniz and colleagues extract directly from the platform's records. The contrast suggests that the transparency a digital social currency makes possible depends on which actor

controls access to the data it generates, a distinction our third vertex, infrastructure, is built to hold onto.

Soares (2006) offers an earlier, theoretical version of the same duality we organize into tension and potential poles. Studying Brazilian social-currency experiences before their digitalization, Soares argues that a currency's limits and its potentialities tend to originate in the same institutional features: the absence of the sanctions and habits that back conventional money restricts a social currency's reach while simultaneously opening room for the creativity, autonomy, and political exercise conventional money forecloses. Our framework extends that observation from the level of a currency's general institutional design to the level of a specific project's governance, circulation, and infrastructure, proposing that the same paired structure Soares identifies at the currency's foundation recurs across the domains a community bank has to manage once that currency is digitalized and embedded in a platform it does not control.

Rede Alegrias' own continuity is itself a finding worth registering. A community bank operating without municipal backing, built largely from small producers and informal workers, has sustained an alternative circulation instrument for six years and across four operational models, holding on to that continuity without dissolving into a larger institutional arrangement and without disappearing for lack of resources. Whether that continuity amounts to autonomy in a stronger sense, or to a durable form of managed dependency, is a question this single case can pose more clearly than it can answer; the Dependency Spiral and Reinforcing Capacity propositions advanced here specify what would have to hold for the answer to lean toward one reading or the other.

6. Conclusion

This study asked how governance, circulation, and infrastructure interact as a solidarity-economy initiative consolidates as a digital community bank. Rede Alegrias' own trajectory offers one answer: these three domains function as vertices of a single structure, in which a tension sharpened by digitalization in one domain reinforces the tensions in the other two, and a potential built to counteract that tension reinforces the potentials of the other two as well.

We developed this answer into a proposed analytical framework, built on three interlocking propositions: a Dependency Spiral, in which the tension poles of governance, circulation,

and infrastructure feed one another; Reinforcing Capacity, in which the potential poles do the same; and Movement, the deliberate work through which a solidarity-economy project keeps the second cycle active during the interval between moments of external urgency. This framework offers community banks operating within a shared platform a way of tracking, in their own governance, circulation, and infrastructure, whether such an interval is being used to build capacity or left to reinforce dependency by default.

The study has limitations associated with a single qualitative case. Fieldwork captured the network at a particular stage of its development, some interviews conducted at fairs were necessarily brief, and the transaction data available did not permit a systematic assessment of how balances are distributed and recirculated across the Alegrias. The three propositions advanced here describe a pattern this case supports; extending it to other community banks operating under similar platform arrangements remains a question for further research.

Future research could examine whether this framework holds across other community banks sharing the e-Dinheiro platform, combine participants' accounts with transaction-level data to trace circulation and concentration directly, and follow a single project longitudinally through more than one interval between moments of urgency. Doing so would clarify whether the balance between a Dependency Spiral and Reinforcing Capacity we propose is specific to Rede Alegrias or a more general condition of digital community currencies operating within infrastructure they do not control.

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PARTICIPATION AND MONETARY SELF-DETERMINATION: SOCIAL CURRENCIES IN CIVIC BLOCKCHAIN INFRASTRUCTURE

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Abstract

This paper examines the encounter between social currencies and civic blockchain infrastructures through the case of CommonsHood, a blockchain-based wallet app that advances a civic approach to blockchains and tokenized economies. The paper engages, first, with a specific strand of the literature on social currencies, where monetary experimentation is understood as a political, institutional and pedagogical process through which communities rethink economic practices, governance and the social meaning of money. It engages, second, with critical debates on blockchain for social good, questioning the assumption that technological innovation can generate socially desirable outcomes by itself. From this perspective, attention shifts from blockchain as a technical device to the values, imaginaries, institutional conditions and forms of mediation through which digital infrastructures are made socially meaningful.

Drawing on a use-based parallelism between money and tokens, the paper argues that tokenised systems make visible a plurality of functions that all-purpose money tends to condense and naturalise: access, recognition, circulation, certification, incentive, and

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governance. The central problem is therefore formulated in terms of monetary self-determination and technological appropriation. Civic blockchain is not a ready-made technological solution, but as a socio-technical infrastructure whose civic relevance depends on how actors participate in defining token functions, access conditions, recognised practices and rules of circulation.

The case of CommonsHood shows that monetary self-determination and technological appropriation emerge as partial and situated outcomes of co-design. They do not imply full control over money creation or over the blockchain infrastructure as a whole. Rather, they refer to the mediated capacity to discuss, configure and revise the meanings, uses and rules through which a tokenised monetary device becomes operative in a local collaborative economy. The paper contributes to social currency research by showing how the monetary question is reconfigured under tokenised conditions, and to debates on blockchain for social good by emphasising the importance of mediation, revisability and social intelligibility in accessible monetary design.

Keywordse: blockchain; agency; participation; social currency; citizenship; collaborative local economy; technological appropriation; monetary self-determination

1. Introduction

Complementary and community currencies (CCC) initiatives are undergoing an increasing trend of experiments with digitalization, which include the adoption of blockchain-based cryptographic tokens as new ways of representing and transferring values. The encounter between social currencies and digital infrastructures should not be read either as a purely technical innovation or as the simple digitalisation of monetary practices. Social currencies have always raised questions of access, recognition, governance, and meaning. What changes in tokenised systems is that some of these questions become more visible, more explicit, and, in specific cases, programmable through design. The issue is therefore not only whether digital tools can support local economies, but how communities may participate in shaping the rules and meanings of the monetary and digital artifacts through which those economies are organised.

This paper addresses that problem at the intersection of two areas. The first concerns social currencies, which are situated within the broader and terminologically heterogeneous field

of CCC. Within this field, the paper draws on a specific strand of the literature that has emphasised their political, pedagogical, and institutional features (Blanc, 2006; Primavera, 1999, 2000, 2002; Orzi, 2012, 2017, Orzi & Plasencia, 2007). From this perspective, social currencies are not simply alternative means of exchange, nor merely currencies with social aims. Rather, they are collectively instituted monetary artifacts through which communities seek to appropriate of monetary functions, redefine participation and circulation, and sustain different economic horizons through shared governance, ideally supported by ongoing collective learning. In this paper, monetary self-determination is used as an analytical formulation to capture this agency and the capacity to question, discuss, and locally reconfigure monetary functions.

The second area concerns blockchain for social good. This field of experimentation has been important in moving attention towards civic, social, and environmental applications of blockchain. Yet critical scholarship has shown that these approaches often remain shaped by technosolutionism, or risk reproducing the speculative and financialised logics they claim to move beyond (Semenzin, 2023). This paper builds on this critique to avoid attributing social outcomes to technical features alone. Drawing on the social shaping of technology perspective (SST), it shifts attention from what blockchain does by itself to the processes through which digital infrastructures are collectively adapted, governed, and made socially meaningful in concrete settings (Williams and Edge, 1996). Here, technological appropriation names this second movement: the situated capacity to interpret, adapt, and make usable a digital infrastructure within a specific social and institutional context.

The gap addressed in this study lies in what happens when these two trajectories meet. Blockchain technology is adopted with so-called social good or social impact purposes in many sectors, encompassing health, development aid, charity, energy communities, environmental sustainability, supply chains traceability (Adams et al., 2017; Bartoletti et al., 2018; Diniz et al., 2021; Tomlinson et al., 2021; Calzada, 2023). Specifically, we address the domain of peer to peer and programmable electronic money (Fines Schlumberger, 2022,), including schemes for financial inclusion, micro-credit, universal basic income, crowdfunding, where blockchain-based cryptographic tokens are what allows the implementation of novel monetary and financial schemes. Broadly speaking, in this field a great variety of approaches and socio-political visions can be found. On one side, the

adoption of existing de-fi instruments and cryptocurrencies within social good initiatives (which is what critical scholars mainly question). On the other side, more radical and transformation-oriented projects that aim at rethinking the very social and political principles on which tokenized economies are designed, and that are encoded in blockchain-based enabling platforms. The latter is the field we address for observing the encounter between social currencies and blockchain-based digital tools.

In what follows, we name these cases as civic token systems. This paper deals with cryptographic tokens, that are the digital representation, on distributed ledgers such as blockchains, of a value or right (property, access) over an asset. Tokenized systems are those systems that circulate values and incentives in the form of cryptographic tokens and via smart contracts, taking advantage of the properties of blockchain technology. They are a complex sets made of computation, financial and socioeconomic (people and organisations) networks (Voshmgir and Zargham, 2019). Here we focus our attention on tokenised system as socio-technical configuration in which tokens are used to organise functions such as access, recognition, circulation, certification, incentive, or governance and represent their value. The term civic here is used in a broad sense, referring to initiatives or projects oriented to the participation of citizens in the daily socio-political and economic life f their community, and to community-based forms of socio-economic organisation where community members, civil society organizations and eventually local authorities cooperates. Indeed, the case study for this paper is an experimental project in which the technical properties and the affordances of blockchain-based cryptographic wallets are intentionally re-oriented to comply with the social goals of community-based economies and of participatory processes at the local level.

While social currency research has examined participatory monetary practices, and critical blockchain scholarship has questioned the assumption that social outcomes can be derived from technology itself, less attention has been paid to the process through which monetary systems and technological meanings are negotiated together.

This paper addresses this gap by focusing on co-design as the site where such negotiation takes place. Co-design is the adoption of participatory methods in processes where developers and tech experts design digital technologies together with potential users. Here, we refer to co-design as specifically implemented in the experimental research on a



blockchain-based wallet app, wich includes not only the co-design of the app itself, but also of the tokenized economies it is expected to enable.

In this perspective, civic token systems are not analysed only as digital tools or alternative means of exchange, but as situated institutional arrangements in which rules of issuance, access, recognition, circulation, and governance are collectively discussed. The problem is therefore not simply whether communities adopt a digital medium. It is whether, and under what conditions, they can intervene - however partially - in defining what monetary functions the system performs, which practices are recognised, which rules are encoded or placed on-chain, and which remain off-chain, manual, revisable.

The paper therefore asks the following question:

How do monetary self-determination and technological appropriation take shape when social currency principles are translated into a civic blockchain infrastructure for locally grounded collaborative economies?

Rather than assuming technological or monetary sovereignty in a strong sense, the paper focuses on the more situated question of agency: which actors are included and what can be collectively defined before a civic token system becomes operative.

To address these questions, the paper examines the CommonsHood blockchain based wallet application as a situated case through which to show how the functionalities of a civic blockchain platform are developed and shaped through co-design across different experimental settings. The case is relevant because local actors, researchers and facilitators are involved in discussing the socio-monetary configuration of the system, while technical constraints are mainly addressed through interaction with developers. The case allows us to follow how a civic token system is made: how actors discuss recognised practices, token functions, access conditions, circulation rules, and the distinction between what is encoded and what remains off-chain.

The paper proceeds as follows. The next section reconstructs the theoretical dialogue between social currencies, sociological approaches to money, tokenisation, and the critique of blockchain for social good. Section 3 introduces CommonsHood as instrumental case of civic blockchain. Section 4 examines how co-design makes visible the mediated and bounded character of monetary self-determination and technological appropriation. The

final sections discuss the implications of the case for social currency research, blockchain for social good, and accessible monetary design.

2. Theoretical framework

2.1 Social currencies and collective agency

The literature on complementary and community currencies is marked by significant terminological and taxonomic plurality. Grassroots experiments and scholarly contributions have classified these monetary practices through different criteria, including territorial scope, governance arrangements, relation to official money, monetary functions, expected effects, and institutional design. These classifications are not neutral. They also depend on prior assumptions about what money is and which dimensions of monetary systems are considered analytically relevant (Toti, 2024). Following Doria and Fantacci's (2017) argument that evaluation does not merely describe a social phenomenon but helps construct it as a scientific and socio-political object, classifications can be read as part of the work through which monetary experiments become visible and intelligible.

Within this broad field, the paper focuses on social currencies and, more specifically, on the strand developed by Heloisa Primavera and Ricardo Orzi. In this perspective, social currencies are not defined primarily by their capacity to produce positive social outcomes, nor only by their distance from official money. Drawing on Primavera (1999, 2002), Orzi (2017), and Orzi and Plasencia (2007), this paper understands social currencies as collectively instituted monetary artifacts. This formulation stresses that these currencies are created, regulated, and sustained by groups and communities, rather than simply adopted as alternative means of exchange. Their relevance lies in the way they reopen monetary mediation to bottom-up intervention: money becomes an object of collective discussion - who may issue it, who may access it, which practices it recognises, which forms of exchange it supports, and which economic horizon it helps to sustain.

This is why social currencies are closely linked to participation, learning, and collective organisation. Primavera's definition is useful because it stresses both the functional and political specificity of these experiments. Social currency retains two classical properties of money - unit of account and means of payment - while excluding the store-of-value function (Primavera, 2004, as cited in Orzi, 2017, p. 127, own transl.). his exclusion is not only technical. It gives social currency an anti-accumulative orientation: its purpose is to sustain

circulation and use, rather than the concentration of monetary value. At the same time, Primavera describes social currency as money created and regulated by groups and communities. The monetary device is therefore not separated from governance: it exists because a collective body defines its rules, gives it legitimacy, and sustains its circulation.

Blanc (2006) helps specify what this transformation implies. Social currencies do more than localise exchange. They also transform the practices and representations of exchange: the status of participants, the relations among exchangers, and the rules that make exchange legitimate. This already points to a political understanding of monetary experimentation. The further step consists in making this transformation more explicit in terms of collective governance, learning, and the appropriation of monetary functions and rules. Orzi takes this point further by defining social currency as a social bond, that is, a complex structure of relations that contributes to the reproduction of the system of which it forms part. This is what makes it possible to think of "another money for another economy" (Orzi, 2017, p. 131, own transl.). Social currency does not simply support another economy; it becomes one of the institutional means through which such an economy may be imagined, learned, and partially enacted.

The pedagogical and emancipatory dimension is therefore not external to monetary design. In Plasencia and Orzi's work, social money is analysed through its capacity to produce learning, participation, and collective awareness around money; in Orzi's later formulation, social currency is understood as a social bond, that is, as part of the relational structure through which another economy can be sustained. Money becomes a space of learning and decision-making: participants may question dominant monetary arrangements, understand how monetary rules work, and take part in defining what counts as valuable, how labour and activities are recognised, which obligations are created, and which uses are legitimate. Its emancipatory potential lies precisely in this appropriation of decision-making power within self-managed collective contexts (Plasencia and Orzi, 2007; Orzi, 2012, 2017).

The experience of the Argentine Red de Trueque is relevant in this respect, because Primavera's contribution was not limited to the diffusion of an exchange mechanism. It also concerned capacitación popular, group facilitation, and permanent learning as conditions for the sustainability of the network. Through Orzi's reading of Coraggio, this pedagogical dimension becomes explicitly political. Otra economía does not refer only to alternative forms of exchange, but to the construction of another society, another culture, and another

subjectivity. For Coraggio, building other economies, markets, redistributive systems, and styles of reproduction means constructing a new social power (Coraggio, 2009, as discussed in Orzi, 2017). Social currencies enter this horizon when they contribute to active citizenship, collective learning, and the reorganisation of economic life around work, social reproduction, and collectively legitimised needs, rather than around profit maximisation.

For the purpose of this paper, this tradition allows social currencies to be read as a form of collective monetary agency.

2.2 Money as social relation and technology

Against approaches that reduce money to a neutral technical medium, Ingham argues that money must be understood as a socially instituted technology embedded in relations of authority, legitimacy, and power. In his earlier formulation, money is not external to social relations but constitutive of them (Ingham, 1996, 2004). In his later work, he describes money as one of the most important social technologies of modern life: an institutional device that stabilises relations across time and operates as a source of social power (Ingham, 2020).

This perspective is relevant here because it prevents two reductions. The first is to treat money as a purely economic instrument, as if its design had no effects on social life. The second is to treat technology as an external support that merely hosts pre-defined monetary features. Once money is understood as a socially instituted technology, questions of issuance, access, recognition, and rule-setting appear as political and institutional choices. As the literature on social currencies shows, these choices may be collective, distributed, centralised, or delegated to specific actors, and they always reflect particular goals and imaginaries.

This view also requires a historical and sociological understanding of monetary forms. Polanyi's distinction between markets and market society helps avoid the idea that the modern monetary economy is the only possible form of economic organisation (Polanyi, 1944). Servet, Théret and Yildirim (2008) further specify this point by distinguishing the anthropological universality of money from the historical particularity of modern Western money. Money is not universal because one historical form can be generalised to all societies; it is universal because monetary institutions organise fundamental social relations. In their formulation, the monetary institution rests on three relations: a relation to

oneself, a relation to others, and a relation to the social totality that transcends individuals and groups. Orzi develops this point by criticising the naturalisation of the neoclassical view of money: when money is treated as an ahistorical and merely instrumental device, its social and political character becomes invisible (Orzi, 2017). These perspectives make it possible to speak not only of the functions of money, but also of its social uses, meanings, and the relations it helps organise.

This perspective can be productively read alongside Zelizer's work on special-purpose monies. If Ingham shows that money is an institutionalised social relation, Zelizer shows that its sociality is never homogeneous. Monetary forms are differentiated through boundaries, uses, obligations, and earmarking practices, rather than functioning as a single and undifferentiated medium across all contexts (Zelizer, 1994, 2005). Her notion of earmarking is particularly important here because it shows that money is not simply spent: it is socially classified, delimited, and attached to specific expectations and intended uses. Taken together, Ingham and Zelizer allow money to be understood not only as socially instituted, but also as differentiated and reinterpreted through concrete uses, boundaries, and meanings.

Read through this sociological understanding of money, the argument developed in the previous section becomes clearer. Social currencies do not simply attach a "social" purpose to a neutral medium. They open monetary rules to collective agency. In solidarity and collaborative economies, this agency also concerns the relation between value and values. As Collin Harguindeguy argues, values are not only abstract ethical principles; they indicate values should not be understood only as abstract ethical principles; they indicate, more concretely, what is given value within a given form of economic life This avoids a moral opposition between economies "with values" and economies "without values" (Collin Harguindeguy, 2012). From this perspective, monetary practices are also cultural and political practices of valuation: they define what is prioritised, which needs are recognised, which forms of conduct are considered desirable, and which forms of exchange are legitimate. Doria and Fantacci (2017) add a complementary point: complementary and community currencies show that sociality is not only an external effect of circulation. It is also embedded in monetary architecture itself, that is, in the rules, functions, and constraints through which a currency operates.

2.3 Tokens and tokenisation

Tokenisation is understood here as the process through which rights, permissions, access conditions, rewards, claims, or representations of value are encoded into digital units capable of circulating within a programmable environment.

Heterodox monetary theories, and especially monetary circuit theory, have shown that the rules through which money is created and distributed shape who can activate production and which economic relations become possible (Graziani, 1990, 2003). From this perspective, tokenisation does not introduce behavioural orientation for the first time. It makes more explicit the way monetary rules can be designed to recognise, enable, constrain, or incentivise specific practices within a bounded circuit.

The parallelism proposed here between money and tokens becomes possible when general-purpose capitalist money is not taken as the only model and measure of monetary phenomena. This parallelism does not begin with digital infrastructures. As Maurer (2017) suggests in dialogue with Zelizer, the bitcoin moment can be situated within a longer history of money-like and token-like devices concerned with representation, accounting, value transfer, and social mediation, rather than treated as an absolute rupture. In a related strand, O'Dwyer (2023) shows that tokens cannot be reduced to payment instruments alone: they may combine exchange, access, identity, social bonds, platform rights, and moral expectations about use. In the present paper, tokens are examined in their digital and blockchain-based form, as situated monetary artifacts whose relevance depends on the functions they perform within specific circuits. Dodd's work is useful in the same direction because it treats money not as a fixed technical object, but as a social form continuously produced through meanings, relations, promises, and collective imaginaries (Dodd, 2014). This reinforces the point that tokenisation should not be read as a rupture with monetary sociality, but as a new setting in which monetary differentiation, social meaning, and collective invention become more explicit at the level of design.

In blockchain-based systems, multiple token types may coexist within the same socio-technical architecture. A token may mediate exchange; another may regulate access; a reward token may recognise a specific action; an NFT may certify a role, an object, or a status within the circuit. Functional differentiation refers here to this separation and recombination of functions that all-purpose money tends to condense. Its relevance is not only technical.

It makes visible which relations, practices, rights, and forms of value are being distinguished and made operative through design.

Tokenised systems therefore make some distinctions explicit, but they do not determine their social meaning by themselves. Technical parameters - token types, wallet types, access rules, permissions, issuance conditions - also define who can act, what can be recognised, and which forms of circulation become possible or legitimate. For this reason, the analysis must move from tokenisation as a design capacity to the socio-technical conditions under which these distinctions are defined, interpreted, adjusted, or contested. This is where civic blockchain and the social shaping of technology become relevant: not because technology explains the social effects of tokenisation, but because design choices, technical architectures, and collective negotiations shape each other over time.

2.4 Civic blockchain as situated technological infrastructure

This section focuses on a specific approach to blockchain-based platforms and situates them within the broader field of civic technologies. Civic technologies are not merely digital tools deployed for public or collective ends. They can be understood as infrastructures and practices oriented towards reshaping systems of governance and power, supporting participation, and enabling collective goals (Schrock, 2019, as cited in Viano et al., 2024, p. 6). From this perspective, civic blockchain can be understood as a specific redeployment of blockchain infrastructure: rather than serving speculative crypto-financial uses, it orients tokenisation towards social collaborative economies, bounded circuits, and community-oriented practices (Viano et al., 2023; Viano, 2024).

Having defined tokens and tokenisation, the question is therefore not whether blockchain can technically support new forms of circulation, certification or access. The relevant question is under which conditions a blockchain-based infrastructure can be treated as civic. In this paper, the civic character of blockchain does not derive from technical properties alone - such as transparency, traceability, decentralisation or automation - but from the way these properties are made accessible, configurable and socially meaningful within situated collective projects. Civic blockchain is therefore approached as a socio-technical infrastructure whose relevance depends on mediation, local adaptation, and the capacity to support collaborative economies without reducing them to pre-defined technical or market logics.

This perspective is important because experiments defined as blockchain for social good has often shown the risk of attributing social outcomes to technological properties themselves, as pointed out by critical works such as Semenzin (2023) and Soutoudenia (2021). Critical analyses of blockchain-based community currencies are particularly relevant here. Barinaga's analysis of the Sarafu community cryptocurrencies in Kenya makes this problem particularly clear in the field of community money. In that case, blockchain and smart contracts were used to embed monetary creation in local savings groups, or chamas; yet the standardisation and automation of monetary rules also risked eroding communal decision-making, shifting the locus of decision from the chama to the code and its developers, and allowing orthodox assumptions about money and economic behaviour to enter the technical architecture (Barinaga, 2020). A similar tension is identified by Raffaelli and Nowak (2025) in their ethnographic study of Moneda PAR, a blockchain-based complementary currency in Argentina. While blockchain addressed some limitations of earlier barter-club experiences, it also introduced new dependencies on technical experts, unequal power over technological tools, and tensions between democratic and technocratic forms of social innovation.

The point is therefore not to ask what blockchain does in general, but under which social, institutional, and design conditions a blockchain-based infrastructure can become meaningful and accountable for a specific community.

This is where the social shaping of technology perspective becomes relevant. SST allows the analysis to move away from a view of technology as a neutral tool whose effects can be assessed only after implementation. Technologies are not black boxes introduced into society from the outside. Their content, design, and use are shaped by organisational, political, economic, and cultural factors (Williams and Edge, 1996; MacKenzie and Wajcman, 1999). Williams and Edge describe technological innovation as a "garden of forking paths": at each stage, different technical options are available, and social factors contribute to selecting some paths while excluding others (Williams and Edge, 1996, p. 866). MacKenzie and Wajcman formulate the point in broader terms: technology and society should not be treated as separate spheres, since they are mutually constitutive (MacKenzie and Wajcman, 1999).

This perspective is particularly relevant for tokenised systems. Token types, wallet permissions, access rules, issuance mechanisms, smart contracts, and platform

parameters are not merely technical features. They are points where social objectives, institutional assumptions, and design choices become operational. They may open certain possibilities while closing others: who can act, what can be recognised, which exchanges are possible, and which forms of participation become easier, harder, or unavailable. For this reason, civic blockchain should not be understood as a simple incentive machine. It is better approached as a relational governance infrastructure, whose civic meaning depends on how monetary and technical functions are interpreted, configured, and made accountable within a situated social context.

By linking tokenisation to cooperation, bounded circuits, and purpose-driven practices, civic blockchain shifts the question from access to infrastructure to the capacity to adapt digital functions to situated collective purposes. Its civic character therefore depends not only on the functions it offers, but on whether those functions can be understood, adapted and used in relation to local needs, values and socio-economic models. Accessibility, non-extractive data practices, no-code or low-code interfaces, and educational and community activities are therefore part of the conditions through which the infrastructure becomes socially operative (Viano et al., 2023; Viano, 2024).

Recent work on civic platforms and platform citizenship helps clarify this point. Cardullo and Kitchin (2025) among others distinguish between commercial or privately owned civic platforms, whose standardised and often black-boxed design tends to reproduce a universal “one-app-fits-all” model, and FOSS civic platforms, whose configurability allows different local instances to support different forms of participation and citizenship. Although CommonsHood is a wallet app for economic transactions, and not deliberative e-democracy tool as the platform analysed by the two authors is, this distinction is useful because it foregrounds configurability as a political issue rather than a merely technical feature. In the case examined in this paper, the question is displaced from civic deliberation platforms to tokenised civic infrastructures: what matters is not only whether the infrastructure can be accessed, but whether its monetary and governance functions can be adapted, interpreted, and revised in relation to situated collective purposes.

Co-design becomes central at this point. It is the process through which monetary functions and technical configurations are brought into relation with local needs, values, and forms of organisation. In civic token systems, co-design does not simply collect preferences before implementation. It is the space where actors discuss what should be tokenised, which

practices should be recognised, who may access the system, which rules should be encoded, and which arrangements should remain off-chain, manual, or open to mediation. In this sense, co-design can operate as a form of collective earmarking: it links specific media, token functions, and access rules to the social relations and values that the local economy seeks to sustain.

This does not mean that all choices remain equally open once they are technically formalised. When design choices are translated into smart contracts, platform parameters, access rules, or wallet permissions, later adjustment is no longer only a matter of collective discussion. It also depends on the technical architecture, the degree of configurability, and the off-chain arrangements that keep parts of the system open to renegotiation. Smart contracts and platform parameters may stabilise collectively defined rules, but they also shape the practical conditions under which those rules can later be modified.

For this reason, civic blockchain is relevant to the paper not as a ready-made solution, but as a situated technological infrastructure. It makes possible certain forms of monetary configuration, while also limiting, channelling, and stabilising them through technical architecture. The next section brings this argument together by formulating monetary self-determination and technological appropriation as two partial and situated capacities: the capacity to discuss and configure monetary functions, and the capacity to make a digital infrastructure socially usable, interpretable, and revisable.

2.5 Monetary self-determination and technological appropriation

Technological appropriation is directly grounded in the social shaping of technology and digital ethnography literature. In this paper, monetary self-determination, by contrast, is proposed as an original formulation derived from the strand of social currency literature discussed above.

Monetary self-determination brings together different emphases within that strand: Primavera's language of monetary reappropriation, training, self-organisation, self-management in relation to grassroot experimentation on social currency (Primavera, 1999, 2002); Blanc's discussion of the democratic stakes of social currencies and of the citizen reappropriation of money (Blanc, 2006); Blanc's taxonomic distinction between complementary and community currencies and national currencies organised within a sovereign framework (Blanc, 2011); Orzi and Plasencia's analysis of the pedagogical and

emancipatory potential of social money (Orzi and Plasencia, 2007); and Orzi's understanding of social currency as a social bond and as one of the institutional means through which 'another economy' may be imagined and enacted (Orzi, 2012, 2017).

The concept used here therefore refers to the situated agency of collective actors to participate in defining monetary architecture: which monetary functions are activated, how access is organised, what uses are legitimate, which relations are recognised, and which behaviours are encouraged or constrained. It does not name monetary sovereignty in the strict sense of legal authority over money creation; rather, it refers to the partial and negotiated capacity to make monetary rules, meanings and uses open to discussion, learning and reconfiguration.

Technological appropriation, unlike monetary self-determination, is directly grounded in the SST and digital ethnography literature. It refers here to the situated process through which actors interpret a digital infrastructure, assign meaning to its functions, negotiate its constraints, and stabilise acceptable ways of using it in practice. It does not therefore indicate simple access to a tool or the adoption of a digital platform. In the SST perspective, technologies cannot be treated as finished objects whose meanings are fixed by designers or suppliers. Analysis must consider the meanings attached to artefacts and the ways actors appropriate them within social structures (Williams and Edge, 1996, p. 878). Pink et al. (2016, p. 63) make a related point by defining appropriation as the process through which people assign meaning to technologies, incorporate them into their own values and interests, and move them from the formal economy of objects into everyday and moral economies of use. Since technology and society are mutually constitutive, appropriation cannot be understood only as what users do after a tool has been delivered. It also concerns the meanings, competences, exclusions, and possibilities that are already organised through design.

The notion of technological sovereignty could also be brought into dialogue with this argument, but it implies a more demanding political horizon than the one addressed in this paper. As reconstructed by Lynch (2019), technological sovereignty refers to projects of radically democratic control over technological development, intertwined with open-source practices, alternative economic models, territorialisation, ethics of care, and the contestation of hegemonic smart-city agendas. Other authors have proposed the notion of technological self-determination as rooted in the autonomy of workers and communities

and alternative to the discourse of technological sovereignty, that they contest as fundamentally state-centered and reinforcing the technocratic elites. Here we only mention this wide debates, for pointing out that, while technological sovereignty and self-determination concern the construction of new structures, relations, and arrangements for meeting collective needs, we rather focus on the situated adaptation of a pre-existing digital infrastructure.

This conceptual framework will be examined through the situated case of CommonsHood. The following sections move from the presentation of CommonsHood as a case of civic blockchain to the analysis of how monetary self-determination and technological appropriation are negotiated through co-design. Section 3 introduces the infrastructure and clarifies why it is analytically relevant to the paper. Section 4 then examines how the co-design of locally grounded tokenised systems makes visible the mediated and situated character of both processes.

3. CommonsHood as a situated case of civic blockchain

CommonsHood is a blockchain-based wallet application developed in the framework of an interdisciplinary and participatory research project in the fields of urban informatics, tokenomics and digital geographies. The app aims at enabling non-technical users to create and circulate different types of tokens - such as coupons, access rights, rewards, complementary currencies, and digital collectibles (Balbo et al., 2020). CommonsHood was conceived from the outset as a tool for realizing what the project itself defines as the civic blockchain approach (Viano et al., 2023): it is an infrastructure for local communities and locally grounded collaborative socio-economic models. It is therefore not a generic platform later redirected toward social goals, but an infrastructure progressively developed in relation to local socio-economic contexts and community-oriented goals through situated experimentation .CommonsHood should not be understood as a finished technical product applied to communities from the outside. Its development has proceeded through co-design, testing, and iterative adaptation across different local contexts. These experimentations have concerned, among others, scenarios such as reward schemes for civic participation, coupon-based access to goods and services, and library-of-things models, and have fed back into both the platform's functionality set and its modular logic (Boella et al., 2024; Viano, 2024) This process has shaped the platform’s current architecture.

The paper uses CommonsHood as a instrumental case through which to examine how questions related from the social currency strand - participation, monetary design, collective learning, and governance - are reconfigured when they are mediated through civic blockchain infrastructure. The analysis draws on the research trajectory developed around CommonsHood, including previous publications on the platform and civic blockchain, project documentation, co-design materials, and the author's involvement in the interdisciplinary work on tokenised local systems for collaborative economies. Its aim is to explore some socio-technical conditions under which monetary self-determination and technological appropriation can be articulated in a tokenised setting for locally grounded collaborative economies.

CommonsHood is relevant to the field of social and solidarity economies because it is designed to support locally grounded collaborative practices such as sharing, reuse, access to common resources, recognition of community-oriented activities, and forms of local socio-economic coordination. In this sense, the tokenised system is approached as a possible infrastructure for collectively organising bounded circuits of value around collectively defined purposes. This is why the case can be read in continuity with the social currency strand, while also raising new questions about how solidarity-oriented practices are translated into digital rules, token types, and platform-mediated forms of governance.

More precisely, what makes CommonsHood relevant here is not simply its civic orientation, but the fact that it becomes context-based through a situated co-design methodology that translates local needs, available resources, and shared meanings into a usable digital configuration (Viano, 2024).

In the case of CommonsHood, co-design does not concern only the definition of local use cases or socio-economic models, but also - within certain limits - the configuration and adaptation of the platform itself. This includes the creation of functionalities and the negotiation between on-chain formalisation and off-chain social arrangements. The most demanding part of the process does not lie only in the technical adaptation of the wallet, but in the preliminary definition of the desired socio-economic model that the tool is expected to support: what should be tokenised, under which exchange rules, by which actors, and what should remain outside formalisation. This point is especially relevant here because it brings civic technology and monetary design into the same analytical level. CommonsHood does not merely host digital interactions. It provides a socio-technical environment in which

different token types, forms of access, reward mechanisms, coupons, certifications, and rights can be configured in relation to locally negotiated values and goals that define the economic model (Viano et al., 2023; Viano, 2024; Domenicale et al., 2026).

What makes it especially relevant here is that the fact that the application supports a plurality of token types does not take the form of an open-ended technological indeterminacy, nor of a rigid one-size-fits-all solution. CommonsHood is gradually developing a modular structure in which a core set of functionalities is maintained, while different communities can activate, combine, customize, or further extend them according to local needs. At the current stage of this research trajectory, the focus lies on two interconnected levels: the ongoing co-design and extension of the platform, where experimentation may lead to the development of further functionalities; and the co-design of local socio-economic systems, where the situated customisation of selected parameters and existing functionalities of the web app becomes central.

Methodologically, this situated configuration has been progressively formalised through an interdisciplinary co-design model structured around four iterative phases: first, the framing of the local socio-economic context, including the identification of actors, resources, needs, shared values, and collective objectives; second, the co-design of the socio-economic system, through the mapping of value flows and the selection of practices to be recognised or mediated; third, the co-design of the tokenised architecture, where token types, issuance rules, circulation mechanisms, access conditions, and governance roles are defined; and fourth, the technical and sustainability refinement of the model, in which the proposed configuration is assessed against platform functionalities, smart-contract constraints, legal and organisational conditions, and the need to preserve social revisability over time (Domenicale et al., 2026). These phases should not be understood as a fixed sequence that unfolds uniformly across contexts. In practice, they are iterated, revisited, or partially overlapping, depending on local conditions, available tools, and the constraints that emerge along the way.

This also clarifies what is at stake in platform co-design. In earlier experimentations, feedback from local actors did not simply concern token uses or exchange models. It also fed back into the development or adaptation of smart contracts and interface functionalities. this openness has practical limits. Smart-contract logic, interface design, usability concerns, and the need to keep the tool understandable for communities all

constrain how far flexibility can go. Local actors may ask for high levels of adaptability, while developers and researchers must mediate these expectations against technical feasibility, coherence of the architecture, and ease of use. In this sense, the space of intervention is neither fully open nor externally imposed, but negotiated under layered constraints (Viano, 2024; Viano et al., 2024). This tension makes revisability a central analytical issue. It is not a residual technical problem, but a condition of monetary self-determination in tokenised civic infrastructures: it concerns whether communities can continue to shape the monetary device after its rules have been formalised. The main risk is that this capacity remains dependent on actors able to modify code, smart contracts, or platform parameters, thereby separating collective deliberation from effective infrastructural control.The current direction moves along two lines: the continued development of new functionalities driven by needs emerging from situated experimentations, and a more concrete deployment of the platform as a service through the configuration and customisation of existing functionalities for specific community uses. What is co-designed locally, then, is not the whole platform, but the specific tokenised socio-economic arrangement to be implemented through it. This includes the relevant token types, the rules of issuance and circulation, the access conditions, the permissions attached to different wallets, and the boundary between what is formalised on-chain, what remains off-chain, and what must be supported by complementary social or organisational arrangements - through which actors can clarify their micro-objectives, shared values, and collective goals.

In this sense, CommonsHood is analytically relevant not because it offers a finished model, but because it makes visible an initial stage in which digital infrastructure, monetary architecture, and the locally negotiated conditions of value, access, and circulation are still being brought into relation. What makes CommonsHood especially relevant, then, is not only its adaptability as a civic digital infrastructure, but also the way it renders visible the point at which civic technology and monetary design have to be negotiated together.

4. Co-design as a site of monetary self-determination and technological appropriation

4.1 Co-designing a tokenised local collaborative economy

The previous section has introduced CommonsHood as a situated instrumental case of civic blockchain and has shown why it is relevant for examining the intersection between civic technology and monetary design. This section turns to the co-design process in order to

analyse how that intersection is negotiated in practice. The focus is not on participation in a generic sense, nor on the adoption of a digital wallet. It is on the moments in which local actors, researchers, facilitators, and developers translate situated visions of local economy (shaped by shared values, collective and micro-objectives, and choices about forms of coordination) into monetary functions, technical configurations, and a situated tokenised local economy. Co-design is therefore not treated here as a method for collecting preferences, but as the practical site where monetary functions, technological constraints, and local socio-economic objectives are translated into token rules, access conditions, recognised practices, and forms of circulation. It is through this process that monetary self-determination and technological appropriation become analytically observable as partial and negotiated capacities.

The broader development of CommonsHood across previous European projects and pilots is recalled in Note 1. The analysis below focuses instead on the co-design process developed within [project name], where the app was configured in relation to local collaborative practices, shared resources and community-oriented forms of exchange.

4.2 Monetary self-determination: recognition, valuation and collective earmarking

This subsection examines monetary self-determination through three connected design problems: recognition, valuation, and collective earmarking. The issue is not simply whether tokens are introduced into local practices, but how actors discuss what should be recognised, which forms of value should be made operative, and which distinctions should remain outside token mediation.

In the C.O.S.O. project - Comunità Organizzata per lo Scambio di Oggetti, an Italian acronym for Organized Community for the Exchange of Objects -, based in Turin (Italy) and organised mainly around physical swap parties and a library-of-things model - this relation became visible from the beginning. Local actors were not simply invited to adopt a pre-existing wallet. Through offline meetings, local cultural events, and co-design activities, they were gradually involved in discussions over what the system should recognise, how tokenisation should be aligned with community-building aims, and which economic vocabulary was acceptable for describing the emerging circuit. What was negotiated was not only the use of a tool, but the social intelligibility of the monetary device itself.

Several questions emerged and made this negotiation concrete. Should donation be recognised as a tokenised flow - that is, should the act of donating an object generate a reward token? If so, how could the system avoid reducing an act of solidarity to a measurable transaction? Should donated objects themselves remain outside token valuation? A similar issue emerged around voluntary work: should volunteering be rewarded, and if so, how can rewards recognise practices that the community wants to stabilise and repeat without turning them into commodified transactions? These discussions were closely linked to the work on language. The introduction of tokens risked evoking market equivalence even where the aim was recognition, reciprocity, and community-building. For this reason, the economic vocabulary of the system had to be discussed and adjusted, rather than simply imported from blockchain or market-oriented language inconsistent with the values of the circuit.

The valuation of second-hand objects raised a further set of questions. Should second-hand objects of different origin and condition be treated as equivalent in the system? In swap parties and in the library-of-things model, the emerging orientation was to treat objects without reference to their original market price or production cost, so that second-hand items could circulate according to a more uniform value logic. Yet this choice also opened further questions: what happens when an object has strong affective value for the giver? What if participants want to attribute a different value to some objects? Similar issues appeared in relation to lending and borrowing. If uploading an object already carries a reward for the lender, should borrowing receive stronger incentives in order to stimulate circulation and avoid stagnation? In this case, the reward does not simply measure an action; it attempts to orient a practice considered important for the functioning of the circuit.

A similar set of open questions emerged in the Community Lab in Aigaleo, Athens (Greece). The Community Lab is a physical space where the local community gathers materials to be upcycled, and makers can use tools and space of do-it-yourself activities. Here the tokenized system is expected to support the Lab and facilitate and encourage circular practices and participation.There, the negotiation concerned the value of tools available for borrowing - treated as equivalent in terms of use - and the more contested question of how to value materials brought to the Lab, such as wood or metal. Should their value reflect market price, utility for collective projects, or physical characteristics such as size and quality? Even small fragments could be considered less useful by some actors and more valuable by others, depending on the project and the practical knowledge involved.

The Aigaleo case also opened questions around access to municipal coupons or discounts connected to the tokenised circuit. Should these benefits be accessible to all participants, or only to those who donate materials, contribute labour, or work for collective objectives? How should the system recognise work oriented towards common goals, and how should it distinguish this from the use of the Lab for personal projects? If participants use the Lab for personal purposes, should they use their tokens? And how should quantities be defined if tokens are already used to access materials and tools? These are not secondary technical details, but precisely the points at which socio-economic models, monetary functions, and platform configurations have to be negotiated together.

The analysis does not focus on the solutions reached in each case. What matters here is the field of questions opened by co-design: donation and volunteering as recognisable practices, the valuation of objects and materials, borrowing incentives, access to coupons, the recognition of collective work and personal participation in relation to personal or shared goals, and the boundary between what should be tokenised and what should remain outside token mediation - not only in terms of exchange or use value, but also in terms of the behavioural orientation embedded in token rules. These are monetary design problems that require facilitation, negotiation, and ongoing collective reflection, and cannot be delegated to technical parameters alone.

These questions make visible the monetary content of co-design. Donation, volunteering, borrowing, the valuation of objects and materials, access to coupons, and the distinction between personal and collective uses are not only operational details. They are points where actors define what counts as valuable, which practices deserve recognition, and how circulation should be oriented without reproducing market equivalence as the only available language of value.

The empirical material also makes the relation between money and tokens more concrete. CommonsHood does not simply add programmable digital representations to already existing relations. It renders explicit distinctions that all-purpose money tends to conceal - between token types, conditions of acceptance, differentiated uses, permissions, and value attributions. The relation with Zelizer's notion of earmarking becomes visible here as a collective design operation. In Zelizer's work, earmarking refers to the social marking of money for specific uses, meanings, obligations, and relations. In CommonsHood, this operation is not only observed in how people classify and use money in everyday life. It is

moved upstream, into a co-design process in which actors negotiate which token type, access rule, reward mechanism, or form of recognition should be attached to which practice. Earmarking thus becomes part of monetary design: social distinctions are discussed collectively and may then be partially inscribed into the architecture of the system.

Taken together, these examples show that monetary self-determination appears as the situated capacity to make monetary rules discussable: what should be recognised, which actions should be encouraged, how circulation should be supported, which distinctions should be formalised, and where the risk of commodification should be contained.

4.3 Technological appropriation: automation, off-chain mediation and revisability

The two cases differ significantly in terms of who participates in the negotiation of the tokenised system and in the temporal depth of the process. In Turin, the co-design builds on COSO as a pre-existing community practice developed over several years around circular economy and sharing practices such as swap parties and library of things . The negotiation of token rules is therefore rooted in already sedimented relationships, vocabularies, resistances, and local meanings. In Aigaleo, by contrast, the tokenised system is being defined in a more mediated and project-driven way. Future users of the Community Lab have not yet been involved in the co-design of the socio-economic system and monetary architecture: their needs and expectations are filtered through local mediators and the technical development process, while direct experimentation with the platform is still pending. The underlying logic is learning by doing approach: the expectation is that the use of the Lab and CommonsHood will gradually generate collective reflection on economic practices and, eventually, a more active redefinition of the rules.

This difference also shapes the relation between monetary negotiation and technical formalisation in each case. In COSO, the decision to automate reward issuance through a smart contract reflects a degree of collective agreement sufficient to stabilise certain rules and encode them into the infrastructure. In Aigaleo, by contrast, manual issuance should not be presented simply as a deliberate choice against automation. It reflects a more contingent process of technological appropriation: local actors are still clarifying how CommonsHood can respond to the needs of the Community Lab, while the available functionalities do not yet fully match the emerging economic model/territorial needs. Manual use therefore becomes both a practical compromise and an exploratory mode of

appropriation. If the system cannot yet automate the relevant processes, actors can still test the infrastructure, use it partially, and keep open the definition of rules that may later require technical development. The distinction between automated and manual issuance is therefore not merely technical. It marks the boundary between what can be formalised within the existing architecture, what requires developer intervention or further platform evolution, and what must remain manual, off-chain, or socially mediated. In this sense, it directly conditions the revisability of the system over time. This point resonates with analyses of blockchain-based community currencies showing that automation and auditability do not remove the need for off-chain governance, social trust, and technical mediation. Once monetary rules are translated into smart contracts or platform parameters, their modification depends not only on collective agreement, but also on who can access, understand, and modify the technical architecture (Barinaga, 2020; Raffaelli and Nowak, 2025).

The choice between automation and manual issuance is therefore not merely technical. It marks the boundary between what can be formalised within the existing architecture, what requires developer intervention or further platform evolution, and what must remain manual, off-chain, or socially mediated. In this sense, it directly conditions the revisability of the system over time.

In both cases, technological appropriation emerges through the attempt to understand what the infrastructure can support, which distinctions can be formalised through token types, wallet permissions, access rules or automated issuance, and which aspects must remain manual, off-chain, or governed through organisational agreements. The cases therefore do not show collective control over the system, but the opening of a bounded space in which monetary rules can be discussed, partially stabilised, and translated into digital form. This space remains shaped by platform affordances, technical constraints, territorial facilitation, and the need to preserve part of the socio-economic model outside automated logic.

Read through the lens of social currencies, CommonsHood is relevant not only because it digitises exchange, but because it opens a limited space in which monetary rules and functions can be discussed as part of a broader process of defining a local socio-economic model, its values, and its operative features. In this respect, monetary self-determination shows the situated possibility of intervening in the practical definition of the monetary device: what it recognises, which relations it supports, how access is organised, and under

which conditions circulation is made possible. In tokenised systems, however, this capacity cannot be separated from the infrastructure through which monetary distinctions are formalised. Decisions concerning token types, permissions, access conditions, issuance rules and circulation mechanisms are monetary in content, but socio-technical in form. Technological appropriation therefore does not appear as a secondary or external issue; it is the mediated condition under which monetary self-determination can be partially enacted. The empirical cases have already shown these questions in concrete terms; analytically, what matters here is that they become discussible only through the joint negotiation of monetary rules and technical form.

For this reason, technological appropriation cannot be reduced to control over code or infrastructure. It concerns the shared construction of meanings, legitimate uses and operational rules through which technology becomes socially usable in a given context. But this appropriation is never unrestricted. The platform retains its own affordances and constraints; some functionalities can be adapted relatively easily, others require more substantial development, and still others remain outside the current scope of the tool. Published work on CommonsHood explicitly recognises this tension: a modular core structure is maintained, new functionalities may be added, and context-specific requirements continue to evolve, but expectations of high flexibility can conflict with technical constraints. This tension becomes especially visible in relation to smart contracts and automation. On the one hand, smart contracts may stabilise collectively defined rules and make tokenised interactions more transparent and operational. On the other hand, once rules are encoded, revising them is no longer simply a matter of collective discussion. More substantial changes may require new contracts or deeper technical intervention. This is one reason why several mechanisms remain off-chain, manual, or governed through complementary organisational arrangements.

Negotiation therefore becomes especially visible where collective expectations meet the sedimented architecture of the platform. Some requests can be translated into combinations or customisations of existing functionalities, while others encounter the limits of smart-contract logic, interface stability and development sustainability. The boundary between what can be formalised on-chain and what has to remain off-chain is therefore not merely technical. It marks a practical limit in the collective capacity to define access,

recognition, circulation and revisability, and thus in the extent to which monetary self-determination can be enacted through the infrastructure itself.

CommonsHood makes two things visible at once. On the one hand, tokenised systems may function as spaces in which communities, researchers and mediating actors attempt to define value, access, recognition and circulation in locally meaningful ways, within the shared horizon of a different socio-economic model oriented towards reciprocity, participation and collective use rather than market equivalence. On the other hand, this process is shaped from the beginning by platform affordances, technical limits, facilitation practices, legal constraints and the need to preserve part of the socio-economic system outside automated logic. The analytical relevance of CommonsHood lies precisely in this mediated space: it shows how collective monetary design becomes possible only through an equally situated negotiation of technological conditions.

4.4 Pedagogical mediation and social intelligibility

The previous subsections has shown that monetary self-determination and technological appropriation depend on the possibility of discussing value, recognition, and circulation. This possibility is not automatic. It requires mediation, vocabulary work, and practical learning, because neither money nor tokenised infrastructure becomes collectively governable if participants cannot understand what is being configured.

By making monetary rules, value attribution, access conditions and forms of recognition explicit, co-design does not merely configure a technical system. It creates a space in which participants can learn to interpret money as an institution that can be collectively questioned, adjusted and redirected towards shared socio-economic purposes. In this sense, appropriation concerns not only the use of the digital infrastructure, but also the collective capacity to make the monetary device intelligible, discussable and, at least partially, reshapable. This is the sense in which monetary experimentation retains its pedagogical and emancipatory potential: not as an automatic outcome of alternative circulation, but as a situated achievement of collective reflection and shared governance.

This is where the co-design and configuration of the platform, based on local requirements as part of the broader co-design of the tokenized system becomes especially important. The more challenging part of the process is not only co-designing digital tools themselves, but also defining the socio-economic models they are meant to enable. In this process,

facilitators do not simply collect preferences. They act as interpreters and mediators between social requirements and technical development. Their role is crucial because they translate technical possibilities into collectively discussable monetary choices. In CommonsHood, mediation allows non-technical actors to engage with questions that are monetary in content but socio-technical in form: token types, issuance rules, access conditions, recognised practices, circulation mechanisms, and the boundary between on-chain formalisation and off-chain regulation. In this sense, technological appropriation is inseparable from a wider process of translation in which local values and expectations must be reformulated in ways that can sustain specific rules of issuance, access, circulation and use. This is also the point at which the double mediation already anticipated in the presentation of CommonsHood becomes analytically decisive: territorial actors and facilitators filter what is locally appropriate or meaningful, while developers and technical constraints filter what is implementable. Active participation and formative processes are therefore not ancillary to monetary experimentation or technological appropriation. They are part of the conditions under which both become intelligible, collectively discussable, and sustainable over time. In COSO, this appeared in the work on vocabulary, in the need to distinguish recognition from market equivalence, and in the collective discussion of donation, volunteering, lending, and borrowing. In Aigaleo, the same issue appears in a different form: the possibility of monetary self-determination and technological appropriation is expected to emerge gradually through learning by doing, as the Community Lab and CommonsHood begin to be used in practice. In both cases, the monetary artifacts can be shaped only to the extent that participants, mediators, and developers learn to name, interpret, and question its rules. This is where the pedagogical dimension of social currencies becomes particularly important: just as monetary arrangements must be understood in order to be collectively shaped, tokenised infrastructures must become discussable and interpretable if any meaningful space of appropriation is to emerge.

The two cases also show that monetary self-determination and technological appropriation depend on pedagogical mediation. Participants can discuss token rules only if monetary and technical choices are made intelligible: what a token type does, what an issuance rule implies, what automation changes, and which parts of the system remain open to social negotiation. Facilitation is therefore not external to the tokenised system. It is one of the conditions through which monetary rules become discussable, technical constraints

become visible, and local actors can participate in shaping the system without being absorbed by technical language or platform logic.

5. Discussion

CommonsHood makes visible the institutional, relational and organisational labour required to construct a tokenised economic system grounded in local practices and relations. This is precisely the labour that tends to disappear when blockchain is treated as a neutral infrastructure for exchange. The case therefore addresses the gap identified at the outset by showing where social currency research and critical debates on blockchain for social good meet: in the situated negotiation through which monetary rules and digital infrastructures are shaped together.

5.1 Collective earmarking and mediated monetary self-determination

In tokenised systems, monetary design is technologically mediated from the beginning. Tokenisation is not an additional technical layer placed upon an already defined currency model, nor a simple digital continuation of social currency design. It is a process in which decisions about coordination, value, access, recognition and circulation must be translated into token types, platform constraints, access rules and forms of use. The comparison between COSO and Aigaleo makes this point visible in two different conditions. COSO shows how token rules can be negotiated within a longer community trajectory, where relations, vocabularies and resistances are already partially sedimented. Aigaleo shows a more mediated and exploratory situation, where future users have not yet entered the process of monetary definition and where revisability and learning by doing remain central to the possible appropriation of both the monetary device and the digital infrastructure.CommonsHood makes visible the institutional, relational and organisational labour required to construct a tokenised economic system grounded in local practices and relations. This is precisely the labour that tends to disappear when blockchain is treated as a neutral infrastructure for exchange. The case therefore addresses the gap identified at the outset by showing where social currency research and critical debates on blockchain for social good meet: in the situated negotiation through which monetary rules and digital infrastructures are shaped together.

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Read through the concept of social currencies, Commonshood reopens a distinctly monetary question. It asks how value is defined, which practices are recognised, who is allowed to participate, and which relations should remain outside token mediation. What the case makes especially clear is that such questions do not disappear when money becomes digital. They become more explicit, because distinctions around access, use, issuance, and recognition must be translated into operational terms. This is also where Zelizer's notion of earmarking becomes empirically productive. In tokenised systems, earmarking does not appear only as an informal social practice operating at the level of individual or household monetary uses. It also emerges as a collective and deliberative process during co-design, where the categorisation of token types results from negotiation grounded in shared values and project objectives. At the same time, it remains a situated practice of use, since participants may still assign meanings and purposes to tokens that exceed, reinterpret, or rework the distinctions formalised in the system.This confirms the theoretical point developed above: tokenisation does not create monetary differentiation from nothing, but makes some distinctions more explicit, discussable, and partially programmable within a digital infrastructure (Zelizer, 1994, 2005; Dodd, 2014; Maurer, 2017; O'Dwyer, 2023). The case of CommonsHood shows that access, recognition, reward, exchange, certification and governance can be separated and recombined through token types and platform rules. What matters, then, is not circulation in itself, but the social and organisational work through which monetary distinctions are stabilised, made intelligible, and attached to specific uses. However, this does not mean that design exhausts monetary meaning. Once tokens enter situated practices, participants may still reinterpret, contest, or rework the distinctions formalised in the system. The analytical issue is therefore not only

how earmarking is translated into token design, but also how far this translation remains open to revision, appropriation, and collective reinterpretation.

Participation is therefore crucial only if it affects the definition of monetary functions, rules, uses, and meanings. The fact that tokens circulate through a civic blockchain system does not make them social by default. In a broad sense, all money is social, since it is always embedded in institutions and social relations, shaped by and shaping it. The issue here is narrower and more concrete: whether the design of the tokenised system shifts, even partially, the capacity to intervene in the social differentiation of the monetary device - in its legitimate uses, its boundaries, and its forms of recognisable value. This is why the notion of monetary self-determination is preferable to any stronger claim about sovereignty. The point is the situated possibility for collective actors to re-enter questions that, in dominant monetary systems, tend to remain externalised and depoliticised. At the same time, CommonsHood allows understanding why this process remains fragile and incomplete. Monetary self-determination is constrained by limited time, uneven participation, asymmetries of knowledge, the need to adapt methods to different groups, and the technical limits of the platform itself. The participatory definition of token rules does not eliminate mediation. It multiplies it. Meanings and rules pass through facilitators, researchers, developers, existing functionalities, and broader organisational and digital constraints. Yet mediation is not only a limit. It is also where legitimacy is produced and stabilised - where some uses become acceptable, some rules actionable, and some interpretations of value effective.

Blanc's reflections (2006) are useful here in preventing a celebratory reading of bottom-up monetary experimentation. Social currencies do not automatically reach the most excluded, nor do they typically create formal employment or directly solve poverty. Their contribution often lies further upstream, in the constitution of networks, sociability, learning, access to resources, and the reactivation of practical capacities. Read in light of CommonsHood case, this suggests that tokenised systems should not be evaluated in terms of automatic emancipation, but in terms of the socio-technical conditions under which they may support participation, recognition, and collective capacity to intervene. It also raises a more specific question: who is effectively included in the process through which access conditions, recognised practices, and monetary distinctions are defined?

The same asymmetries that shape recognition also shape participation in co-design. The actors who take part in workshops and testing activities are not necessarily representative of all those who may later be affected by the tokenised system. Factors such as time availability, digital literacy, trust in mediators and initiators, care responsibilities, previous involvement in local associations, knowledge of participation calls. The ways in which local actors are identified and invited may shape who is able to participate and with what degree of influence. This does not invalidate the co-design process, but it prevents it from being read as a transparent expression of "the community" as a whole. From the perspective of social currency research, this is crucial: monetary self-determination cannot be assessed only by asking whether participation occurred, but also by observing whose needs, practices, objectives, and definitions of value entered the monetary architecture, and whose remained marginal or absent.

Technological appropriation and monetary self-determination cannot be understood as spontaneous or disintermediated processes precisely because they depend on mediation, facilitation, and translation among heterogeneous actors - community participants, local mediators, researchers, and developers - who contribute through different roles, forms of expertise, and degrees of influence. Power, in this context, does not depend only on technical capacity or formal authority, but also on whose interpretations are taken into account, translated, and allowed to shape the design process.

The role of mediators is closer to the formative and pedagogical dimension already present in social currency experiments: they help make the monetary device intelligible, its rules discussable, and its possible uses open to collective interpretation. In CommonsHood, this mediation concerns both the technical infrastructure and the monetary architecture, since their features and forms must be translated into what non-technical actors can understand and negotiate. Mediation is therefore the point at which monetary self-determination and technological appropriation meet: it allows the collective redefinition of monetary architecture to take place within a digital infrastructure without being absorbed by technical language, platform constraints, or asymmetries of expertise. In this respect, pedagogy is not an external addition, but one of the practical conditions of appropriation.

5.2 Civic blockchain, trust and revisability

This also resonates with work on civic blockchain that questions the political neutrality of digital technologies. Lapaolo et al. (2023) show that the political relevance of civic

blockchain does not lie only in its declared purposes, but in the imaginaries, practices, organisational forms, material infrastructures and codes through which it is designed and used. In CommonsHood case, this means that the democratic potential of the infrastructure cannot be inferred from blockchain properties such as transparency, decentralisation or traceability. It depends instead on whether these technical features are embedded in situated processes through which local actors can understand, discuss and reshape the monetary and organisational rules that the infrastructure makes operative and the features of infrastructure itself.

That question has a further dimension in tokenised settings, where the risk of behavioural quantification becomes relevant. In tokenised civic systems, practices such as reuse, care, participation, reciprocity or community engagement may become visible and recognisable through rewards or token rules. Yet this visibility is not neutral. If these practices are translated into rewardable units without collective reflection on the values that should orient recognition, tokenisation may reproduce a form of commodification: it may turn socially and environmentally meaningful practices into measurable behaviours detached from the relations and purposes that give them meaning. This is why the problem is not simply whether an action can be tokenised, but who defines the criteria of recognition, which values guide that definition, and whether participants can contest or revise it over time.

This point also helps address the so-called trustlessness of blockchain. In blockchain-based social currency systems, security, transparency and auditability may support some technical and organisational conditions of trust, but they cannot replace the social construction of trust required for a monetary community to emerge and endure. The case of Moneda PAR is instructive in this respect: Valdecantos et al. (2025) show that blockchain may strengthen methodical and hierarchical trust, but sustained adoption still depends on social bonding, market-building, and the consolidation of relations, needs, and productive capacities within a specific territory. This argument is directly relevant for CommonsHood. Civic blockchain may enable new forms of socio-economic interaction and provide tools for incentivising cooperative practices (Viano et al., 2022), but these possibilities do not become effective through token issuance and circulation alone. The current stage of CommonsHood development shows how co-design can work upstream on the social, organisational and pedagogical conditions under which meaningful circulation may later become possible. From this perspective, the issue is not only whether tokens circulate, but

whether the local circuit is socially intelligible, organisationally supported, and sufficiently connected to concrete needs, capacities, values and objectives. Economic sustainability is therefore approached not as an achieved outcome, but as a condition to be progressively constructed through social bonding, mediation, facilitation and the consolidation of a locally grounded socio-economic circuit. This tension is also highlighted by Raffaelli and Nowak (2025), who analyse Moneda PAR as a case where blockchain-based complementary currency experimentation raises questions about empowerment, technical dependency and the relation between democratic and technocratic forms of social innovation.

The same argument also clarifies the distance between civic token systems and the monetary imaginary criticised by Ingham in relation to cryptocurrencies. This also clarifies why CommonsHood should be distinguished from the cryptocurrency imaginary criticised by Ingham. Ingham (2020) shows that Bitcoin was presented as superior to conventional money on three main grounds: its algorithmically limited supply, intended to imitate the scarcity of gold and avoid the alleged excesses of fiat money and bank credit; the security of encryption, presented as safer than conventional banking infrastructures; and the promise of anonymous ownership, supposedly comparable to cash. Ingham's critique is useful here because it shows that these claims do not remove the social and institutional foundations of money. Artificial scarcity did not prevent speculation and bubble dynamics; cryptographic security did not eliminate infrastructural vulnerability; and anonymity did not replace the need for trust, authority and institutional mediation.

CommonsHood moves in a different direction. It does not propose a scarce cryptocurrency designed to replace state or bank money. Nor does it treat trustlessness as a substitute for social relations. In the cases examined here, the issue is not to create a universally scarce digital asset, but to define bounded tokenised circuits in which different token types perform different functions: access, recognition, exchange, reward, certification and governance. Issuance is therefore not grounded in artificial scarcity, but becomes a design and sustainability problem: who can create tokens, under which rules, for which practices, and with what effects on circulation. At the current experimental scale, the risk of over-issuance remains limited, but it becomes analytically relevant as soon as rewards, community tokens and automated mechanisms expand. The question is therefore not how to imitate the scarcity of commodity money, but how to balance liquidity, use-value, recognition and revisability within a local circuit.

The role of cryptographic security and smart contracts should therefore be read in civic and institutional terms. They may provide security, traceability, operational stability, and a clearer record of actions that a community decides to recognise. Yet they do not replace social trust, off-chain agreements, facilitation, or collective governance. On the contrary, the more rules are technically formalised, the more revisability becomes central. Smart contracts can stabilise collectively defined rules, but they can also make later changes more difficult, especially when modification requires new technical intervention or developer mediation. Revisability is therefore not a residual technical issue. It is a criterion for assessing whether a tokenised civic infrastructure remains open as an institutional space or becomes a closed technical architecture. In CommonsHood, this criterion concerns the possibility of reopening token rules, access conditions, issuance mechanisms, recognised practices, and off-chain arrangements after they have been formalised. From this perspective, civic digital infrastructures cannot be evaluated only through initial participation, accessibility, or local adaptation. They must also be assessed through their capacity to remain intelligible, adjustable, and contestable over time.

This brings the argument back to soft infrastructure. As Cardullo and Kitchin (2025) show, democratic digital infrastructures depend not only on technical configurability, but also on the social, institutional, and organisational arrangements that sustain adaptation and collective governance. Applied to CommonsHood, this means that revisability depends not only on whether platform parameters can be modified, but also on mediators, shared understandings, organisational capacities, and off-chain agreements through which communities can reopen decisions after technical formalisation.

5.3 Accessible monetary design and the institutional life of tokenised currencies

The broader implication is therefore twofold. For social currency research, tokenised civic infrastructures displace the central question from whether communities can institute ‘other monies for others economies’ to the socio-technical conditions under which they can continue to shape them, once monetary distinctions are formalised through digital architectures. For civic technology research, the same point shows that democratic infrastructures cannot be defined only by participation, accessibility, or local adaptation, but also by the mechanisms through which collectively defined rules remain open to interpretation, contestation, and revision over time. Mediation, formative processes, and the boundary between on-chain rule-setting and off-chain negotiation are therefore not

secondary elements. They are part of the institutional life of the currency itself. CommonsHood suggests, in this sense, that research on social currencies in tokenised settings should point towards a broader concern with accessible monetary design. What matters is not the technological promise as such, but whether the infrastructure can sustain the practical conditions - mediation, formative processes, off-chain arrangements, and organisational support - through which monetary rules are collectively defined, made intelligible, and kept contestable and revisable after formalisation.

This is, ultimately, the condition under which a tokenised system can remain an open institutional space rather than a closed technical architecture: one in which communities retain, however partially, the possibility of asking what the monetary artifact is for, who it serves, and how it should be changed.

6. Conclusions

This paper investigated how monetary self-determination and technological appropriation take shape when social currency principles are translated into a civic blockchain infrastructure for locally grounded collaborative economies. By analysing CommonsHood, it has shown that this translation is neither a simple digitalisation of social currency practices nor a purely technical innovation. It is a socio-technical process in which monetary questions - what is recognised, who may participate, how tokens are issued, which practices are rewarded, and which rules are automated or kept off-chain - become matters of both collective design and technical configuration.

The case shows that monetary self-determination takes shape as a form of collective monetary agency rather than as monetary sovereignty. It does not claim the legal-institutional authority to create sovereign money, but concerns the collective determination of a monetary architecture oriented by shared values and by a desired territorial socio-economic model. This involves the capacity of collective actors to define, discuss and configure the monetary functions, access conditions, recognised practices and circulation rules of a situated monetary artefact. Technological appropriation follows a parallel path: it concerns the capacity to make the digital infrastructure interpretable, usable and revisable within local practices. Both processes depend on mediation, facilitation, learning, translation among actors, and the organisational arrangements that allow communities to engage with technical constraints without being absorbed by them. In CommonsHood, this agency is exercised through co-design, mediation and technical translation, where social

currency principles are transformed into token types, platform rules and off-chain arrangements.

The main conclusion is that civic token systems should not be assessed only by asking whether tokens circulate or whether blockchain functions are available. The more relevant question is how these functions are appropriated for collective purposes, how they contribute to the construction of shared meanings, and whether they remain understandable, negotiable and revisable after formalisation. CommonsHood shows that the political and pedagogical processes developed within social currency experiments remain central in tokenised settings: programmable infrastructures make monetary distinctions more explicit, but they also expose them to new asymmetries of expertise, access and control.

The meeting point between social currency research and civic blockchain research is therefore the problem of accessible monetary design. This does not concern only the technical configuration of tokens, but the prior collective work through which a community defines what the monetary artefact is for, who it serves, what it represents, how it should circulate, and how it may be changed over time. In this sense, accessible monetary design is the practical condition through which monetary self-determination and technological appropriation can take shape together.

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DETERMINING KEY FACTORS OF HIGH-IMPACT COMMUNITY CURRENCIES – A COMPARATIVE ANALYSIS OF 9 CASES FROM AROUND THE WORLD

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Abstract

This article focuses on community (or: local/social) currencies and seeks to determine key factors that support local currencies having strong economic and social impacts. The article focuses on the methodology, case-selection, and execution of a comparative analysis of 9 different community currencies from Latin America, Europe and Africa to corroborate the identified (potential) key factors. The methodology employed is based on Qualitative Comparative Analysis combining qualitative and quantitative elements. The results broadly corroborated the key factors, providing valuable insight for practitioners and current debates within the (international) community of local currencies.

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1. Introduction

It has been almost 100 years since the first community currency –the German "Wära" (1929)– sprang up during the Great Depression. The history of local currencies reflects their enormous variety: from the "labor certificates" issued by the municipality of Wörgl (Austria) levied with a Gesellian *demurrage*-fee, to the Argentine "Créditos" being a mutual-credit-system that expanded from a garage in Buenos Aires to reach millions of households some 6-7 years later, to the case of the "Mumbuca" as a digital municipal community currency currently paying (among others) a monthly basic income benefiting more than 100,000 low-income citizens while helping the local economy flourish (Onken, 1997; Gómez, 2019; Silva and Amaral, 2023).

Against this background, a crucial question for practitioners and observers alike is why some local currencies expand and generate higher economic and social impacts in their communities than others. Which are the key factors that enable a community currency to reach a large number of people and strong economic benefits? This article seeks to identify and corroborate potential key factors that favor community currencies having strong economic (and social) impacts by way of a comparative analysis.

This paper is a derivative of a (more extensive) ongoing doctoral research project. Although considering cases from around the world, the research project (and article) puts a special emphasis on Mexico and Latin America. Furthermore, it is important to clarify that although there are other forms of social complementary currencies –such as Local Exchange Trading Systems (LETS) or time banks– this research is limited to community currencies using physical bills and/or electronic payment systems (debit/credit-cards and mobile apps).

The methodological approach chosen for this investigation is a combination of case studies (e.g., Villarreal and Landeta, 2010) –based mainly on existing literature and semi-structured interviews– as well as the Qualitative Comparative Analysis (QCA) approach. The QCA was popularized particularly by Ragin (2000; 2005) and can be classified as a mixed methodology that incorporates both qualitative and quantitative elements. More precisely, this method is based on Boolean algebra with a coding system from 0 ("full nonmembership": factor not present at all) to 1 ("full membership": factor 100% present). Instead of being limited to binary coding (yes/no) corresponding to "crisp sets", here "fuzzy sets" were applied using different scales of certain variables. This way, continuous fuzzy sets allow assigning a score

(between 0 and 1) with respect to the "membership" (i.e., conformity) of a case with a given variable (Ragin, 2005; Rosati and Chazarreta, 2017).

Before presenting the selection of cases to be analyzed, it is necessary to explain the variables scrutinized in the comparative analysis, corresponding to five potential key factors of high-impact community currencies. These variables resulted from an exhaustive review of existing literature, as well as theoretical insights on community currencies and economic theories (e.g., Wray, 2004; Kennedy et al., 2012; Zeller, 2020).[4] The key factors and their rationale are the following:

(1) **Economic and social hardships**: the greater the economic (and social) hardships in the region of implementation, the greater the impact of the community currency;

(2) **Government/institutional support**: the greater the government/institutional support, the greater the impact of the community currency;

(3) **Ample opening hours**: the longer the opening hours of participating businesses, the greater the impact of the community currency (in contrast to currencies used only on special market days or other events);

(4) **Backing by official currency**: the more backing by official money, the greater the impact of the community currency;

(5) **Ease of use**: this factor consists of three sub-factors that are considered favorable for the impact of community currencies: nominal parity (1:1) with official money, full acceptance (100%, i.e., no "mixing" of community and official currency), and the absence of a *demurrage*-fee (holding costs/negative interest rates). This category might also include other (less common) practices that affect the ease of use (or circulation) of the community currency.

These five variables were explored as part of the presentation/analysis of each case study concluding with a figure indicating and explaining the score from 0 (full non-conformity with case) to 1 (full conformity with case) for each key factor according to the QCA-methodology for continuous fuzzy sets.

[4] A detailed account of how the variables were created can be found in the ongoing doctoral thesis.

Figure 1: Scoring system for each (potential) key factor

Potential key factor	**Scoring system** (according to QCA)
Economic and social hardships	No hardships (0) to a lot of hardships (1)
Government / institutional support	No support (0) to a lot of support (1)
Ample opening hours	Market day or event (0) to ample, universal opening hours (1)
Backing by official currency	Not backed (0) to 100% backed (1) by official currency
Ease of use (average value of the three sub-variables or other factors if applicable)	Nominal parity: difficult rate (0) to 1:1-rate (1)
	%-rate of acceptance of community currency: difficult %-rate (0) to 100%-acceptance (1)
	Demurrage: with demurrage-fees (0) to no demurrage-fees (1)

Before diving into the analysis of the cases and key factors, it is necessary to explain the selection of cases which is the objective of the next section.

2. Comparative analysis of community currencies

In the following, the rationale and process of the case-selection are presented, followed by short summaries of the chosen cases, alongside the final scoring and discussion of the key factors/variables of the comparative analysis.

2.1 Selection of cases

First, it is necessary to explain the logic behind the case-selection that defined the community currencies to be included in the comparative analysis. This process was based on two criteria: the number of users of the community currency and the economic benefits they generate/d. The subsequent selection of 13 historical and current community currencies is not to be considered exhaustive with some cases left out due to limitations of scope or special focus of the investigation.

The selection criteria were based to some extent on the categorization of Seyfang and Longhurst (2016), whose “diffusion success”-metric used a benchmark that measures the number of users of the complementary currency. The authors’ other two variables – “replication” and “translation” in other contexts– were not considered here but did influence some cases. Similarly to Seyfang and Longhurst (2016), values of 0 (not applicable or no data) to 3 (high coincidence with the criterion in question) were used. The criteria are summarized in the following table 1:

Table 1: Case selection criteria

	Score			
Criterion	**0**	**1**	**2**	**3**
Users	N/A	1-200	201-1000	> 1000
Economic benefits	N/A	few	medium	high

For the criterion “Economic benefits” it was more difficult to establish such a clear-cut indicator due to the disparity and general lack of information. However, some data does exist for several community currencies, particularly larger ones. For example, in the case of the Argentine “Créditos” there were different estimates, including those regarding the macroeconomic impact (% of Gross Domestic Product); or for the Kenyan “Sarafu” (and its precursors) surveys indicated additional income for participants (in %), among others (Colacelli and Blackburn, 2009; Ruddick et al., 2015). However, there is no common benchmark indicator.

Another important point to highlight is that the selection of cases did not focus solely on high-impact community currencies, but also included other projects that have/had a medium or lower impact. This aimed to provide greater validity to the comparative analysis by using a modified form of control groups, a tool more common in quantitative experimental methods. However, when implemented without interfering with the natural context, control groups are also used in qualitative methods, particularly comparative ones (Lloyd, 2003; Ragin, 2008).

The following table 2 records the 13 cases that were considered in the shortlist for the selection. It is essential to mention that, for example, in Brazil there might be more community currencies that qualify as high-impact cases (such as the “Arariboia” in Niterói) but those cases share many similarities with the “Mumbuca”, which was chosen as “representative” being the pioneering (and largest) Brazilian municipal community currency (Scalfoni and Torres, 2022; Silva and Amaral, 2023). Several Mexican community currencies were also included due to the research focus mentioned above.

Table 2: Shortlist of community currencies for case selection

Potential community currencies for case selection
"Labor certificates" used in Wörgl, Austria
"Chiemgauer" circulating in Bavaria, Germany
"Créditos" used in barter markets in Argentina
"Eusko", circulating in the Basque Country region, France
"Grama", circulating in Santa Coloma Gramenet, Spain
"Mixiuhca" circulating in Mexico City, Mexico
"Mumbuca" circulating in Maricá, Brazil
"Palmas" circulating in a neighborhood of Fortaleza, Brazil
"Sarafu" circulating in different locations in Kenya
"Sardex" circulating on the island of Sardinia, Italy
"Tlaloc" used in Mexico City, Mexico
"Túmin" circulating in several locations in Mexico
"WIR", circulating in Switzerland

After the analysis of those 13 (historical and current) community currencies, the following table 3 summarizes the scores of each case. Furthermore, based on these scores, the cases were categorized into three different groups: projects with high, medium and lower economic impact, in addition to two special cases and two community currencies (of medium impact) that were excluded from the analysis, mainly to reduce the length of the research.

Table 3: Results and clustering of case selection

Impact (group)	Community currency	Score	
		Scope	Econ. Ben.
High	"Labor certificates" (Wörgl, Austria)	3	3
	"Créditos" (Argentina)	3	3
	"Palmas" (Fortaleza, Brazil)	3	3
	"Sarafu" (Kenya)	3	3
	"Mumbuca"(Maricá, Brazil)	3	3
Medium	"Chiemgauer" (Bavaria, Germany)	3	2
	"Túmin" (Mexico)	3	2
Lower	"Tlaloc" (Mexico City, Mexico)	1	1
	"Mixiuhca" (Mexico City, Mexico)	1	1
Special	"WIR" (Switzerland)	3	3
	"Sardex" (Sardinia, Italy)	3	2
Excluded	"Grama"(Sta. Coloma Gramenet, Spain)	3	2
	"Eusko" (Basque Country region, France)	3	2

Five of the six community currencies with the maximum score of 3 and 3 were grouped into the high-impact group, while the medium-impact- (high scope and medium economic benefits) and lower-impact (limited scope and economic benefits) community currencies served as control groups, each consisting of two community currencies (three of these being Mexican). Thus, a total of 9 cases were considered in the comparative analysis.

As shown in table 3, the cases of "Grama" and "Eusko" were excluded due to the scope of the investigation. However, the conceptual models of both of these European community currencies are similar to the "Mumbuca" (in the case of the "Grama") and to the "Chiemgauer" (in the case of the "Eusko") which both were included in the comparative analysis (Muns et al., 2019; Edme-Sanjurjo et al., 2020).

Furthermore, it was decided to cover the "WIR" and "Sardex" cases in a separate and condensed manner in the (ongoing) doctoral investigation. Beyond the need to limit the scope of the comparative analysis, the main reason lies in the case of the "WIR", which –given its history, conceptual design, and recent trends– is somewhat unique and difficult to assess using the chosen methodology based on QCA. Created during the despair of the Great Depression, it became a regulated cooperative bank –with traditional financial services in Swiss Francs as its core business– in one of the world's richest countries. And the "WIR" is not backed by Swiss Francs but informal exchanges have existed. The "Sardex", on the other hand, was inspired heavily by the "WIR" but shares some characteristics with other community currencies, for example, the "Créditos", "Túmin" and "Sarafu", which were covered in the comparative analysis (Studer, 1998; Kennedy et al., 2012; Littera et al., 2017).

2.2 Description and analysis of selected cases of community currencies

In the following, the nine selected community currencies are presented (due to the limited space here) by way of short summaries, focusing on the mentioned key factors. After each summary a figure is provided indicating and briefly explaining the scores (for the above mentioned five variables) of the respective case.

1) "Labor certificates" used in Wörgl, Austria (historical case: 1932 – 1933)

The "labor certificates" were the first community currency to be widely disseminated mainly because of their economic success ("Miracle of Wörgl") –due to a virtuous cycle of investment, multiplier effect and tax payments– which contrasted sharply with the misery

during the Great Depression in the rest of Austria. Issued by the municipality itself, this community currency was 100% backed by official currency at a 1:1 "exchange rate" and included the concept of *demurrage* (holding costs) in the form of stamps that were stuck on the banknotes each month. Just over a year after its launch, this highly successful project was prohibited on behalf of the Austrian central bank (Onken, 1997; Schuldt, 1997; Kennedy et al., 2012).

Figure 2: Summary of key factors of Wörgl's "labor certificates"

Key factor	Score	Explanation
Economic and social hardships	**0,9**	Wörgl was relatively prosperous but experienced severe economic hardships during the Great Depression.
Government / institutional support	**1**	Issued and promoted by the municipality; its prohibition is not considered here.
Ample opening hours	**1**	Used during regular opening hours, in salaries and (public) investments.
Backing by official currency	**1**	100% backed by official currency.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,7**	1:1 parity; full (100%) acceptance; with demurrage-fee.

2)"Créditos" used in barter markets in Argentina (historical case: 1995 – 2003)

The barter clubs originated in Argentina during a severe economic and social crisis that culminated in the *Corralito* (2001-2002), which simultaneously fueled the explosive growth of the "Créditos" with thousands of *Clubes de Trueque* (barter clubs/markets, also called *nodos*) and millions of users. The "Créditos" were community currencies based on mutual trust, with a nominal parity of 1:1 to the Argentine peso but without backing by or exchange to official currency. The markets were held once or more per week, but many participants attended several *nodos* and could use their "Créditos" practically all week. The relation with governmental institutions was a controversial issue between the two main factions of this ecosystem –the *Red Global* vs. the *Red Solidaria*– but in any case, the "Créditos" had the support of different public entities since 1997. Around the time of their maximum extension in 2002, the "Créditos" suffered from several inflationary and fraudulent practices that caused the implosion of the system during the same year (Primavera, 2002; Hintze, 2003; Gómez, 2019).

Figure 3: Summary of key factors of Argentine "Créditos"

Key factor	Score	Explanation
Economic and social hardships	**0,9**	Severe socio-economic hardships during the Argentine crisis (especially 2001-2002).
Government / institutional support	**0,8**	Gov't. support from various sides (although being a controversial issue).
Ample opening hours	**0,5**	Market day-opening hours but ample availability of barter markets, including some transactions outside of markets days.
Backing by official currency	**0**	Not backed by official money.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**1**	1:1 parity; % full acceptance (100%), including in different "nodos"; no demurrage.

3) "Palmas" circulating in a neighborhood of Fortaleza, Brazil (2002 – present)

The "Palmas" in their earliest form (1998: "PalmaCards") were essentially cardboard cards where users manually recorded their purchases. Eventually those cards evolved into "Palmas" paper bills and nowadays exist (exclusively) in the form of debit cards/app as e-money ("e-dinheiro"), all versions issued through microcredits by Banco Palmas. The "Palmas" are backed 1:1 by and can be exchanged to official currency (Real), and are being used in the (formerly very poor) neighborhood *Conjunto Palmeiras* in Fortaleza, Brazil. In their current form (e-money) there is a 2% transaction-fee levied on commercial vendors. With the support of the first government of Lula Da Silva (2003-2011), Banco Palmas extended its community bank-model (and the "e-dinheiro"-platform) throughout the country, being crucial to, arguably, the most dynamic community currency sphere worldwide at present (Carvalho et al., 2012; Ansorena et al., 2021; Melo, 2023).

Figure 4: Summary of key factors of the "Palmas"

Key factor	Score	Explanation
Economic and social hardships	**0,9**	Initially very severe structural economic and social hardships in Conjunto Palmeiras.
Government / institutional support	**0,8**	Supported by federal government, *Banco do Brasil* and others.
Ample opening hours	**1**	Used during regular opening hours.
Backing by official currency	**1**	100% backed by official currency.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,7**	1:1 parity; % full acceptance (100%); no demurrage; but 2% transaction-fee.

4) "Sarafu" circulating in different locations in Kenya

The "Sarafu" is one of the most technologically advanced community currencies in the world. This is all the more impressive considering the meso and macro environment in Kenya, characterized by strong economic and social hardships and the lack of government support for the project. The history of this community currency reflects sustained growth, along with significant conceptual changes, particularly regarding the backing by and exchange to official money, from its precursors "Eco-Pesa" and "Bangla-Pesa" to the "Sarafu" mutual credit system with various mechanisms to balance and absorb potential imbalances among participating enterprises (Ruddick, 2011; Ruddick et al., 2015; Ussher et al., 2021).

Figure 5: Summary of key factors of "Sarafu" (including "Eco-Pesa"/"Bangla-Pesa")

Key factor	Score	Explanation
Economic and social hardships	**1**	Severe hardships in the slums/communities where "Sarafu" operated / operates.
Government / institutional support	**0,3**	Few government support but some help from international cooperation and donations.
Ample opening hours	**1**	Used during regular opening hours.
Backing by official currency	**0,5**	Since 2013 it has not been backed by official money; however, there are mechanisms that function as partial backing.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,8**	1:1 parity; full acceptance (100%); previously, mechanisms similar to demurrage-fee.

5) "Mumbuca" circulating in Maricá, Rio de Janeiro, Brazil (2013 – present)

The "Mumbuca" was not only the first Brazilian municipal community currency, but has also become a national and international benchmark since its creation. It is the largest community currency in Brazil and a cutting-edge technological project that developed its own e-money system (debit cards and a mobile app). The "Mumbuca" is issued by the Banco Mumbuca as a basic income (among other social benefit-payments) through municipal funds. Therefore this community currency is backed by and inter-changeable to official currency (1:1). Several studies support the significant economic and social impact of the "Mumbuca" especially on the beneficiaries of its social payment programs, but also

participating small businesses and local employment (Silva de Faria et al., 2022; Banco Mumbuca, 2023; De Souza, 2019).

Figure 6: Summary of key factors of the "Mumbuca"

Key factor	Score	Explanation
Economic and social hardships	**0,7**	Structural economic and social hardships (not extreme, but stronger among beneficiaries).
Government / institutional support	**1**	Created and funded by the Municipality of Maricá.
Ample opening hours	**1**	Used during regular opening hours.
Backing by official currency	**1**	Backed by official currency.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,8**	1:1 parity; full acceptance (100%); no demurrage; but 2% transaction-fee (soon to be abolished).

6) "Chiemgauer" circulating in Bavaria, Germany (2003 – present)

The "Chiemgauer" is one of the longest-standing and well-established community currencies in Europe and the world, serving as a benchmark for other local currencies such as the "Eusko" and "BerkShares". With a more traditional model backed by official currency (1:1) and a *demurrage*-fee, it has grown thanks to the great commitment of its founders and many individuals and businesses in the region. This community currency eventually incorporated innovations such as electronic money and a "climate-bonus". Despite its considerable (nominal) sales volume, the economic impact of the "Chiemgauer" is limited, as the project focuses more on social and environmental issues (Gelleri, 2009 and 2022; Gelleri and Stodder, 2021).

Figure 7: Summary of key factors of the "Chiemgauer"

Key factor	Score	Explanation
Economic and social hardships	**0**	Few economic, social and structural hardships.
Government / institutional support	**0,3**	Supported by the local *Waldorf*-school, later collaboration with Savings/Cooperative Banks.
Ample opening hours	**1**	Used during regular opening hours.
Backing by official currency	**1**	Backed by official currency.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,7**	1:1 parity; full acceptance (100%); with demurrage-fee.

7) "Túmin" circulating in several locations in Mexico (2010 – present)

Since 2010, the "Túmin" has become the largest community currency in Mexico, expanding from its origins in Veracruz to other regions (with almost 3000 users in 2023), particularly in southern Mexico where economic and social hardships are most prevalent. Its model is based on mutual trust (not backed by official currency) among the network's members/businesses, with nominal parity (1:1) to the Mexican peso and a minimum acceptance rate of 10% which means that payments involve mixing "Túmin" and pesos. Also, its organizational structure shows an affinity for cooperative principles with a fundamental skepticism towards larger government or private entities. The "Túmin" is exclusively a paper currency. There is no data on transactions, volumes, etc. of this community currency, but a qualitative study and especially its gradual growth in users suggest positive economic impacts (Junta de Buen Gobierno, 2014; Consejo General del Túmin, 2023; Hernández et al., 2017).

Figure 8: Summary of key factors of the "Túmin"

Key factor	Score	Explanation
Economic and social hardships	**0,8**	Structural economic and social hardships.
Government / institutional support	**0,3**	Few gov't. support but limited partnerships with universities and municipalities.
Ample opening hours	**1**	Used during regular opening hours.
Backing by official currency	**0**	Not backed by official money.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,7**	1:1 parity; limited acceptance-rate (min. 10%); no demurrage-fee.

8) "Tlaloc" used in Mexico City, Mexico (historical case: 1996 – 2014)

The "Tlaloc" was one of the first community currency experiences, not only in Mexico (where it is considered a pioneer), but also in Latin America. The model shared some features with the Argentine "Créditos" in terms of its operation on specific market days and the lack of backing in official currency. This community currency was not issued at par with the official currency (1 "Tlaloc" = 25 Mexican pesos) with a smaller unit called "Tequio" (parity 1:1 with pesos) and a 20% minimum acceptance rate. In its initial phase, the "Tlaloc" was used by a larger number of people (approx. 100 per month), a figure that later decreased during smaller meetings every two weeks. The "Tlaloc" ceased circulation in 2014, leaving an

important legacy of example and inspiration (incl. certain conceptual points) for subsequent/current Mexican community currencies (Lopezllera and DeMeulenaere, 2000; Santana, 2008; Collin, 2007).

Figure 9: Summary of key factors of the "Tlaloc"

Key factor	Score	Explanation
Economic and social hardships	**0,7**	Certain economic and social deficiencies.
Government / institutional support	**0,1**	Few to no gov't. or institutional support.
Ample opening hours	**0**	Market day-opening hours (limited).
Backing by official currency	**0**	Not backed by official money.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,3**	Parity: 1:25, then 1:30 and 1:50 (changing); limited acceptance-rate (min. 20%); no demurrage.

9) "Mixiuhca" circulating in Mexico City, Mexico (2010 – present)

The "Mixiuhca," along with the "Túmin," is the oldest active community currency in Mexico. Its model is heavily inspired by the "Tlaloc," operating as a market-day currency (currently held once a month) where both members and "solidarity consumers" from outside gather to buy (and sell) products. Circulation of the "Mixiuhca" (parity: 1 "Mixiuhca" = 5 Mexican pesos) is limited to members, whereas the auxiliary currency "Cacao" (parity 1:1 to pesos) is used by everyone. While this community currency is not backed by official currency, "Cacaos" can be exchanged for pesos on the market days. The acceptance rate for "Mixiuhca" varies from 50-100% and members are bound to sign this paper-currency upon exchange. Although some additional and higher-quality products (and services) are available to its members, the project's impact can be found more on a social and cultural level (Caballero et al., 2021; C. Caballero, personal communication, November 25, 2025[5]).

[5] Interview conducted on the 25th of November 2025 as part of the (ongoing and still unpublished) doctoral thesis.

Figure 10: Summary of key factors of the “Mixiuhca“

Key factor	Score	Explanation
Economic and social hardships	**0,6**	Certain economic and social hardships.
Government / institutional support	**0**	No public support.
Ample opening hours	**0,2**	Market day-opening hours (limited), sometimes also used outside of fairs.
Backing by official currency	**0**	Not backed by official money.
Ease of use (parity 1:1, easy %-rate of acceptance, no demurrage-fee)	**0,3**	Parity 1:5; broad acceptance rate 50-100%; no demurrage but signatures are used on bills.

2.3 Comparative analysis

The following table 4 summarizes the scores assigned to the key factors of the various case studies. As mentioned, the analysis and the subsequent figures were based on the Qualitative Comparative Analysis (QCA) methodology, specifically continuous fuzzy sets. Additionally, the cases were grouped by their level of impact (high, medium, and lower), and sums and averages were provided per case and per factor (for each group). This is followed by a brief description and discussion of the comparative analysis.

Table 4: Synthesis of the comparative analysis

Impact-group	Case	Socio-econ. hardships	Gov't. / inst. support	Ample ope-ning hours	Backing by off. currency	Ease of use (3 sub-var.)	Total (per case)
High	**LC of Wörgl**	0,9	1	1	1	0,7	4,6
	Créditos	0,9	0,8	0,5	0	1	3,2
	Palmas	0,9	0,8	1	1	0,7	4,4
	Sarafu*	1	0,3	1	0,5	0,8	3,6
	Mumbuca	0,7	1	1	1	0,8	4,5
	Average (factor)	0,9	0,8	0,9	0,7	0,8	4,1
Medium	**Chiemgauer**	0	0,3	1	1	0,7	3
	Túmin	0,8	0,3	1	0	0,7	2,8
	Average (factor)	0,4	0,3	1,0	0,5	0,7	2,9
Lower	**Tlaloc**	0,7	0,1	0	0	0,3	1,1
	Mixiuhca	0,6	0	0,2	0	0,3	1,1
	Average (factor)	0,65	0,05	0,1	0	0,3	1,1

* The case of the "Sarafu" includes the precursor projects "Eco-Pesa" and "Bangla-Pesa"

Regarding the results of table 4 at a first glance, it is worth noting that:

- The case with the highest score was the "labor certificates" of Wörgl (4.6), closely followed by the "Mumbuca" (4.5) and "Palmas" (4.4). The average score in the high-impact group was 4.1.
- The medium-impact cases had scores of 3 ("Chiemgauer") and 2.8 ("Túmin") respectively (average of 2.9). Both lower-impact cases ("Tlaloc" and "Mixiuhca") showed scores of 1.1.
- Analyzing only the factors in the high-impact group, the factors with the highest validation/average were "Socio-economic hardships" and "Ample opening hours", both with an average of 0.9. These were followed by the factors "Government/institutional support" and "Ease of use" with averages of 0.8. The least consistent (and therefore somewhat ambiguous) key factor in the high-impact group was "Backing by official currency" with an average of 0.7.

Diving a little deeper into table 4, from an analytical and comparative perspective, the following is worth mentioning[6]:

- In general terms, the comparative analysis corroborated the key factors. In other words: there indeed is a correlation between the key factors and the economic and social impact of the analyzed cases. This can be confirmed by the subsequent points:
  - The average value of the sums of the scores per case: high-impact group: 4.1 vs. medium-impact group: 2.9 and lower-impact group: 1.1.
  - Any case in the high-impact group had a higher score than in the medium-impact group: the "Chiemgauer" with 3 (highest score in the medium-impact group) versus the "Créditos" with 3.2 (the lowest score case of the high-impact cases). Also, the average (2.9 vs. 1.1) and lowest absolute score (2.8 vs. 1.1) of the medium-impact group were higher than the scores of the lower-impact group.
- Comparing the key factors across the different impact groups, it can be argued that the clearest of the five variables analyzed is "Government/institutional support". Although

[6] It is worth mentioning that 9 cases constitute a relatively small data set which is, however, typical of QCA which prioritizes in-depth knowledge over statistical inference (Ragin, 2005 and 2008).

this factor only averaged 0.8 in the high-impact group, the differences compared to the averages in the medium- and lower-impact groups were the most significant (medium: 0.3; lower: 0.05). This contrasts somewhat with, for example, the two highest-averaging variables in the high-impact group –"Socio-economic hardships" and "Ample opening hours" both at 0.9– which were lower than in the medium-impact group (in the case of "Ample opening hours") or where the lower-impact cases exceeded the average of the currencies with medium impact (in the case of the "Socio-economic hardships"). In the other two key factors ("Backing by official currency" and "Ease of use"), the averages were aligned with their impact group, but less distinguished compared to the "Government/institutional support" factor. Overall, what matters most, arguably, is the whole set of key factors which –although their scores can vary from case to case– corroborated the connection between the variables and the socio-economic impact.

- The reason for the relatively low score of the key factor "Backing by official currency" among the high-impact community currencies was mainly due to the somewhat isolated case in this group: the Argentine "Créditos" which differed significantly in the factors "Backing by official currency" (score: 0) and "Ample opening hours" (score: 0.5) from the other cases in their peer (high-impact) group. This caused the total score of the "Créditos" (3.2) to fall below the average of its group (4.1) and close to the case of the "Chiemgauer" of the medium-impact group, but at the same time not so far from the score of the "Sarafu" (3.6). This (latter) was the other distinctive case of the high-impact group, which was the only one in this group with little "Government/institutional support" (0.3) and a special relationship with regard to the Kenyan shilling ("Backing by official currency": 0.5).

This short analysis, both horizontal (sums/scores of the cases and in aggregate) and vertical (comparing the different key factors and their averages), concludes the comparative analysis for this article.

As mentioned, there were two cases ("WIR" and "Sardex") that in this article could not be included but (in the doctoral thesis) are analyzed after the comparative analysis, together with a discussion of the following additional factors that emerged during the research process:

- Transaction fees and fees for exchanging community currency to official money;

- Financial sustainability of operations and organizing team;
- Digital technology base;
- Social infrastructure;
- Legal framework.

3. Key findings and discussion

As can be seen from the case studies and the comparative analysis, community currencies are tremendously diverse in origins, settings and design, and so are the potential factors that influence different facets of their operations and community, the socio-economic impacts being an important one of those. Generally speaking, the key factors/variables used for this investigation proved to be adequate. Perhaps other factors could have been included but most of these additional factors can be considered basic (technological base, financial sustainability of operations and organizing team, and social infrastructure) or out of reach (legal framework). Maybe the issue of fees levied on the exchange from community to official currency –in community currencies that are backed by official money– could have been covered in some form. However, the presumably negative influence of transaction costs on community currency turnover was included in some cases in the "Ease of use"-variable.

The most important findings of this investigation are that –applying the chosen methodology– the key factors/variables scrutinized in the analysis of the selected cases were corroborated as key factors that promote high-impact community currencies. The insights into these key factors can be used to modify existing or create new community currencies with the objective to induce stronger economic (and social) impacts.

Concerning individual key factors, the clearest-cut one from this analysis was "Government/institutional support" and the "Ease of use"-variable, while "Socio-economic hardships" and "Ample opening hours" concurred as well, but less clear-cut due to higher average scores in one of the control groups. The somewhat ambiguous key factor was "Backing by official currency" which had the lowest score (0.7) in the high-impact group; still this was higher than the average scores of the control groups. Both the mentioned special cases ("WIR" and "Sardex") are not backed by official money (Sartori and Dini, 2016; Studer, 1998) but, on the other hand, there might be quite a few high- and medium-impact cases –

with backing in official currency– that were not considered in the analysis, such as the "Grama", the "Eusko" or other Brazilian municipal community currencies. Or maybe the answer here could be somewhere "in between": apply the backing in official money in the early stages of a community currency in order to build sufficient trust in the system to eventually "break free" from this important financial constraint. The story of "Sarafu" (and its precursors) reflects this approach. However, further research including more cases might be needed to gain a better perspective.

At the same time, some of these key factors are subjects of discussion within the international community of local currencies, for example, the mentioned issue of backing in official currency or the question of partnerships with governmental institutions. Concerning the latter, sure enough there are risks associated with government support for community currencies. In this investigation, four of the five high-impact community currencies entered into collaborations with the government, be it at the local, state/provincial, or federal level. All these forms of collaboration carry the risk of losing (some) operational, financial, and reputational independence should the political winds shift by way of elections, changes in management/staff, etc., a fairly common phenomenon especially in Latin America. Considering that the key factor "Government/institutional support" was the most clear-cut one out of the five variables, it appears that the classic logic of risk-taking applies here as well: stronger partnerships with public entities may yield higher gains (here: impact) but they also increase the risk of negative consequences.

With regard to the methodology, the approach used here, based on Qualitative Comparative Analysis (QCA) in its form of continuous fuzzy sets, proved to be valuable in providing an explicit yet flexible framework for a systematic analysis of the identified variables. The scoring system aids the analysis by forcing a clear evaluation of different points and (sub-)factors, while also allowing for comparisons and conclusions to be drawn from a (limited) numerical basis. For further research a similar kind of comparative analysis for community currencies could be extended to maybe 20-30 cases, including all high-impact but also more control group cases, giving it a broader data base.

Finally, it is important to emphasize that the variables/key factors, the case-selection and -studies, as well as the comparative analysis all sought to explain why some community currencies have a greater economic and social impact than others. This should not be interpreted as a negative assessment of smaller community currencies, but rather as an

issue of research focus. Other dimensions worth exploring could be aspects such as the degree of economic self-sufficiency or (on a more sociocultural note) the personal and social ties among users ("creating community") that smaller local currencies manage to foster better than larger ones.

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THE MORE THINGS CHANGE, THE MORE THEY STAY THE SAME: A CONCEPTUAL FRAMEWORK FOR UNDERSTANDING MONETARY SYSTEMS

Joseph Wu

Abstract

It seems that every day we hear about a new payment technology that will revolutionize the way we use money, or a hot startup that promises to shake up the financial industry, or a new policy framework that proposes bold reforms. How do we cut through the noise and understand the nature of these potential changes? Furthermore, how do we pick up signals in non-traditional avenues of innovation that may drastically disrupt the monetary system as we understand it?

This paper introduces a conceptual framework to understand a monetary system in four layers:

1) Ideological

2) Institutional

3) Administrative

4) Functional

First, this framework is applied to understand the dominant monetary arrangement in the modern capitalist order–nation state backed central banking model, where credit issued by private banks functions as “money”, which then circulates in the broader economy. We analyze how the assumptions and imperatives from a foundational layer direct the composition and behavior of the subsequent layers. We also discuss the structural problems attendant to these assumptions and imperatives. The analysis draws from a

variety of well-established evidence and theories from macroeconomics, history, anthropology, and sociology.

Following the application of this theoretical framework to the status quo, this paper examines various historical and contemporary alternatives, as well as case studies of modern innovations, analyzing their impact at different layers of the monetary system and their downstream consequences. Discussion of alternative monetary systems include the Ancient Near East civilization, early colonial economy, the Soviet system, etc. Modern case studies range from FinTech companies, the emergence of challenger banks in the UK, digitization of money, to Modern Monetary Theory and other emerging movements. Lastly, this paper highlights the contemporary influence of transnational mega-corporations on what "money" ought to be.

The purpose of this layered conceptual framework is to provide an analytical structure to better understand the origin of problems and the nature of proposed solutions concerning the monetary system. Certain problems in the monetary system can only be addressed by innovating at the right layer. Changes in a more superficial layer often do not impact more foundational layers but in fact reinforce the inherited assumptions and imperatives. In the design of any alternative or complementary currency systems, this framework is also helpful in identifying key system assumptions and stakeholders, as well as understanding system dynamics and trade-offs.

Section 1: The Monetary System As It Is

In modern capitalist economies, the dominant monetary system is one in which the default currency is issued by nation states, administered through the central bank and banking sector, as debt-based fiat currency. This paper proposes the following structural analysis framework to understand a monetary system, breaking down its assumptions, dynamics, and characteristics in 4 layers:

1) Ideological

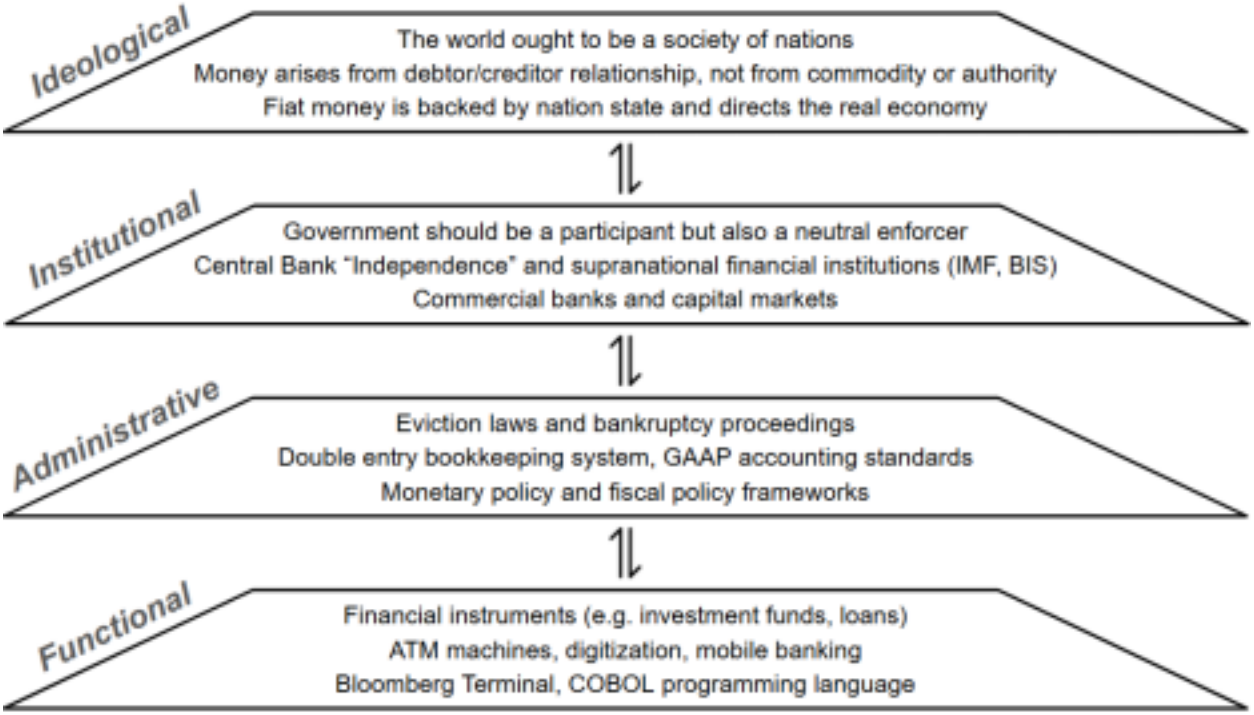
2) Institutional

3) Administrative

4) Functional

First, the ideological layer concerns the ideological underpinnings that legitimate the system as it is. A shared and enforced "worldview" that brings salience to certain identities and values is necessary to justify a particular monetary arrangement as an accepted representation of value. Second, the institutional layer involves the institutions arising from the ideology in order to uphold and maintain the monetary order, as well as the positioning of these institutions relative to each other. Third, the administrative layer deals in the processes and rules by which the institutions interact with each other and the wider society, typically to increase the stability and efficacy of the monetary system. Lastly, the functional layer comprises the financial products, technology stack, and user experience in the day-to-day operations of the system. These are the most visible and interactive ways that everyday people engage with the monetary system.

The diagram below offers an application of this framework. While not an exhaustive list, it is a helpful starting point to demonstrate some key characteristics of the system at each layer.





Section 1.1: The Ideological Layer

In Alexander Berkman's brilliant essay "The Idea is the Thing", he makes a strong argument for ideology to be the foundational layer of any social structure (Berkman, 1929).

That is the crux of the whole matter: present-day society rests on the belief of the people that it is good and useful. It is founded on the idea of authority and private ownership. It is ideas that maintain conditions. Government and capitalism are the forms in which the popular ideas express themselves. Ideas are the foundation; the institutions are the house built upon it.

A new social structure must have a new foundation, new ideas at its base.

While ideology and material conditions often influence and reinforce each other in complex ways, it is especially critical to enumerate the assumptions and beliefs underpinning a social structure such as the monetary system, where value inherently involves human judgment.

To provide some historical context around the first statement in the preceding diagram, by the dawn of the 20th century, the gradual waning of alternative political systems such as feudalism, theocracy, monarchy, or dynasty over the prior centuries precipitated a series of collapses in the Ottoman Empire, the Italian Papal States, the Qing Dynasty, and more. This gave way to rapid formations of the modern nation states all over the world. There were only 53 sovereign nation states in 1900 and there are 195 commonly recognized nation states in the present day (McWhirter, 1964). The continuous formation and development of nation states around the world in the past centuries culminated in the driving ideology of the 20th century that "the world ought to be a society of nations". This was perhaps best articulated by President Woodrow Wilson's 1918 address to Congress, the 14 Points, which advocated for a stable world order organized by "society of free nations" (Wilson, 1918). President Wilson's subsequent work related to establishing the League of Nations laid the groundwork for the modern United Nations. It is no coincidence that the Federal Reserve was chartered in 1913, also during Wilson's presidency.

It is important to recognize that the modern nation state was not the doing of any particular individual but represented the convergence of major historical trends. But, this begs the question: what is the nature of the "nation state" and how does it influence the structure of the monetary system which originates from it?

Early 20th century thinkers like Max Weber and Hannah Arendt have provided foundational analysis on the nature of the emerging political system known as the modern nation state. In Weber's 1919 *Politics as a Vocation*, he defined the nation state as such:

> a state is a human community that (successfully) claims the monopoly of the legitimate use of physical force within a given territory.

The two key characteristics of the state, highlighted by Weber, which are most relevant to the discussion in this paper, are that physical violence is central to the power of the state, and that the state's power is exercised over bounded geography (borders and territory). One century later, this exact sentiment is echoed by economist Paul Krugman in his New York Times column, where he declares that "fiat money… is backed by men with guns" (Krugman, 2018). In *The Origins of Totalitarianism*, Hannah Arendt ultimately makes a structural critique of the nation-state itself in causing some of the greatest tragedies of the 20th century (Arendt, 1951). Arendt points out the inherent contradiction between the nation, people with shared cultural or ethnic identity, and the state, a political-legal structure meant to uphold human rights. When a strong national identity guides the state's capacity for violence, the result is all forms of brutality against the marginalized, "stateless", or anybody not considered to be a part of the shared national identity. When the value of nation state issued currency depends on a monopoly of violence and the violent instruments of the state are frequently directed at marginalized groups, this has profound implications when it comes to structuring a monetary system based on artificial scarcity and permanent competition.

Another important aspect in the ideological layer is that money in the modern economy is created through creditor and debtor relationship, rather than backed by commodity or direct authority (Herzog & Sandberg, 2023). In the modern economy, money is loaned into existence, with a creditor/lender and a borrower, mediated through the banking sector. For example, when a person applies for a mortgage, the bank reviews and approves the loan, hence new money is created to finance the purchase of that house. The terms of the creditor and debtor relationship, in the case of a mortgage, include the collateralization of the house and the enforcement of non-repayment, which is foreclosure and seizure of the collateral. In theory, the ability of banks to make loans is constrained by their liabilities and reserve requirements. In practice, the banking sector at large has tremendous power in directing newly created money supply, since the money created from loans becomes deposits/reserves fueling an ever-expanding credit cycle (Werner, 2014). The vast majority of



"money" as understood and used by everyday people in developed economies is bank deposits created through lending. Estimates put credit created money as high as 98% of the total money supply (Ryan-Collins et al., 2011).

It is necessary to place a finer point on the nature of money as a social relation between creditor and debtor, as well as the social dynamics created as a result of the types of creditor and debtor relationships that exist in the modern economy. If money is created as debt, with a lender and a borrower and differing interest rates, who are the lenders? Who are the borrowers? What kinds of debt relationships are allowed to exist in the modern economy? In a debt based monetary system, one person's asset is another person's liability. Therefore, it is impossible for any individual or institution to run a surplus without another incurring a deficit. It is also widely acknowledged that higher interest rates, all else equal, tend to raise bankruptcies and defaults. In a sense, adjusting the interest rate is akin to dialing the knob on the "competitiveness" of an economy. Since the total outstanding money supply will always be less than the total debt obligations, when growth in money supply slows, it is a matter of "when" and "for whom", not a matter of "if", debt obligations can no longer be met. Higher interest rates simply accelerate this process. In the modern economy, there has been unprecedented access to credit for the average person, financing anything from homes, to cars, to consumer spending. However, when government debt, corporate debt, consumer debt are all denominated in the same monetary system, this creates a Hobbesian struggle of "a war of all against all", as described by Anwar Shaikh, Economics Professor at The New School for Social Research (Shaikh, 2016). In order to stay financially solvent, individuals are competing against each other, as well as against institutions such as corporations and the government, to scramble for money that will inevitably leave someone short. The "Historical Alternatives" section will discuss how different types of money, including other forms of debt-based money, can result in different social dynamics.

Lastly in the ideological layer, nation state backed fiat money is not simply a neutral medium of exchange, but actively directs the real economy. A nation state backed fiat money, such as the US Dollar, or Mexican Peso, or Japanese Yen, necessarily creates a separation between the real economy, where production and consumption of real goods and services happen, and the financial economy, which manages the growth and allocation of money supply. Because the modern state is not directly responsible for production (i.e. the government doesn't directly produce or distribute food, clothing, or medical services) yet

backs the money that enables most economic activities, the amount of fiat money in a person's possession essentially gives a proportional share of access, out of existing money supply, to all of the real economy under the purview of the nation state. In Bernard Lietaer's *The Future of Money*, he concludes that "for a bank-debt-based fiat currency system to function at all, scarcity has to be artificially and systematically introduced and maintained. This is one of the reasons why today's currency system is not self-regulating, but requires the active role of central banks to maintain that scarcity." Jackson and McConnell have summarized it as "debt-money derives its value from its scarcity relative to its usefulness" (Lietaer, 2002). As challenging as it is for governments and central banks to employ proper policy tools to manage the "scarcity" of fiat money, it is even more difficult for them to actively support industries and businesses to ensure the "usefulness" of fiat money. This is the root cause for much of the economic dislocations in a modern nation state economy. In Rana Foroohar's study of the 2008 Great Recession and the subsequent recovery, she observed that Wall Street (the finance industry) recovered quickly and was still able to extract profits even as Main Street (the real economy) weathered the losses and lagged behind (Foroohar, 2016). In such a scenario, the economy can become a negative sum game, where even as real economic value is destroyed, it is still advantageous to capture a bigger share of the growing money supply by "making money out of money".

The idea that a managed monetary system actively shapes and drives the real economy has been a pillar in contemporary economic and political theories, a divergence from classical economic theory that assumes money to be a neutral system of measurement. To correctly understand the role money plays in the economy, we must first dispel the myth of money organically emerging as a solution to the problem of double coincidence of wants in a barter system. The latest anthropological research shows no evidence of a barter economy existing before the introduction of "money" as we know it. Early small-scale human societies predominantly operated in gift economies. In John Kenneth Galbraith's *Money: Whence It Came, Where It Went* (1975) and David Graeber's *Debt: The First 5000 Years* (2011), both authors make compelling and evidence-based argument that money has always been a creation of organized political institutions in order to direct economic activity, rather than a neutral tool that emerges from free trade. This sentiment is also echoed, more than a century prior, in Marx's seminal text *Das Kapital* (1867), that modern capitalist economy operates according to the circuit of exchange, from Money to Commodity back to Money, aimed at maximizing exchange value. This is in contrast with pre-capitalist economies operating

according to the circuit of exchange, from Commodity to Money back to Commodity, aimed at maximizing use value. Therefore, the accumulation of money becomes the primary incentive for rational economic participants, rather than the pursuit of utility maximization, as classical economics would assert. This is also one of the core assumptions behind Keynesianism, the policy orthodoxy for much of the 20th century, that governments should actively manage aggregate demand through public spending (Keynes, 1936). Even later in the 1970s, Milton Friedman's monetarism and quantity theory of money, which advocated for a more constrained and rule-based central bank monetary policy rather than government fiscal policy, at its core still rejects the notion of money as a neutral system of measurement, and sees the monetary system as something to be managed, albeit with a different approach (Friedman, 1963).

So far, we have analyzed in detail three key characteristics of the ideological layer of the dominant monetary system in the present day:

1) The world ought to be a society of nations

2) Money arises from debtor/creditor relationship

3) Fiat money is backed by nation state and directs the real economy

What are the implications of a monetary system structured this way in the ideological layer?

History has proven that mobilizing for war has been the only reliable way for a nation state economy to achieve full employment. This was the case during early 20th century world wars as well as present day, when Russia reached record low unemployment mobilizing for the conflict with Ukraine (Kolyandr, 2026). The structural reason for this phenomenon can be understood through a combination of factors in the ideological layer. As previously discussed, since the nation state is a monopoly on violence and the value of its currency is ultimately backed with its capacity for violence, all the human productive capacity within that nation state can only be fully leveraged when that violence is turned outwards towards another nation state adversary. During ordinary times, since fiat currency derives its value relative to scarcity, that violence is inevitably turned inwards, to ensure that money supply stays relatively scarce and to ensure a reserve pool of labor. This inward violence can take the form of crackdown on labor union activities or civil protests, enforcement of mass evictions, and all manners of brutality against the marginalized "have-nots".



"They got money for wars, but can't feed the poor" (Shakur, 1993)

Tupac's iconic lyrics reflect a widespread public sentiment about the government's distorted priorities. However, on a closer look, we must realize that the very money that could be used to feed the poor only has that value because of the enforcement mechanisms of the state. The enforcement arms of the government, whether military or police, require maintaining a capacity for violence and essentially constitute the operational cost of enforcing this particular type of value in this monetary order. In the unique case of the United States at present, the Dollar as the world's reserve currency depends on the US ability to deploy the use of force abroad and project order worldwide. As a result, military or police spending for the upkeep of the state's capacity for violence always takes precedence over civil expenditure in a nation state economy. In the US, the Pentagon has failed eight consecutive audits, with estimates of $35 trillion in accounting adjustments, yet receives record budget allocation year after year (Capaccio, 2020).

Another structural consequence of debt-based fiat money is accelerating economic inequality and the need for monetary expansion, even in the face of dwindling resources and shrinking real economy. The problem of entrenched structural inequality in the modern economy has been widely acknowledged and analyzed by many contemporary economists, most notably Thomas Piketty and Joseph Stiglitz. In Piketty's *Capital in the Twenty First Century* (2013), he attributes accelerating inequality under capitalism to the rate of return to capital greater than the rate of growth in the real economy. In his work, Stiglitz focuses on the consequences of unchecked economic inequality, eventually leading to economic stagnation and political instability (Stiglitz, 2012). Higher inequality results in lower marginal propensity to consume and lower social mobility, both of which undermine the growth of the real economy. The analyses by both Piketty and Stiglitz imply a decoupling of the financial economy from the real economy. Even as the economy grows "on paper", the capacity for production and consumption in the real economy may lag behind. However, both economists focus on the importance of government intervention and proper policy framework to mitigate economic inequality. While this may help, whatever the government does will ultimately be swimming against the tide, as there are deeper structural forces for accelerating inequality, the most important of which is the monetary structure itself. For Bernard Lietaer, inequality is structurally "baked into" the design of the modern monetary system, since debt-based money requires endless growth and artificial scarcity, inevitably

leaving more and more people behind (Lietaer et al., 2012). In Michael Hudson's research, Bronze Age societies such as Sumer and Babylonia, which pioneered many aspects of what later became the modern monetary system, also had runaway inequality that destabilized society and required periodic debt jubilees to reset the system (Hudson, 2018). The problem of inequality clearly goes further back than capitalism itself and cannot be adequately addressed by government intervention alone.

Section 1.2: The Institutional Layer

The institutional layer of the modern monetary system is primarily composed of the government, the central bank, the banking sector, and capital markets. This layer also deals with the role of each entity within the overall system, as well as how they should interact with each other. This section explores these institutions in more detail and the often paradoxical nature of their roles.

The first paradox concerns the roles that the government must play in the monetary system, both as an impartial "referee" but also as an active participant. Under classical economic theory by the likes of Adam Smith, governments should take a laissez-faire approach and treat the economy as a self-organizing system (Smith, 1776). Although assumptions like these became seriously challenged in a series of systemic crises in the early 20th century, it is not lost on anyone the importance of at least having the appearance of a legitimate authority figure that is "above the fray", especially when it concerns the allocation of resources and enforcement of property rights. In the Keynesian and post-Keynesian paradigm, there is increasingly an expectation for governments to act as "borrower of last resort" and "spender of last resort" to actively lead the economy out of economic downturns. Although it is widely recognized that government intervention can be necessary and effective at least in the short term, the constant tension between the government's opposing roles has led to a host of issues in the modern economy. For example, frequent corporate subsidies and bail-outs have raised the issue of moral hazard. Legal processes such as the Investor-State Dispute Settlement mechanism have been introduced for investors and corporations to sue governments for damages before private international tribunals. When governments are treated as contractual partners rather t han sovereign entities, they can no longer assume the role of impartial "referee".

In the modern monetary system, the concept of "central bank independence" has been another subject of debate and source of contradiction. The establishment of the Bank of

England in 1694 is widely credited as the earliest model for modern central banking (Beagley, 2021). This was in big part, an act of compromise by monarchs in distress from financing ever more expensive wars. In the case of the Bank of England, King William III accepted constraints on the sovereign's right to issue currency, in order to secure a more reliable source of funding through an "independent" financial institution that is better able to mobilize the financial resources of the entire nation for sustained war. For nation states, there has also been historical precedence for governments to directly issue currencies, without the help of a central bank. Beyond the contested origin of the central banking model, there are still two major questions regarding the independence of such an institution: "*can* a central bank be truly independent from the government?" and "*should* a central bank be truly independent from the government?" On the question of *can*, central banks are typically chartered by governments and central bankers typically appointed through some government process. Although central banks are granted legal independence with some procedural insulation from political pressure, longstanding central bank policies such as window guidance, yield curve control, quantitative easing, open market operations all, in effect, tilt the playing field in favor of the government and blur the boundaries of "independence". On the question of *should*, the modern central banking model has been the target of criticism both from Marxist economics tradition and libertarian Austrian school. Marx believed in the centralization of credit in the hands of the state and nationalizing the banking sector (Marx & Engels, 1848). Austrian economists like Hayek opposed the very existence of a central bank and advocated for free banking, with competing private currencies (Hayek, 1976).

In the modern monetary system, the government no longer directly issues currency but can finance itself by borrowing from a financial system that is ultimately backstopped by the central bank. The central bank is granted the unique privilege to control the nation's money supply, which is ultimately backed by the legal authority of the government. As far as how the central bank interfaces with the banking sector at large, the central bank has historically positioned itself as the banks' bank, backstopping systemic risk, but not directly intervening in bank operations. The general separation of powers was originally proposed by Bagehot in 1873 and has guided central bankers for over 100 years, recently reiterated by Bernanke while managing the 2008 Great Recession (Bernanke, 2013). In practice, over 100 years of financial history has shown that a systemic outcome of the central banking model is gradual consolidation in the banking sector. Before the establishment of the Federal Reserve, around

30,000 banks existed in the US in the early 20th century. As of 2025, there are just over 4,000 licensed banks in the US, a tenfold decrease amidst a century of rapid economic and population growth (FDIC, 2026). As the banking sector becomes increasingly concentrated and oligopolistic, larger banks can better weather changes in monetary policy, making it more difficult to achieve intended policy outcomes for central banks. Since smaller banks are more vulnerable to policy changes and rising compliance costs, this accelerates consolidation in the banking sector.

Capital markets, particularly the bond market, make up a vital component of the institutional layer; their relationship to the government and the central bank shapes the economic conditions that everyday people interact with. In nation state economies, the "risk free rate" is proxied by the yield of the short term government bond, issued in its own currency. This sets the floor for expected returns for all other investment activities in the economy. Central bank interventions in the capital markets through policies such as yield curve control and open market operations have major downstream effects on the real economy by shifting this baseline. The discussion around the specifics of central bank policy frameworks, i.e. the modus operandi of central bank intervention, belongs in the administrative layer of the monetary system.

The increasingly globalized economy has necessitated the emergence of supranational financial institutions, such as the International Monetary Fund (IMF) and the Bank for International Settlements (BIS). IMF typically engages with national governments and BIS is "the central bank for central banks", but the source of funding and power for IMF and BIS comes from nation states and central banks, respectively (Blomberg & Broz, 2013). In this regard, these institutions serve as facilitators and proxies for the interests of powerful nations rather than decision makers across national economies.

Section 1.3: The Administrative Layer

The administrative layer of a monetary system deals in the processes and rules by which the institutions interact with each other and the wider society, typically in the interest of increasing the stability and efficacy of the system. The policy discussions most visible to everyday people, whether in public debates, news coverage, or school curriculum, usually concern topics in this layer. This is also the layer that the intellectuals of society are most readily employed to advise on and effect change. For the scope of this paper, this section provides a high-level overview of several key components in the administrative layer of the

modern monetary system, such as legal/regulatory frameworks, standards and metrics, and monetary/fiscal policy frameworks.

In a debt-based monetary system backed by the nation state, the framework with which the government enforces debt obligations and balances the interests of lenders vs borrowers is critical to upholding the value of the currency. Specifically, how does the government enforce seizure of collateral to protect the interest of lenders? How does the government make allowances for dischargement of debt through bankruptcy proceedings? After the 2008 Great Recession, upwards of 10 million people in the US were displaced due to foreclosures. This process of foreclosure, displacement, and eviction is ultimately backed with state violence, if the homeowner refuses to vacate the foreclosed property. Economists have argued over different approaches over how to deal with the financial fallout, with some arguing for more homeowner support rather than bank bailout (Mian & Sufi, 2014). Whatever the approach, at the core of this debate, economists are simply trying to find the optimal balance among the affected institutions, while weighing factors such as saving the financial "plumbing" in the banking sector, upholding the democratic legitimacy of government, stretching the charter of the central bank, restoring stability of the capital markets, and lastly, the public interest. The same sort of balancing act also applies to the evolution of legal frameworks around bankruptcy. In Margot Finn's study of debt in pre-Victorian and Victorian England, debt was an economic and social necessity, but also viewed as a moral failing (Finn, 2003). The debtors' prison system emerged as a form of physical punishment for the moral failure to repay debts. However, debtors' prison eventually collapsed due to serious systemic contradictions. Once imprisoned, debtors were no longer able to earn a living and generate income to pay back creditors. This also imposed a huge administrative burden and lost tax revenue on the state. Since indebtedness was so widespread in English society, class-based legal inconsistencies and enforceability issues eroded public trust in the system. In *Debt: The First 5,000 Years*, Graeber (2011) argued that the move from debtors' prisons to modern bankruptcy laws did not occur for humanitarian reasons, but represented a shift in how capitalist societies manage and enforce debt more efficiently. The transition to modern bankruptcy laws was ultimately a result of administrative calculation, balancing the enforcement cost of the state, the opportunity cost of punishment, the need for debt expansion to fuel economic growth, and the necessity of debt enforcement to uphold the value of debt-based money.

Another important aspect of the administrative layer is the accepted standards and metrics used to guide and facilitate the operation of the monetary system. The creation of GAAP (Generally Accepted Accounting Principles) standards in the decade following the 1929 market crash was one such example to restore confidence in and standardize operations of the capital markets. GAAP standards also defined the framework with which government regulators can consistently enforce compliance on the business reporting practices of private companies. Establishment of GAAP standards also marked a pivotal change in regulatory framework to a hybrid "delegated authority" model, where the SEC delegated the specifics of standard-setting to the accounting profession's own committees (Seligman, 2003). In modern economies, perhaps no metric has been more influential than the Gross Domestic Product (GDP), yet its original intent has deviated substantially from its contemporary usage. The creation and early usage of the GDP measure was to assess the total productive capacity of an economy during wartime, and estimate what a nation state can realistically mobilize towards war effort. There were heated debates since its inception regarding what should and should not be counted in this figure, such as government purchases of tanks and bombs, or how to measure social welfare. There has been persistent criticism of the government using the GDP as a neutral, technocratic goal, where growth in GDP is falsely equated to a more affluent society (Galbraith, 1967).

To effectively manage macroeconomic cycles, central banks around the world have experimented with a variety of monetary policy frameworks in the past century. On October 23, 2008, in the throes of the subprime meltdown, Federal Reserve chairman Alan Greenspan had a mea culpa moment in his congressional hearing, where he admitted his view of the world was wrong (Leonhardt, 2008). This marked the transition from the Greenspan era of self-regulating financial markets, to the Bernanke era of central bank interventionism. Bernanke advocated for a comprehensive central bank toolkit, from quantitative easing, forward guidance, to yield curve control, and negative interest rate to actively combat deflationary pressure (Bernanke, 2022). The Japanese Central Bank used the window guidance policy to drive economic development, which caused the boom in the Japanese economy and the subsequent asset bubble in the late 20th century (Werner, 2003). These policy frameworks are examples of administrative strategies of the central bank to more effectively coordinate with other entities in the institutional layer of the monetary system in order to respond to macroeconomic changes.

Section 1.4: The Functional Layer

The functional layer of a monetary system comprises the product offering, user experience, and technical tooling available to the broader society, i.e. businesses and individuals who act as users/participants in the system. Innovations in the functional layer typically extend the capability and efficacy of the monetary system, without changing any of the underlying logic or dynamics. This section examines a few impactful areas: creation of new financial instruments, information technology, and innovation around banking experience and digitization of money.

Newly available financial instruments like collateralized debt obligations (CDO), or exchange traded funds (ETF) increase access and optionality, and often lower cost for users of the monetary system. During the early 2000s real estate boom, using CDOs to resecuritize mortgage-backed securities (MBS) was hailed as a transformative innovation. Statisticians like David Li applied the Gaussian Copula model to suggest negligible joint default risk when unrelated mortgages are sliced and pooled together, which became the justification for inflated credit ratings on subprime mortgages (Li, 2000). For a while, the model held up, and CDOs expanded access to mortgage investments for a variety of investors. At the end of the day, no amount of clever data modeling or productizing financial instruments can overcome the systemic risk with rapid debt expansion by the people least able to afford it. A similar playbook is occurring with the rise of exchange traded funds (ETF). By using an “arbitrage mechanism”, ETFs are able to track Net Asset Value more efficiently, allowing retail investors to buy a diversified basket of stocks for a fraction of the cost of traditional mutual funds or index futures (Ben-David et al, 2017). Financial innovations like CDO and ETF create meaningful optimizations in the way people engage with the monetary system, but do not result in changes in the ideological or institutional layers. Financial instruments like CDO can contribute to a crisis like the 2008 subprime meltdown, which may necessitate changes in the administrative layer.

While advancements in information technology have provided unprecedented convenience and access, technological trends such as digitization also help entrench the systemic incentives of powerful institutions, namely governments, central banks, and the banking industry. There has been a concerted effort by major institutions to move away from cash and towards a digital financial system (Beretta & Neuberger, 2021). For governments, digital ledger systems facilitate tax compliance and legal enforcement while providing granular

data for economic planning purposes. For central banks, digital ledger systems enable more efficient monetary policy transmission, and unconventional monetary tools such as negative interest rate. For the banking industry, digitization has created an opportunity to lower operational and labor costs by closing physical locations (Barca & Hou, 2024). Innovations in the technical infrastructure, such as Common Business-Oriented Language (COBOL) or Bloomberg Terminals, have drastically accelerated the flow of information across the financial industry. In the words of Langdon Winner, technologies are inherently political, since their very creation and operation require specific social arrangements (Winner, 1980). What appears as convenience and ease of access to everyday people has an underlying systemic logic that can only be understood by unpacking the monetary system layer by layer, from ideology, to the roles and interests of the institutions, to the administrative dynamics among the institutions and the broader society.

Section 2: Historical and Contemporary Alternatives

The development of the modern monetary system is not inevitable or necessarily an improvement over previous systems, but rather a brokered compromise among the various priorities of the time. This section examines several historical and contemporary examples of monetary systems that are structured differently at the ideological and institutional layers, and their downstream consequences at the administrative and functional layers. Each case study incorporates a brief discussion of relative merits and drawbacks of alternative systems compared to the modern monetary system.

Section 2.1: The Ancients

During the Bronze Age in Mesopotamia, the Ancient Near East civilizations–particularly the Sumerian and Babylonian empires–developed sophisticated financial systems that laid much of the foundation for modern monetary systems. The anthropological analysis of how these ancient societies conducted their financial systems draws from Michael Hudson's work in ...*And Forgive Them Their Debts* (2018) and David Graeber's *Debt: The First 5,000 Years* (2011). The monetary system in the Sumerian and Babylonian empires was primarily credit-based, where debts owed to the palace or temple circulated as money. Periodically, when a new king took the throne or during times of crisis, "Clean Slate" decrees would be issued to annul debts, restore forfeited land, and release debt-servants. In Hudson's analysis, the rulers of the Ancient Near East understood these debt jubilees to be pragmatic

policies to maintain social stability, ensure military readiness, and prevent the rise of an oligarchic class.

Applying the layered framework in this paper, the monetary system of the Ancient Near East can be understood as follows. Ideologically, these societies believed that these city-states in which they reside were owned by the gods and the king had divine stewardship to manage the god's estate. Although money was credit-based, it was a debt directly owed to the palace, which had the divine responsibility to manage the flow of resources on behalf of the gods. The major institutions taking part in the monetary system were the king/palace, the temple, and the class of trained scribes who administered the system. In the administrative layer, key characteristics include the charge-and-discharge single entry accounting system and periodic debt jubilees as standard policy of the palace. In the functional layer, scribes of the Ancient Near East invented various clay tools like tablets and tokens, cylinder seal signatures, and the sexagesimal (Base 60) mathematical system, all of which ensure the effective operations of their monetary system.

A key structural difference between the Sumerian/Babylonian monetary system and the modern monetary system is the shift from centralized debt creation to decentralized debt creation. In a centralized credit system, money supply is predominantly debt owed to the palace, making it much more feasible to implement an administrative adjustment like debt jubilee. In the modern system, anyone or any institution can be a creditor or debtor, and one party's liability becomes another's asset. This interconnectedness makes it near impossible to extricate debt while keeping the financial system operational. This structural logic is reflected in the accounting methodology itself. While modern double entry bookkeeping was designed to track equity and profit, single entry systems used in the Ancient Near East prioritized stewardship by tracking the movement of resources across a centralized authority (University of Nottingham, n.d.).

Section 2.2: Religious Compliance

In societies where organized religion plays a pre-eminent role, monetary systems are structured differently from the ideological layer in order to adhere to religious laws and principles. The Islamic and Jewish traditions offer two salient examples where structural differences in their monetary system have produced socioeconomic outcomes distinct from those of the modern financial system.

A 2010 IMF paper comparing Islamic banks versus Western banks in the aftermath of the 2008 Global Financial Crisis found that Islamic banks were more resilient to the financial shocks due to the way their mortgages were structured (Hasan & Dridi, 2010). Since Shari'ah laws ban *Riba*, or interest-bearing loans, Islamic banks must provide equity-based mortgages, or *Musharaka*, where the bank and the buyers become co-owners of the property and the bank charges rent for their share of the property. Since Shari'ah laws also ban *Gharar*, or uncertainty/speculation, Islamic banks have higher collateralization of physical properties and stricter controls for investments in risky financial derivatives. Although Islamic banks are not immune to the consequences of a global financial crisis, adherence to Shari'ah principles shielded them from the financial contagions of "toxic" mortgage-backed securities.

In the Jewish diaspora, Hebrew Free Loan Societies (HLFS) have operated chapters worldwide for over a century, to provide interest-free loans for a variety of purposes, in compliance with *Halakha*, or rabbinic laws (Tenenbaum, 1993). In accordance with the Torah, which forbids charging interest between Jews, Rabbis ordained that every Jewish community should establish a *Gemach* to provide interest-free loans for members. The Hebrew word for interest used in the Torah is *Neshekh*, literally translated to "snakebite", because it is understood that the compounding effect of interest is akin to a poison that slowly consumes the debtors and eventually the entire community. Since they cannot use interest to offset the risk of default, these societies use a "Social Credit" model, where borrowers find guarantors or cosigners, often through their connections in the synagogue. In this way, the synergy between the financial institution of HLFS and the religious Jewish community is reinforced.

The ideological layer of monetary systems that prioritizes adherence to religious principles has an implicit assumption that "religious laws ought to govern economic and financial activities". Of course, these religious laws were not created in a vacuum and often contained lived wisdoms from ancient societies with embedded understanding of debt, inequality, and social stability. In the institutional layer, scholars with religious training are required in a supervisory capacity to ensure compliance, in addition to existing financial institutions. The Shari'ah governance framework, where each Islamic bank must establish an internal Shari'ah Supervisory Board, ensures that the operations of a bank are synchronized with Islamic jurisprudence. In the administrative layer, there are often unique classifications and

processes for these institutions. For example, Hebrew Free Loan Societies are established as non-profits that raise funds through donations and endowments, instead of through capital markets. These contemporary examples, in the Islamic and Jewish traditions, serve more as modified systems that operate in parallel with formal monetary systems.

Section 2.3: Commodity and Paper Currency

In the modern monetary system, money is created purely through the social relation of debt, not backed by physical commodities or directly issued by a central authority. This is discussed in detail in Section 1.1 The Ideological Layer. Historically, money has been used as, or backed by, a variety of commodities, most famously gold and silver. Central authorities like emperors or governments have also directly printed paper notes to finance expenses, which then circulated in the economy as money. Each of these configurations makes a foundational change in the ideological layer, about what "money" ought to be and what is accepted as a legitimate representation of value.

In *Money: Whence It Came, Where It Went*, Galbraith (1975) provides a comprehensive analysis on each major currency type used in U.S. history. During the colonial period, American colonists primarily used beaver pelts, wampum, and tobacco as commodity money since Britain intentionally restricted outflow of gold and silver species to colonies. For most of the 19th century, gold and silver became the standard for currency, whether directly used via coins or represented by paper notes. Although all of the aforementioned currencies are considered commodity currencies, the type of commodity chosen to be "money" introduces its own unique set of problems and dynamics. For resource-based commodity currencies, the primary advantage is accessibility: beavers can be hunted, wampum can be collected, and tobacco can be grown. However, this leads to standardization issues where resources of varying quality are traded at the same face value, or environmental issues related to land use and overhunting. Since colonists often lacked the skills to procure beaver pelts, its usage as currency meant that the money supply was dependent on relationships with Native American allies. In the case of wampum, hyper-inflation resulted when Europeans used industrial processes to mass produce wampum beads, flooding the colonial economy with added money supply. Thus, the blessing of the democratic access enabled by resource-based currencies also became its downfall. For precious metals like gold and silver, availability becomes the bigger issue. This is best encapsulated by William Jennings Bryan's generation-defining "Cross of Gold" speech:

> You shall not press down upon the brow of labor this crown of thorns. You shall not crucify mankind upon a cross of gold. (Bryan, 1896)

In Galbraith's analysis, the advocacy for bimetallism represented a political struggle over the control of money supply. Due to the inelastic supply of gold-backed currency, the working class had been crushed by decades of deflation while the financial elites benefitted from the rising value of their money. By advocating for free coinage of silver, the populists hoped to expand the money supply, ensuring an adequate level of inflation to relieve the debt burden of the agrarian and working class.

Greenbacks during the American Civil War was an example of sovereign fiat currency directly issued by a central authority, without a private financial intermediary. The value of Greenbacks was enforced through its legal tender status and suffered relatively mild inflation through the duration of the war. This monetary arrangement gave tremendous flexibility to the government and also benefitted the working class, at the expense of the creditor class. Even though the gold standard was eventually restored, Greenbacks proved to be a successful monetary experiment.

Section 2.4: Free Banking Era

In the 19th century, several Western nations—most notably Scotland, Canada, and the United States—adopted free banking models, where private banks issued their own currencies. In the institutional layer of the monetary system, the free banking model is an important structural alternative to the central banking model. Although banks still operated within a nation state framework and issued credit based money, there was no central bank and no unified national currency, which decentralized control of the economy. This era remains one of the most polarizing periods in economic history, since it enabled unprecedented access to credit and economic growth while unleashing its own form of chaos.

Galbraith credits the free banking system with being the financial engine for the rapid industrial and urban development of the late 19th century, what he dubbed as the era of "magnificent chaos" (Galbraith, 1975). However, he criticizes the inherent chaos and instability of decentralizing the right to issue money. By the time of the American Civil War, over 7,000 unique bank notes had been issued. Counterfeits and bank failures were rampant. Galbraith also criticizes the practice of "wildcat banking", purposely establishing

banks in remote locations to make it difficult for people to redeem banknotes. In the administrative layer of this monetary arrangement, the absence of standardized currency and centralized policy created the need for an industry of "Bank Note Reporters", whose function is to provide assessments and updates on the credibility of various privately issued banknotes. In the functional layer, many clever tools and information catalogs were developed to help businesses and workers to navigate the maze of competing banknotes. Despite his objections to the free banking model, Galbraith concedes his admiration for the democratic quality of such a chaotic system, where easy access to credit gave the everyday person unprecedented economic opportunities.

In contrast, Hayek and the Austrian school economists were staunch proponents of the free banking model, believing that money itself must be subject to market discipline. For Hayek, the perceived chaos of the free banking model is actually a necessary market discovery mechanism. In his dispersed knowledge theory, he argues that "dispersed knowledge is *essentially* dispersed, and cannot possibly be gathered together and conveyed to an authority charged with the task of deliberately creating order" (Hayek, 1988). To ban the thousands of private currencies in circulation and establish the appearance of stability through a central authority like the central bank would only destroy critical market signals. Hayek cited the more successful implementations of the free banking model in Scotland and Canada, which are arguably less regulated than the US model (Hayek, 1976). Since state governments in the US often required banks to back their currency issuance with state bonds, crashes in the value of government bonds caused more bank failures.

How the Free Banking Era ended highlights the limitations of changes in the institutional layer. Since the free banking system operated within the nation state framework, it ultimately could not survive the pressure to centralize monetary planning, resulting from existential issues of the nation state. For the US, this was the Civil War. For Scotland, Britain's imperial structure could not tolerate such decentralization. For Canada, the pressure to interface with other nations' central banks in a globalized economy forced it to abandon its successful free banking system.

Section 2.5: State or Central Bank Dominance

Whereas the free banking model is a configuration in the institutional layer that decentralizes monetary power, there are also examples of monetary systems with more centralized institutional layers, with or without a central bank. As discussed in Section 1.2, there is an

implicit assumption in modern Western-style monetary systems that governments and central banks should largely remain neutral to market activities, only intervening during systemic crises. However, governments or central banks can take a more dominant role in actively steering the banking sector and economic activities, as exemplified by the Soviet Union and Japan.

In the Soviet command economy, the central bank and the commercial banks were no longer independent policy or economic actors, but fused into a "monobank" system (Gosbank) that performed administrative functions to facilitate the policy objectives of the government (Nove, 1986). This unique institutional configuration was downstream from an ideological shift on the nature of "money" itself, where the Soviet Communists attempted to transition to a "moneyless society" with direct physical allocation of resources.The Gosbank was intended as a transition phase, where money was stripped of its logic of profit and accumulation under capitalism and reduced to a passive ledger. Due to Soviet policies of price controls and suppression of market dynamics, Gosbank's primary responsibility was to manage shortages and monetary overhang, rather than inflation and employment targeting associated with modern central banks. In the administrative layer of the Soviet monetary system, accounting methodologies were adjusted accordingly. While still using the structure of double entry bookkeeping, Soviet-style accounting removed the calculation of shareholder/private equity since there were, in theory, no longer any private capitalists. Instead, surplus value on the balance sheet was called "People's Equity" or "Socialist Property", which in practice was funneled back to the government to support policy objectives.

In Post-WWII Japan, the Japanese central bank took a leading role in the institutional layer, actively steering the flow of credit in the economy through the mechanism of "Window Guidance". Whereas Western central banks typically lever the economy through interest rate policies, the Bank of Japan directly interfaced with commercial banks to set sector-specific lending quotas (Werner, 2003). Commercial banks that did not comply faced liquidity restrictions and administrative guidance from the Bank of Japan. This policy was tremendously successful in the post-war re-industrialization efforts, contributing to the Japanese "economic miracle" of the 20th century. However, the excesses of mandated credit creation eventually caused a severe asset bubble and the subsequent "Lost Decade" of the 1990s, a prolonged period of economic stagnation.

Monetary systems with a centralized institutional layer are highly efficient at mobilizing resources for large industrial projects, such as war economy manufacturing. The Soviet Union's rapid transition from a semi-feudal society to an industrial power and Japan's rapid post-war re-industrialization are testaments to the advantages of this model. However, the suppression of bottom-up feedback mechanisms, such as price signals, makes the economy less dynamic and less responsive to the needs of everyday people.

Section 3: Emerging Trends

The modern monetary system is in crisis. The dominant monetary system in the modern capitalist order–nation state backed central banking model, where credit issued by private banks functions as "money"–has run into increasingly severe structural challenges with increasingly limited solutions. Structural unemployment, stagnant wages, frequent financial crises, and accelerating inequality have become staple features for developed nations. The two structural solutions from the last century–war and government deficit spending–have reached the end of their efficacy. War, for the purpose of mobilizing a nation state economy, is pyrrhic in a post-industrial world dominated by nuclear-armed hegemons. As government debt levels for most developed nations exceed their GDP, increasing fiscal spending has yielded diminishing stimulative effects on the economy. Furthermore, unmanageable debt burdens have also led more governments to adopt austerity politics, which worsen socio-economic problems.

During a time when changes are desperately needed, what is the state of monetary innovations in each of the four layers–ideological, institutional, administrative, and functional?

Section 3.1: The "Innovative" Functional Layer

The functional layer of the modern monetary system has benefitted the most from private sector dynamism. "Innovation", as understood by consumers and the business media, deals almost exclusively in the functional layer. This entails the improvements and expansion of product offering, user experience, and technical tooling in order to extend the capability and efficacy of the monetary system, without changing any of the underlying logic or dynamics. In late stage macroeconomic cycles where systemic issues have reached a point of crisis, functional innovation has largely reached its logical limits. Nevertheless, here are a few

major categories of ongoing functional innovation, based on public information from venture capital backed companies (Andreessen Horowitz, n.d.).

One theme is enterprise software for workflow or infrastructure, tailored to increasingly specialized market segments. The FinTech portfolio of Andreessen Horowitz (a16z) offers a few such examples. Adaptive is an automated financial management platform for the construction industry, leveraging artificial intelligence to automate financial controls. Camber offers automated workflow tools and billing services for the behavioral healthcare industry. Stripe is a suite of APIs powering online payment processing and commerce solutions, which found initial traction with small and medium e-commerce businesses. The rationale behind this pattern is to combine advantages of information technology with specialized market knowledge to generate incremental efficiency optimizations.

A second theme is consumer facing technology to increase access to financial information and existing financial products. For example, companies like Credit Karma streamlined the credit reporting process by delivering real-time credit information directly to consumers. Point offers home equity financing for a fractional share of home value. Tellus provides a variety of high-yield savings accounts through passive income products, without requiring users to directly invest in the markets. Lowering the fixed cost of access ultimately improves the efficiency of the monetary system by eliminating friction—whether by removing the fees for credit report or reducing the upfront capital required for home equity financing. Yet, these improvements actually reinforce the underlying logic and dynamics of the monetary system, often amplifying its systemic vulnerabilities. Expanding retail access to financial products has consistently resulted in asymmetric market dynamics where institutional insiders and early investors offload overpriced assets to latecomers, worsening structural risk and economic inequality.

A third theme is the popularization of novel financial products such as Buy Now, Pay Later (BNPL), or crypto investment products. Services like Affirm or Addi provide instant point-of-sale financing for online purchases, which allows consumers to pay in monthly installments. Coinbase is an exchange platform for users to trade, transfer, and store digital assets, i.e. cryptocurrencies like Bitcoin and Ethereum. Innovations in novel financial products, whether for consumers or investors, align with the monetary system's structural imperative for credit expansion. Consumer loans serve as the conduit for credit creation in the real

economy, while novel investment products provide additional avenues to recycle capital into the asset market.

Lastly, there has been no shortage of creativity in the aspect of user experience. Major banks have adopted mobile banking, leaning on software applications and AI to provide financial services. EarnIn lets workers access the earnings from their paycheck faster than biweekly intervals. Coverd offers a credit card where purchases are eligible for 100% cash back based on a sweepstake system. Digitization and mobile-first user experience improve convenience and engagement, while gamification adds the "fun" factor. While delighting users is important for businesses, such features do not impact beyond the functional layer of the monetary system.

Section 3.2: The Stagnant Institutional and Administrative Layers

In contrast to the hyperactive functional layer, reforms in the institutional or administrative layers that may mitigate systemic risks in the modern monetary system have largely stalled. In the administrative layer, proposed changes in domestic or international policy frameworks to better manage unsustainable debt levels have encountered structural gridlock. In the institutional layer, internal and external pushes for structural change have either proven ineffective or struggled to move beyond ideation. This section examines some of these proposed changes and their structural impediments.

Late-stage credit expansion cycles have resulted in unsustainable debt accumulation systemwide, across both public and private balance sheets, domestically and internationally. In the US, the growth of student debt on private balance sheets has reached a crisis point. As of 2026, total student loan debt has crossed $1.84 trillion, with approximately 43 million American borrowers. Nearly 9 million of these borrowers are in default, accounting for over $208 billion of the total balance (Student Borrower Protection Center, 2026). Student loan debt is especially pernicious as it cannot be discharged through standard bankruptcy proceedings and disproportionately burdens young people who often graduate into uncertain economic conditions. The policy response to the student debt crisis has been feeble. Proposals for sweeping debt cancellation remain dead on arrival. Instead, the government has settled for narrow concessions, such as extending loan durations in exchange for lower monthly payments, and restricting outright forgiveness to highly specific categories like public service workers or disabled borrowers. To view the modern student debt crisis as merely a policy mistake is to misunderstand the structural mandates for credit

expansion in an over-financialized economy. The flipside of the rapid expansion in student debt, which is underwritten by the government and insulated from bankruptcy, is a booming higher education sector. The role of government policy in the modern monetary system can only be to mitigate the worst excesses of these lending practices, not to interrupt or reverse the credit expansion process. Public sector debt has also reached concerning levels in the US and internationally. As of 2026, the US national debt stands at $39 trillion, surpassing the total annual GDP. Despite right wing deficit hawking and claims of fiscal responsibility, runaway government debt is a bipartisan policy, with both Republican and Democratic administrations expanding the public balance sheet (U.S. Department of the Treasury, 2026). The dollar's status as the global reserve status affords the United States the "exorbitant privilege" of running massive budget deficits with minimal risks of currency devaluation or sovereign debt crisis. Unfortunately, this same privilege does not extend to the Global South. When confronted with balance-of-payments crises, nations like Argentina, Egypt, or Bangladesh are forced to accept IMF (International Monetary Fund) loans with brutal structural adjustment conditions of fiscal austerity and market liberalization. The former Chief Economist of the World Bank, Joseph Stiglitz, provided an indicting critique of the IMF Structural Adjustment Programs (Stiglitz, 2002). The "Washington Consensus" framework, from which the IMF operated, imposed the same template on borrower nations–fiscal austerity, monetary control (high interest rate), privatization of state enterprises, and trade liberalization. However, these policies frequently caused economic devastation and social unrest in these nations, rather than economic stability. Despite the mountain of evidence on the failure of these interventions, the IMF has settled for largely symbolic concessions of "social spending floors" or sustainability targets, while keeping the policy of austerity intact in their loan conditionalities. For New School heterodox economists like Clara Mattei, austerity can no longer be adequately explained as bad policy; rather, it represents the structural imperative to protect capital by the logic of the modern monetary system (Mattei, 2022).

The private sector has sought to impact the institutional layer through the creation of "challenger banks" and "neobanks", expanding credit access to market segments that had been left behind by decades of consolidation in the banking sector. The popularization of mobile phones and changes in consumer behavior have carved out a path for newer entrants into the banking sector. Companies, such as Monzo and Revolut in the UK, and SoFi and Varo Bank in the US, have eventually secured full banking licenses. This influx of tech-savvy

entrants has temporarily reversed the trend of consolidation in the banking sector and expanded credit access. However, the structural reality of a central banking system remains. Empirical data confirm that neobanks underperform their traditional peers and carry significantly higher risk profiles, frequently collapsing due to inadequate funding for capital requirements (Citterio et al., 2025). The new entrants that survive are either absorbed by legacy banks via mergers and acquisition, or forced to pursue similar strategies as legacy banks, leading to more consolidation. As a result, the balance sheet of a mature neobank begins to look identical to that of a traditional bank. Ultimately, the upsurge of neobanks has become a temporary anomaly that could not overcome the trend of consolidation in the banking sector under a central banking system.

Other developments in the institutional layer that aim to change the role of the central bank or the government remain either on the political fringes or exclusively in the ideation stage. In the US, the libertarian wing of the Republican party has pushed for the abolition of the Federal Reserve, formalized by H.R. 1846 The Federal Reserve Board Abolition Act sponsored by Rep. Thomas Massie and Senator Mike Lee. From the judicial branch of government, the unitary executive theory has gained traction, especially among conservative judges and legal scholars. Proponents of the theory support the constitutional interpretation that because the executive power is unified under a single individual, the President possesses absolute control over all executive branch agencies, including the central bank (Menand, 2026). This will dissolve any illusion of Central Bank Independence, as the President can remove central bankers at will and directly dictate monetary policy. Although the unitary executive theory is a widely recognized legal doctrine, the judiciary branch has traditionally applied the framework narrowly and has not shown any signs of extending this to the consideration of the Federal Reserve. The Federal Reserve has internally worked on prototypes of Central Bank Digital Currency (CBDC) and FedAccounts, which would allow the Federal Reserve to open up its digital ledger to accept deposits from everyday people and businesses (Ricks et al, 2021). A direct to consumer model would radically reconfigure the institutional relationship between the central bank and the banking sector, potentially leading to bank disintermediation. However, it has been the Federal Reserve's explicitly stated requirement that the implementation of a CBDC must be intermediated through the existing banking sector (Board of Governors, 2022). Referring back to the discussion in Section 2.5, the combination of the unitary executive theory, which subordinates the central bank to the government, and a comprehensive FedAccount

system, which absorbs private banking sector into the central bank, would structurally replicate the architecture of the Soviet Gosbank monobank. Both of these contemporary impulses towards institutional centralization harken back to past non-capitalistic monetary systems.

Section 3.3: Transformational Change at the Ideological Layer

The failure to adequately address structural crises within the means of the existing monetary system has inevitably given rise to transformational ideas that challenge the foundational assumptions at the ideological layer. Such ideological innovations have come in forms such as leveraging parallel structures outside of the nation state economic framework, or rethinking the nature of money itself.

The nation state paradigm itself has increasingly fractured when confronted with challenges of the modern economy. Rana Dasgupta's *After Nations: The Making and Unmaking of a World Order* (2026) offers a historical analysis on the structural decline of the modern nation state system. Relative to human history, the nation state is a very recent and highly contingent historical phenomenon, rather than a permanent feature of global organization. Dasgupta argues that the modern sovereign state was fundamentally a product of European powers domesticating the four core civilizational forces–God, Money, Law, and Nature. Specifically, the nation state system took over the modern world by formulating the right mix of scientific secularism, debt-based fiat money system, judiciary processes anchored by a monopoly on violence, and industrial technology to harness natural resources. The nation state formula, which has been tremendously successful in the past centuries, can no longer contain these civilizational forces, when confronted with globalization and transnational capital, exponential debt expansion, nuclear proliferation, and ecological collapse. As detailed in Section 1.1, a nation state must successfully establish a monopoly of violence over a bounded territory. Structurally, this makes a nation state highly effective at regulating physical assets that are geographically fixed, but ill-equipped to manage the flow of information and value that can easily transcend borders. Benjamin Studebaker takes this analysis a step further, by pointing out that as the flow of wealth and labor accelerates with technological advancements, the relative advantage of capital flow over labor flow also compounds, worsening problems such as inequality and structural unemployment (Studebaker, 2023). As it becomes increasingly difficult for territorial states to govern flows of wealth and people, they are ultimately confronted with the impossible choice to super-

nationalize or decouple. For Studebaker, relying on a set of super-national governing bodies is a political fantasy due to competing national interests while unilaterally decoupling spells economic catastrophe. Therefore, the nation state system has no way out as the control of economic flows inevitably slips away.

Around the question of potential successors to the nation state system, contemporary thinkers have generally converged on a recognition of corporations as increasingly sovereign actors. Both Dasgupta and Studebaker acknowledge this dynamic and provide their respective analysis. Dasgupta focuses on the sheer scale and speed of modern corporations, as technological developments diminish the relevance of physical distance. Studebaker points out how corporations actively cultivate and exploit political paralysis, elevating corporate sovereignty at the expense of nation states. In considering potential futures after the age of nation states, Bernard Lietaer outlines the Corporate Millennium as one of the most likely scenarios, where corporations and their proprietary currencies become the bedrock of the world economic order (Lietaer, 2002). In such a future, the first assumption in the ideological layer that "the world ought to be a society of nations" can be reformulated as "the world ought to be organized around supply chains and economic value, rather than geographical territories". In both *The New Industrial State* (Galbraith, 1967) and *The People's Republic of Walmart* (Phillips & Rozworski, 2019), the authors marvel at the governance capabilities of the modern corporations. Galbraith highlights the fusion of the modern state and modern corporation, with corporations already absorbing much of the logic, technique, and personnel from government bureaucracies. Phillips describes corporations as islands of central planned economies in a sea of market competition. In the Corporate Millennium, much of the existing institutional and administrative layers under the nation state framework can be rapidly repurposed for corporations. Alternatively, if the Corporate Millennium does not materialize, Lietaer also posits the scenario of systemic collapse, followed by emergence of self-sustaining local communities.

Several heterodox schools of thought around the nature of money itself have recently gained mainstream attention. Some notable movements in this space include the Modern Monetary Theory championed by Stephanie Kelton, and proposals for money as public utility or resource-based money. Whereas MMT is mostly an institutional reconfiguration that advocates for government fiscal spending to take precedence using taxation as a primary tool for inflation control, other proposals for money draw inspiration from MMT and

fundamentally change the definition of money (Kelton, 2020). The Public Utility paradigm conceptualizes money as a social information ledger that requires democratic governance (Money on the Left Editorial Collective, 2020). Proposal for resource-based money is an intervention against ecological collapse, mandating environmental sustainability in the issuance and operation of money.

Conclusion

We are living through an age of crisis. There are increasingly serious fractures in our governance models, economic systems, and relationship to the environment. At the heart of these crises is the monetary system, a constructed logic of value that governs how our world operates. After decades of research on government intelligence operations, financial crimes, and peak oil production, investigative journalist Michael Ruppert eventually concludes:

> Until you change the way money works, you change nothing. (Smith, 2009)

A real economy with finite people and resources cannot be compatible with a monetary system that requires infinite growth via credit expansion. A monetary system backed by state violence cannot lead to long term sustainability. A monetary system that requires artificial scarcity and permanent competition will inevitably tear society apart. The monetary system must change.

To make the right changes requires a proper understanding of the modern monetary system and why problems exist in the first place. The purpose of this paper is to provide a structural analysis framework for monetary systems, to understand the system characteristics and dynamics in four layers–ideological, institutional, administrative, functional. The configuration of each layer traces back to the underlying logic of a more foundational layer. For example, the legislative evolution of bankruptcy proceedings is a product of administrative optimizations for a debt-based monetary system. Progress in the institutional or administrative layers is often rapidly undone by a crisis in the ideological layer. For example, decades of operational and legislative refinements in the free banking system were abruptly abandoned when the changing needs of the nation state required a central banking model.

This layered structural analysis framework also serves as a tool to evaluate and refine emerging models for different monetary systems. While this paper identifies some trends

and examples, by no means does it provide an exhaustive list of potential solutions. There are many more interesting and promising proposals for alternative or complementary monetary systems. For example, there have been several local currency systems that are time-based, such as the Ithaca HOUR where a single currency unit corresponds to an hour of work. The foundational components of the ideological layer for such a system may be articulated by radical equality (people's time is fundamentally equal), or labor theory of value (value comes from people's labor). From this ideological baseline, unique institutional and administrative characteristics such as local monetary authority and methods of circulation are established and refined.

This framework is not intended to be used to judge the "best" monetary system, or predict future monetary paradigms. The best outcome is likely multiple complementary monetary systems, each with distinct advantages and disadvantages, working in parallel to support human needs.

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RAMICS in Rio 2026
Plurality of Social Currencies: solidarity economy, municipal and community currencies for inclusive and sustainable futures
Pluralidade das Moedas Sociais: economia solidária, moedas municipais e comunitárias para futuros inclusivos e sustentáveis
8 - 12 Jun 2026 | Rio de Janeiro (Brazil)

THE MAKKIE TIMEBANK IN AMSTERDAM: A COMMUNITY CURRENCY BETWEEN TRANSFORMATION AND COOPTATION

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Abstract

Global financialization has led the politics of money and debt to be increasingly contested. Through the proliferation of complementary currencies, communities show that there are ways to reclaim and reorganize monetary systems to sustain their livelihoods beyond conventional market relations. This paper investigates the Makkie, a timebank-based community currency in Amsterdam-Oost, to explore how such initiatives negotiate the tensions between grassroots experimentation and institutional integration. Drawing from sustainability transitions theory, community currency research, and institutional logics, we examine how the Makkie evolved from a neighborhood-led initiative into a municipally co-financed welfare instrument, and how this trajectory reflects broader dynamics of institutional capture that constrain the transformative potential of grassroots monetary innovations. Based on qualitative fieldwork, we analyze how competing value systems shape the network's design, governance, and socio-economic effects. While the Makkie fosters care-based labor, builds social capital, and challenges the scarcity logic of mainstream currencies, its integration with welfare bureaucracies has constrained its transformative potential. This study highlights the double-edged nature of hybrid community currencies: they can support inclusion but risk becoming compensatory mechanisms that

[1] Commons Network.
[2] Drift for transition.
[3] Drift for transition.



mask rather than challenge neoliberal exclusion. We conclude by offering design and policy recommendations for sustaining community currencies as vehicles for economic democratization and monetary transformation.

Note: This abstract refers to a manuscript accepted for publication in the forthcoming IJCCR special issue on time banks. The final version of the paper will be available upon publication of the special issue.

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THE END OF AN ILLUSION: MONEY AND EMERGING BRAVE NEW WORLDS

Reflections on Six Years of Experience with Social Currencies in Latin America

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This essay draws on research and field observations of initiatives developed by RedLASES and also those of others, over the past six years in the field of complementary currencies, particularly those we have proposed calling "social currencies" because they are self-managed and independent of the banking system and the state (Primavera, 1999). Although our observations focus on several Latin American countries, we haveC maintained an ongoing dialogue with similar initiatives in Germany, Spain, Portugal, and France.

Here, we explore the central ideas that have guided our research as a starting point for understanding these different initiatives in light of the social changes that have taken place during this period. Given the explicit aim of the various projects to build "sustainable buen vivir" (well living), and the difficulty of replicating previously successful models, the questions that first prompted our hypotheses were these:

- How did the COVID-19 pandemic affect the conditions in which local initiatives could develop?
- How has rapid technological change—particularly AI, which makes new tools available to grassroots and government initiatives—affected existing initiatives?

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(Latin American Network for Solidarity Socioeconomics)



- Why do so many initiatives that seek to replicate "successful" models fail?
- What evaluation tools are available to help us move forward when we are committed to social transformation at scale?
- To what extent could the heterodox thinking we propose be more fruitfully incorporated into efforts to foster the "anomaly" represented by community-based, self-managed social currencies?

Drawing on our research to date, we explore the impact of complex thought, bringing Clifford Geertz's approach of "thick description" into dialogue with the systemic logic of Kevin Kelly's "divine laws" Together, these approaches seem to refresh and enrich our capacity to interpret, understand, and redesign models seeking to grow.

The reflections that follow arise from our analysis of experiences undertaken from the beginning of the COVID-19 pandemic - May 2020 through July 2026 - within the Self-Managed Social Currencies Training Program promoted by the Latin American Network for Solidarity Socioeconomics (RedLASES redlases.org). This program involved Argentina (Par, Sonqo, and Sol currencies), Ecuador (Muyu), Uruguay (Trueque con Sol), Chile (Pétalo), and Colombia (Luna and Keya). Partial results are available on the RedLASES YouTube channel: bit.ly/REDLASES.

Appendix 1 presents a synthesis of 20 semi-structured interviews conducted between March and May 2026: redlases.org/aportes At the same time, they allow us to claim for a discussion on the issue of the authorship of this paper, whose meaning absolutely depend on the active participation of the "authors" mentioned in this appendix: Primavera (2025) wouldn`t exist without the permanent, ongoing dialogue since May 2020. This means this paper has a collective author, with different responsibilities: the production of relevant income (exchanges plus meaning of these exchanges) belongs to the Pirca Collective, whose testimonies were the basis for our Geertz/Kelly complexity approach, being at the same time co-responsible for the ongoing Training Program; the further discussion with the different theoretical approaches of complexity and thick description belongs to Primavera (2025).

We should remember that this work builds on thirty years of accumulated experience (Primavera, 1999), beginning with Argentina's barter networks, as well as Brazil's pioneering Palma currency. Palma is now consolidated as public policy through Brazil's 182 community

banks and has gained international recognition (Lietaer, 2001; Lietaer and Primavera, 2013; Primavera, 2017; Primavera and Singer, 2017).

The possibilities for scaling and institutional transformation opened up by AI make complex thought especially timely: it can help us move beyond understanding and toward design, a dimension largely absent both from territory projects and academic research currently under way in both hemispheres.

With this context in place, we put forward for discussion seven ideas/hypothesis of varying scope:

1. “The end of an illusion” refers not simply to the failure of money as the institution governing social relations, but to the exhaustion of the belief that we can transform a social order that systematically generates inequality without significantly changing the architecture of the international monetary system, which is based on bank interest (Kennedy, 1992) and the governance of the international Central Banks system, as analyzed by Bernard Lietaer in its relation with BIS - Bank of International Settlements - weirdly absent of most theoretical (political?) approaches in the field of complementary currencies research (Lietaer, 2001; Lietaer, 2012). Could this be another missing link? Why? How can our responsibility be elicited when such information is so absent in the field? Where else to explore? When could we address this issue, if we consider our hypothesis not enough fertile to face the current inequality crisis?
2. From palliative currency response to a new ludic-political system: Our observations from 2020–2026, compared with the period 1990–2003, point to a significant shift in priorities. Although scarcity develops as fast as in the first industrial revolution; although the employment crisis grows comfortably, the testimonies below mainly point at an unanimous new meaning: social currencies cease to be merely a means of exchange and become rather a pretext for fostering new forms of social relations and practices, that expand “prosumer” awareness. Whether held in person or online, and using paper or digital notes, markets go beyond buying and selling. They explicitly encompass all three phases of the economy: artisanal and personalized production, trading conducted entirely in social currency, and ethical, responsible consumption.

Imagination flourishes, along with new roles and skills nurtured by the mutual contagion of regular weekly gatherings. This shift connects directly with the proposal we have been developing in different territories: "Let us scale impact on well living (buen vivir), not merely on the amount of transactions." This is new. Why such a change, compared with the previous decades? Which consequences on politics as a whole could this drive?

3. An epistemological anomaly?

   These reflections pose a new challenge both to social actors, activists and researchers:

   Why do the social, political sciences struggle to understand - and then help promote - social, community-based, or municipal currencies?

Which conceptual lenses prevent us from seeing what is happening "behind" the apparent "physical" markets?

Our field observations lead us to argue that Geertz's approach of "thick description" (1973) has helped us move beyond traditional conceptual categories toward a more effective way of catalyzing the social transformations embodied in many participants' utopias—the work of those "cathedral builders."

By way of a brief introduction to our pairing of Geertz and Kelly, we outline the contributions we have drawn on throughout the post-pandemic period.

Kevin Kelly's contribution (1994) has significantly helped our understanding the behaviour of groups ("nodes") and, as a consequence, redesign them in the community network through his nine "divine laws": 1. Distribute the new being; 2. Control from the bottom up; 3. Reproduce what works; 4. Grow by parts, not from the whole; 5. Invest in the marginal; 6. Honor errors; 7. Pursue multiple goals, not optimal ones; 8. Seek persistent disequilibrium; 9. Accept that change changes...

In interpreting interviews with representatives of the five social currencies in the Abya Yala Collective (Sol, Muyu, Trueque con Sol, Luna, and Keya), we have sought to incorporate key features of Geertz's (1973) "thick description":

- Human beings are suspended in webs of significance they themselves have spun, and culture consists of those webs.

- To study a culture is to interpret it, not to formulate causal laws about it.
- Thick description does not mean describing a great deal or at great length; it means reconstructing the significance of actions within their context.

We should seek, then, to draw broad conclusions from small but densely interconnected facts.

For example, when a woman exchanges a service for a coat, the event may appear small—a simple transaction. Through thick description, however, it can be reconstructed as a chain of meanings:

value → reciprocity → trust → care → currency → community → economic transformation

Our data are our own constructions of the constructions other people make of what they themselves are doing.

We do not treat these testimonies as "objective data" that simply need to be coded. Instead, we ask: *How does this person make sense of that experience today?*

lived experience → memory → present-day interpretation → new meaning

This introduces an extraordinarily rich temporal dimension. In our particular case, what can we learn from thirty years of small, ongoing exchange experiences that remain invisible when we count only currencies and transactions?

The seven ideas announced here are not intended to form a closed framework. Six are developed in this essay; the seventh remains deliberately open - not as an omission, but as an invitation to move forward, extend the inquiry, and co-create the emerging worlds that are still to come.

4. Artificial Intelligence as an Ally and Tool for Transformation

Within the Abya Yala Collective's social-currency space (Sol, Muyu, Luna, Keya, and Trueque con Sol), something has happened almost simultaneously: AI, "spontaneously" discovered at one point in the "great network of loving prosumers," is beginning to be seen not as a technological threat but as an available tool for the symbolic and material empowerment of grassroots initiatives. We dare using the word "empowerment" to describe what most members consider as a "liberation of their potential". Participants are creating imaginative



flyers, marketing their own products and services, and, in some cases, organizing weekly themed gatherings... even if "professionals" may consider this production as a "low level" one. They seem to cultivate an important community value: autonomy.

Paradoxically, everything seems to be (a little more) within everyone's reach: singing, cooking, dancing, experiencing new well living practices (not affordable in the "other" market), designing new life proyects...

This raises an exceptionally timely question: *Can AI democratize the capacity for institutional design, or will it simply reproduce existing institutions? Which role could researchers play in this trend?*

5. From simplistic replication to continuous adaptive design

With Flores (1994), Geertz (1973), and Kelly (1994) as guides, we can apparently move beyond the search for "the right model" and instead, think in terms of complex systems, adaptation, learning, and the emergence of other worlds.

In our early reflections, we examined the weight of "hidden institutions" that shape our behavior and may prevent the widespread adoption of social currencies (*saving, rent and inheritance*) (Primavera 2003). We later connected these to three concepts with previous academic resonance: *cognitive blindness, epistemological inertia, and conceptual irresponsibility* (Primavera 2010)

That is why, in our view, a social currency may change the medium of exchange while leaving untouched the institutions that determine:

Who owns wealth, who can access it, who accumulates it, and who passes it on.

The question is then, no longer simply: How do we design a social currency that works?

It becomes instead:

* What institutional transformation is needed for a social currency to generate sustainable impact?

* Who will develop such proposals?

* What new concepts will they draw on?

This does not mean abandoning the utopian promise of social currencies. Perhaps we need only stop asking them to accomplish on their own what in fact requires a redesign of the integrated political and economic ecosystem.

6. Voluntary Servitude to a System We Say We Want to Eliminate

Prompted by thick description, and by our difficulty in making social-currency initiatives resilient, we turned to the work of Étienne de La Boétie. In the mid-sixteenth century, his "Discourse on Voluntary Servitude" raised a compelling central question:

Why do human beings willingly obey a power that dominates them?

Among the author's key ideas, we can highlight the following:

Domination is not sustained by force alone

La Boétie reframes the problem: a tyrant cannot control a multitude through soldiers or violence alone. If millions obey one person, the subjugated themselves are, in some way, cooperating in their own subjugation. That is the paradox of voluntary servitude.

Power feeds on obedience

The tyrant may appear to possess power in his own right, but his power actually comes from those who obey him: one → a few → many → everyone.

The structure reproduces itself because each level gains some advantage from the level above and, in return, helps keep those below it subordinate. This anticipates a networked understanding of power, rather than treating power as something held solely by "the ruler."

Custom makes domination seem "normal"

One of La Boétie's strongest arguments is that people are born free, yet those who grow up under domination eventually come to regard it as natural.

"It has always been this way"—and therefore, "it must be this way." Custom creates a kind of blindness to the possibility of another form of social organization.

Here we see a strong connection with the concept of epistemological inertia that we have proposed.

The tyrant must manufacture dependency

La Boétie observes that power is sustained not only through fear. It also distributes privileges, honors, perks, favors, and… small shares of power. In this way, some of the dominated become intermediaries in a pyramid of domination: tyrant → court/intermediaries → officials/beneficiaries → population.

That is why the system is so difficult to dismantle: many people have something to lose if it disappears.

The people have the capacity to withdraw

Here we encounter perhaps the most radical idea in the text. La Boétie does not necessarily advocate a great, violent revolution. His question is much simpler: What would happen if people stopped obeying?

The tyrant's power would collapse because it depends on the cooperation of those who sustain it. Hence the famous idea, paraphrased: "Resolve to serve no more, and you will be free."

Freedom precedes obedience

La Boétie starts from an anthropological intuition: human beings have a natural disposition toward freedom and relationships among equals. Servitude, then, is not simply a condition imposed from outside; it must be continually reproduced.

Here we return to the triad proposed earlier (Primavera, 2003), bringing Étienne de La Boétie into dialogue with the field of monetary rebellion:

La Boétie (1547)	Primavera (2003)
"Domination becomes invisible through custom"	Cognitive blindness
"It has always been this way"	Epistemological inertia
"We actively participate in reproducing what dominates us"	Conceptual irresponsibility



La Boétie asks how we fail to see our own participation in what dominates us. This takes us from the familiar question - *Who holds power?* - to a more uncomfortable one: *What do we do every day to keep that power in place?*

La Boétie thus seems strikingly contemporary: Foucault, Bourdieu, Arendt, and even some approaches to institutional economics can be read as later developments of a question he had already posed in the sixteenth century.

This connects especially fruitfully with our proposal concerning the "hidden institutions" of saving, rent, and inheritance, which have become normalized and need not coerce us explicitly (Primavera, 2003). They can structure our possible courses of action so that we end up voluntarily reproducing arrangements we never consciously chose.

We propose a hypothesis here for a shared line of inquiry:

The most effective form of domination is not to prevent people from thinking, but to ensure that they think only within categories that render invisible the possibility of ceasing to obey.

We must ask whether this condition applies in every setting.

Where do we draw the line between neutrality, complicity, and commitment to the oppressor when we fail to offer an interpretation that fundamentally questions the legitimacy of social currencies not backed by official currency?

Perhaps the time has come to move from conceptual irresponsibility to rebellion and conceptual creativity in monetary creation. With Geertz and Kelly, Polanyi, Marx and/or La Boétie, we could commit ourselves to transforming the world they glimpsed but did not live to see.

Who else, if not us?

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Appendix 1. Summary of 20 testimonies collected between April and May 2026 from different experiences with Par, Sonqo, and Sol currencies (Argentina); Muyu (Ecuador); Trueque con Sol (Uruguay); and Luna and Keya (Colombia): https://redlases.org/aportes



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