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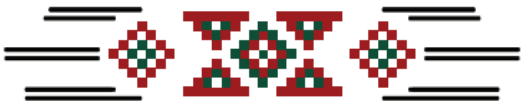

COMPLEMENTARY CURRENCY SYSTEMS BRIDGING COMMUNITIES

Full papers of the 6th RAMICS Congress

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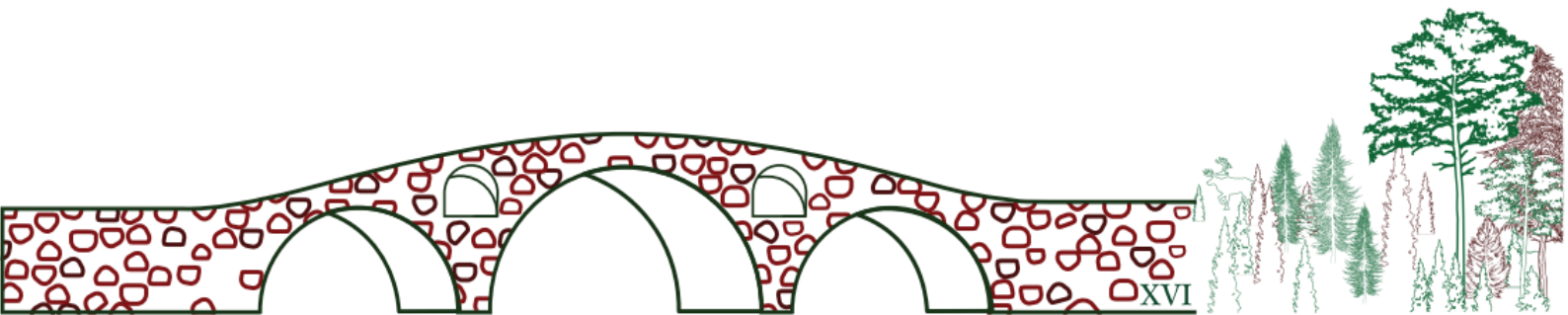

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Dialectic of money

The nature of modern money as 'ideational money' that diversifies as private money such as community currencies and cryptocurrencies
- in view of evolutionary perspective* -

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Keywords *Money, Evolution, Ideational money, Gresham's law, Community currency, Cryptocurrency*

ABSTRACT:
The tree diagram of evolution of money shows that meterial money (commodity money) and credit money (debt money) independently emerged and evolved in parallel as external money, and that there was diversity of money and exchange according to the counterpart and the sphere of circulation. Modern fiat money without redemption obligations has still been recorded as debt on the balance sheet of the central bank after the introduction of the floating exchange rate system in 1973, however, it can no longer be conceived as credit money as a debt instrument. Given this reality, it is appropriate to regard them as securities or utility tokens and record them as equity/ capital on the balance sheet. Doing so is expected to have the effect of reducing the risk of insolvency of the central bank and promoting a change in the cognitive and behavioural rules (internal institutions) of economic agents so that it can provide more stability with a global financial system. The fundamental problem is that modern legal tender is neither material money nor credit money, but a third type of money, i.e. 'ideational money' or 'symbolic money', which is established and maintained as the self-realisation of two ideas, 'past customs' and 'future expectations', and this is the common nature of modern money, including community currencies and cryptocurrencies. Currently, communities (including nations and regions) that share different ideas and symbols are diversifying due to digitalisation and online access. The emergence of a situation of multiple belonging of individuals to communities has led to the diversification of private currencies such as cryptocurrencies and community currencies, which have different names, different standards of exchange and different spheres of circulation with non-fixed exchange rates, promoting what Hayek calls the 'denationalisation of money'. There, instead of quantitative competition based on Gresham's Law ('bad money drives out good'), qualitative competition based on the principle of choice in currency ('good money drives out bad') operates, and the characteristics of 'good money' other than stable monetary value are created and discovered through monopolistic competition for money.

The relevant theme of RAMICS2022: I. Dialectics of CCS and/or money

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0. Introduction

The central question for understanding and envisioning modern money in the 21st century is the enigma of what fiat central bank notes that exist at the core of the modern myth of finance 'one nation, one money' are and what they are worth. To dispel the myth and solve the enigma, we should reconsider the real nature of modern legal tender as inconvertible central banknotes under the floating rate system operating since 1973. Although the Bank of Japan's balance sheet still shows outstanding banknotes as liabilities, fiat central banknotes are not material money, nor are they credit money with repayment obligations like convertibles. They are purely informational money, completely independent of physical use values and debt-credit relationships. In other words, they should be regarded as a third type of money, what we call "ideational money" or "symbolic money. This characteristic is shared not only by modern national currencies, but also by increasingly diverse private currencies, including cryptocurrencies and community currencies. If we rethink Bank of Japan notes as equity securities or utility tokens and conduct a thought experiment on what might happen if they are listed as net capital on the balance sheet, we can begin to see the possibilities of a future in which currencies are diversified.

How such new ‘currencies’ survive through users’ choice in money and what the criteria of such decision are crucial points to be considered. In such diversity of money where it is possible to seek the kinds of money to be desired, we must realize the true meaning of Hayek’s principle of choice in currency in terms of ‘quality', which is ‘good money drives out bad’, instead of the Gresham’s law only regarding ‘quantity', which is ‘bad money drives out good’. For the principle of ‘choice in currency’ to function well, 1) different denominations for distinction of money in quality, and 2) the non-fixed exchange rates are necessary. Since cryptocurrencies met these conditions, the principle of choice in money began to work. They satisfied the forementioned two conditions for users’ choice in money to begin to work and simultaneously took the test for good money through users’ search for it. However, cryptocurrencies failed to pass the criteria of 'a stable value of money' that Hayek attached importance to for good money.

For cryptocurrencies and other digital money to become 'good money,' it is at least indispensable to have 'a stable value of money' that enables for currency to be more accepted and smoothly circulating. Whether a community-based or local consumer market can be formed, and workers' salaries can be paid by it are also other important factors for good money. In this respect, DCC with the connotation of local area and community could be a strong candidate for good money. Two DCCs in Japan, Sarubobo coin and Aqua coin are now challenging towards realization of good money. Finally, we will introduce Good Money Lab, an industry-academia-government-private consortium to foster DCCs as good money.

1. Dematerialization of Money: “Dematerialization of Monetary Substance" and "Demonetization of Monetary Media"

The digitalization of money and the shift to cashless transactions, which are currently underway, became possible only on the premise of the dematerialization of money, which was made possible by the emergence and spread of fiat money. This is because the value embodied in fiat money has been completely separated from the physical use value of the specie (gold coin or bullion) used to secure it. By switching from traditional physical value representation media composed of materials such as ink, paper, and printing presses, which are used for printing fiat money, to other physical value representation media composed of hardware such as computers, smart phones, smart cards, as well as software such as operating systems and applications, in addition to infrastructure such as power plants, power lines, optical fibers, radio towers, and artificial satellites, we can replace all the analog information of money with digital information. This has enabled smoother, more efficient, remote, global, and automatic monetary transactions even without human intervention.

The current "dematerialization of money" means the dilution of things as substance that embody and represent value, rather than things as media that express and transmit value. In other words, the "dematerialization of money" means the "dematerialization of monetary substance" and not necessarily the "dematerialization of monetary media". In the ongoing digitalization of money and cashless society, out of the genuine money consisting of "cash" and "deposits," we are trying to reduce the tangible things

~~expressing analog information called "cash" as much as possible by substituting the digital information~~ of "value" of electronic money and digital coins (cashless society), and integrate as much genuine money as possible into intangible figures of digital information called "deposits".

In this case, we notice that there are important intangible industrial products such as electricity, electromagnetic waves, light, and sound as well as many tangible industrial products such as electric wires, optical fibers, computers, and smartphones, the latter of which we can only see and touch, and that those intangible and tangible industrial products for enabling digital monetary media have rather increased in volumes. In other words, we can see that the "dematerialization of monetary substance" has currently progressed, but the "dematerialization of monetary media" has not progressed much.

In the white paper by Satoshi Nakamoto, Bitcoin was intended to be a "P2P digital cash system" that would use blockchain (Distributed Ledger Technology) to completely digitize "cash" through distributed ledger and distributed issuance (Nakamoto 2017). Thereafter, the core idea had been forgotten, and Dr. Craig Wright, who I assume to be considered as one of the members stood for Satoshi Nakamoto, has been struggling to reinstate it as Satoshi's original vision and has established the true Bitcoin as Bitcoin SV incorporating Satoshi's Vison (Wright 2019). On the other hand, the idea of Central Bank Digital Currencies (CBDCs), which would allow the state and central bank to turn cash into digital cash while maintaining the traditional central bank centralized issuance, is being promoted mainly in China and is one step closer to reality. CBDCs can be either wholesale, which is used only for settlement among financial institutions and businesses without changing the existing coexistence of analog "central bank notes (cash)" and digital "current accounts (deposits)" in the existing central bank currency, or general-purpose, which changes the existing structure of cash and deposits by completely digitizing cash and is used by all entities, including citizens. In any case, if we can completely eliminate analog central bank notes, we will be able to settle funds more efficiently, but even in that case, we will need to answer the fundamental question of whether Bank of Japan notes as 'cash' are certificates of obligation or something else.

2. A Tree Diagram of money with four stages: primitive money, material and credit money, cash and deposit money, and various non-national moneys

Central banknotes have a long history as the legal tender of the nation-state and have a solid institutional foundation, so their value may appear to be unassailable. However, if you recollect it, it has only been about 280 years since Peel's Bank Act of 1844, which practically established the monopoly of the Bank of England, the first central bank in history to issue notes. In terms of human history, that's just a blink of an eye, and it's an event that could change at any time. We are not trying to say that the value of Bitcoin is much more stable or solid than legal tender. If we look at the evolution of money from a very long-term perspective of thousands of years, both legal tender with its 280 years of history, and Bitcoin with its only 10 years of history, are not that different in terms of the length of time they have been around. In addition, they both share the common characteristics of modern money.

The value of modern money, such as fiat legal tender, cryptocurrencies, and community currencies, is not supported by intrinsic value such as the use value of the physical goods that make up the currencies, nor by the credit-debt guaranteed by the currencies, nor by expected future earnings such as interest and dividends. In other words, modern money is neither material money (commodity money) nor credit money, and it is not securities such as bonds and stocks that pay interests and dividends, either. Then, what exactly are these modern money?

According to the theory of the origin of material money (commodity money), it emerges spontaneously as a means of exchange to mediate indirect exchange because direct exchange (barter) becomes more difficult as the number of goods increases. This leads to another assertion that thus emerging material money such as gold coin or bullion is the principal money, and credit money is derived as an IOU that proves the credit-debt relationship of material money. In contrast, the theory of the origin of credit money argues that the credit settlement system is the money because the ledger, which is a record of transactions written by numbers and letters, plays the role of money even if there is no physical object as in material money in the first place. In other words, credit money can be established on its own without the existence of real entity such as use value of material money if there was some acknowledged ledger

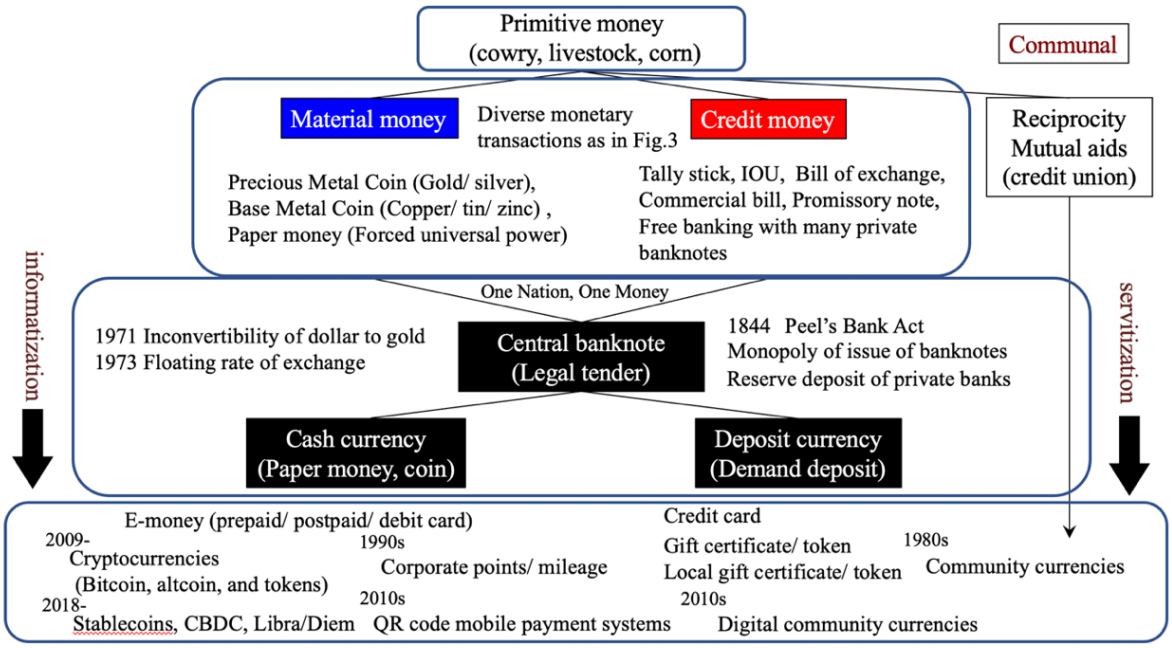
form using written language. According to this view, money is not a thing as a means of exchange, but a transferable credit or debt. It is a transaction clearing system consisting of three basic elements: 1) a unit of value, 2) an accounting system, and 3) transferability.

Perhaps because cryptocurrencies like Bitcoin and Ethereum use a distributed ledger technology called Blockchain, the latter idea is growing in power. Thus, credit money is now becoming to be believed to be not necessarily a derived representation of material money nor emerged in capitalist economy but to have already existed in the ancient world. In medieval Europe, wooden-made split tally sticks were widely used, in which the creditor and debtor recorded their debt information, which was then split in two and kept by both parties as a certificate. Single tallies, in which debt information was recorded on animal bones, can be traced back to the Paleolithic period. This type of credit money was used not only by private merchants and artisans, but also between them and the official state. Thus, it has become increasingly clear that credit money has a history as long as that of material money.

As a result, the view that the essence of money is not material money but credit money, and that modern money is an IOU that circulates on the basis of credit relationships, has gradually gained strength. Randall Wray, one of the founders of Modern Monetary Theory (MMT), developed a theory of money whose origin is credit money. It combines nominalism, which holds that money is merely a unit of nominal value, and chartalism, which holds that money is created as a means of direct economic activity of the state, such as fiscal spending, with its compulsory right to collect taxes. In Wray's view, modern central banknotes do not represent real value as in the case of material money but are negotiable instruments of indebtedness (IOUs) that represent a unit of account and are issued on the basis of the state's ability to collect taxes. Whether this view of MMT is correct or not will be discussed later.

Here the problem is if it is appropriate to ask which expresses the essence of money, material money or credit money, and which is the historically prior origin? For the question itself may be wrong. The reason why we think that the money that forms the market economy is *either* material money *or* credit money is because we unconsciously assume that money has developed on a straight path in history. This is probably because the modern money that we daily get used to under the current "one nation, one money" system is only one type of national currency. However, if the evolution of money branches into multi-track rather than just single-track, and if the ways of monetary exchange have been always diverse in history, it should not be possible to explain the actual history using only a single theory or position.

Fig.2 A Tree Diagram of Money (prepared by the author)



The tree diagram depicts the evolution of money in four stages: 1) the emergence of primitive money as a medium for gift-giving and reciprocity in primitive communities; 2) the parallel development and growth of "material money" represented by gold, and "credit money" represented by IOUs (I Owe You), as media for equivalent exchange in the market economy since ancient times; and 3) the coexistence of two currencies, cash currency and deposit currency, with the core of central banknotes integrating material money and credit money in the period of establishment of capitalism; and (4) the ongoing diversification of private currencies, such as cryptocurrencies, corporate currencies, gift certificate/ tokens, and community currencies.

The salient feature of such primitive money is that it was used to realize ritual and customary bilateral gift-giving and return within a certain community, or multilateral reciprocal relation as a chain of gift-giving among three or more parties. In addition, primitive money contained both economic and commercial purposes as well as social and cultural purposes, the latter often being more important. When money emerged from primitive money in the community used for reciprocity as well as redistribution eventually to provide the principle of equivalent exchange in the market, it branched into two types of money, material money and credit money, and evolved in parallel while influencing each other. In the history of mankind, primitive money, which is internal money and special-purpose money for community reciprocity and redistribution, has been the forerunner, and material money and credit money, which are external money and all-purpose money for the development of market economies outside and among communities, have continued to expand in parallel (Polanyi, K. 1957).

3. Plurality of Monetary Exchanges in History and the Evolution of Money through Self-organization, Replication, Variation, and Selection

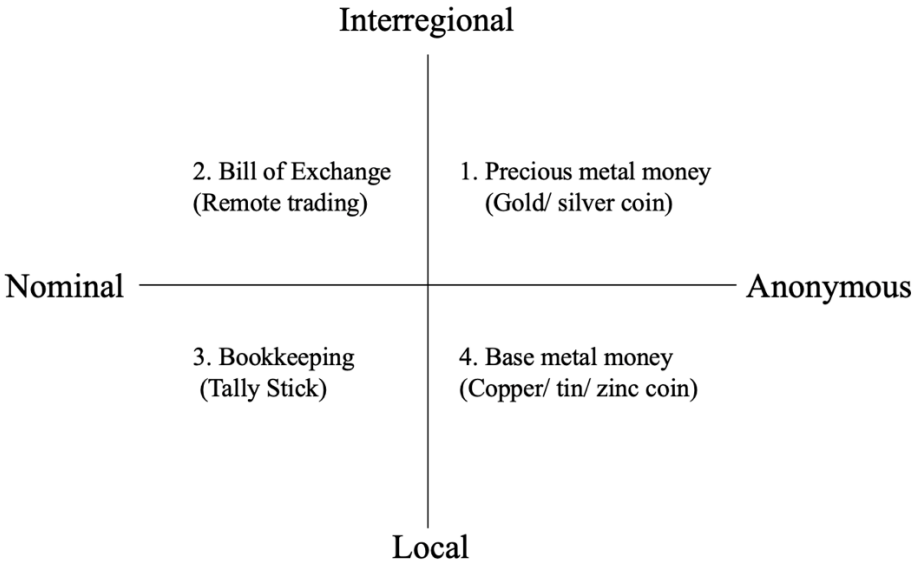
From a global historical perspective, it is known that there were a variety of ways of monetary exchange, not a single way (Kuroda 2020). In Fig.3, the horizontal axis indicates whether transactions are anonymous or nominal (named), and the vertical axis indicates whether they are interregional or local. According to these two axes, monetary exchange can be classified into four different areas. First, let's look at the first quadrant, which is anonymous and interregional. In the international marketplace, where traders who are strangers to each other engage in high-value transactions, they are paid in precious metals (gold and silver coins), which are material money. Next, in the second quadrant, which is both nominal and local, remote trade could be conducted using bills of exchange, which are credit money mediated by a trustworthy third party, because it is possible to trust a partner with whom one has had a long-term face-to-face business relationship. Furthermore, the third quadrant, which is manifestly nominal and localized, corresponds to the case where consumers shop at neighborhood stores or artisan workshops. Since small transactions were carried out by acquaintances who knew each other, bookkeeping transactions were carried out using credit money such as tallies to describe credit-debt relations. Finally, the fourth quadrant, which is anonymous and localized, refers to transactions in non-permanent markets such as regular markets and bazaars around cities. In small transactions between strangers at fish and vegetable markets, where the buyers and sellers were strangers, payment was made with base metal currency, which is material money.

In this way, material money is used in anonymous business relationships and credit money is used in nominal (named) business relationships, and the specific form of money is determined according to whether the transaction is interregional or local. However, from the 19th century onward, with the development of capitalist market economies and the establishment of central banks, the "one nation, one money" system was established, and the diversity of monetary exchange was lost, and material money with physical use value became cash money and credit money in commercial banks became deposit money. As a result, the plurality of monetary exchanges was lost. The diversity of currencies, which had once disappeared, is now emerging again as the diversity of non-national, private currencies, taking the form of e-money.

Money, like language, was not originally invented or deliberately created by anyone, but was naturally created through the repeated interaction of people. In addition, the rules differ slightly from region to region, and as the rules change little by little over the long period, the system that is accepted by the people of each region and era is inherited, and the system that is not is discontinued and no longer used.

Money is thus self-organized, propagated, and spread, and new types and characteristics are created through innovations in which people intentionally change the rules regarding new materials, technologies, and the scope of distribution. Those that adapt well to the sometimes rapidly changing environment survive, and those that do not perish. In other words, the evolution of money is a dynamic and complex phenomenon that consists of four different processes: 1) self-organization (emergence), 2) replication (propagation and diffusion), 3) variation (innovation as artificial mutation), and 4) selection (survival and extinction)[1]

Fig.3 Plurality of monetary exchange
(Source: Kuroda 2020, amended by the author)



4. Reconsidering the nature of legal tender as national currency

Let us now reconsider the controversial issue of central banknotes, which make up the bulk of legal tender and underpin the national monetary system at large. What exactly is a central banknote? Is it a liability or an asset? Why do they circulate from person to person? Let's take Japan's central bank, the Bank of Japan as an example.

If Bank of Japan notes are held by all economic entities other than the Bank of Japan, including the Japanese government, private financial institutions, corporations, and citizens, they are recorded as "cash" in the assets section of their balance sheets. However, in the Bank of Japan's own balance sheet, the balance of outstanding Bank of Japan notes (the total amount of Bank of Japan notes held by all entities other than the Bank of Japan at a given point in time) is recorded as "banknotes issued" in the liabilities section of the balance sheet. Bank of Japan's "current accounts" in the same liabilities section are deposits made with the Bank of Japan by all private financial institutions.

When the Bank of Japan engages in "buying operations" to purchase previously issued bonds from financial institutions, it transfers the proceeds to the BOJ current accounts of the counterpart financial institutions, thereby increasing the BOJ current accounts. The Bank of Japan issues Bank of Japan notes and supplies them to the market when private financial institutions withdraw Bank of Japan notes as cash from the Bank of Japan current account. When this happens, the number of Bank of Japan notes issued increases and the Bank of Japan current account decreases by the same amount.

[1] For more information on the basic concepts and framework of evolutionary economics, please refer to the following literature and papers: Aruka (2015), Dopfer, Potts (2008, 2009), Nishibe (2006, 2012).

Conversely, if financial institutions do not need cash, they will deposit it in the Bank of Japan's current account, which will reduce the amount of banknotes issued and increase the Bank of Japan's current account by the same amount. This return is called the 'reflux' of Bank of Japan notes. On the other hand, 'cash' is recorded in the assets section of the balance sheet. This portion is recorded as "cash" because it is issued when the Mint, an independent administrative agency, manufactures coins on behalf of the government and delivers them to the Bank of Japan. In other words, 'cash' does not refer to Bank of Japan notes but to the supplementary currency issued by the government and held by the Bank of Japan, different from daily usage of the term 'cash'.

Thus, central banknotes issued by the central bank are certificates of indebtedness and represent liabilities of the Bank of Japan to other entities, and only government money (supplementary currency as coin) held by the Bank of Japan itself is considered to be an asset as "cash". According to the Bank of Japan's financial statements as of March 31 shown in Fig. 4, total assets were 604,484.6 billion yen, total liabilities were 599,937.2 billion yen, and net assets were 4,547.3 billion yen. The balance of banknotes issued by the Bank of Japan is 109,616.5 billion yen. At present, cash as asset accounts for only 0.19% of banknotes issued as a liability.

Fig. 4 Balance Sheet of Bank of Japan (March 31, 2020) Source: Financial Statements for the 135th Fiscal Year/Fiscal 2019 (https://www.boj.or.jp/en/about/account/zai2005a.pdf)

Item	yen
ASSETS	
Gold	441,253,409,037
Cash	205,061,074,044
Japanese government securities	485,918,129,988,422
Commercial paper	2,551,889,033,716
Corporate bonds	3,220,825,190,968
Pecuniary trusts (stocks held as trust property)	727,714,519,973
Pecuniary trusts (index-linked exchange-traded funds held as trust property)	29,718,938,645,617
Pecuniary trusts (Japan real estate investment trusts held as trust property)	575,305,889,680
Loans and bills discounted	54,328,648,000,000
Electronic loans	54,328,648,000,000
Foreign currency assets	25,966,256,288,216
Foreign currency deposits	1,732,262,396,986
Foreign currency securities	2,355,224,668,143
Foreign currency mutual funds	60,613,713,087
Foreign currency loans	21,818,155,510,000
Deposits with agents	23,994,220,003
Other assets	590,051,545,382
Bills and checks in process of collection Capital subscription to the Deposit Insurance Corporation, and the	6,356,685
Agricultural and Fishery Cooperative Savings Insurance Corporation	225,000,000
Capital subscription to an international financial institution	15,278,374,364
Withdrawn cash to be returned to the government	38,707,429,941
Refund on accrued tax	52,621,989,719
Accrued interest receivable	470,183,576,216
Others	13,028,818,457
Tangible fixed assets	216,444,108,401
Buildings	105,726,690,246
Land	84,124,182,999
Lease assets	7,598,665,055
Construction in progress	7,458,248,538
Other tangible fixed assets	11,536,321,563
Intangible fixed assets	129,890,768
Utility rights	129,890,768
Total assets	604,484,641,804,227

LIABILITIES	
Banknotes	109,616,575,483,650
Deposits (excluding those of the government)	447,076,239,363,367
Current deposits	395,256,035,035,254
Other deposits	51,820,204,328,113
Deposits of the government	12,633,850,593,434
Treasury deposit	150,001,026,112
Domestic designated deposit	12,239,860,364,524
Other government deposits	243,989,202,798
Payables under repurchase agreements	24,116,347,566,200
Other liabilities	84,086,119,657
Remittances payable	14,760,764,172
Taxes payable	28,031,000,000
Lease liabilities	7,988,759,130
Others	33,305,596,355
Provision for retirement benefits	203,316,793,791
Provision for possible losses on bonds transactions	4,799,292,993,013
Provision for possible losses on foreign exchange transactions	1,407,536,000,000
Total liabilities	599,937,244,913,112
NET ASSETS	
Capital	100,000,000
Legal reserve	3,252,007,626,093
Special reserve	13,196,452
Net income	1,295,276,068,570
Total net assets	4,547,396,891,115
Total liabilities and net assets	604,484,641,804,227

Here, the following points should be noted. If the government manufactures 200 billion yen in coins at a cost of 40 billion yen and delivers them to the Bank of Japan, 200 billion yen in "cash" will be recorded in the assets section of the Bank of Japan, but no liabilities will be incurred by the government. Therefore, the difference between the two, 160 billion yen, becomes revenue. This gain on money issuance is called seigniorage. In the Middle Ages, seigniorage referred to the privileges of feudal lords, and especially to the profits from the issuance of gold and silver coins. If seigniorage occurs in coins, does it also occur in Bank of Japan notes? It is tempting to think that if 100 trillion yen of Bank of Japan notes are printed and issued at a cost of 20 trillion yen, the difference of 80 trillion yen would be seigniorage, but the general view is that seigniorage does not occur because Bank of Japan notes are recorded as liabilities, not assets. We will discuss whether this is true or not later.

The Bank of Japan used to issue convertible banknotes that had to be exchanged on demand for the nation's standard currency, specie (gold or silver coin). A convertible banknote is a check of deposit of specie, a certificate of debt obligation guaranteeing that the bank will hand the specie over to the person who brings it to the bank. Under the gold standard and/or silver standard, specie is a coin that contains a certain amount of precious metal based on par value and whose real value does not differ from its marked face value, i.e., gold/ silver coin or bullion. In Japan, the New Currency Ordinance of 1871 set the gold parity at '1 yen = 1.5 grams of pure gold', but the Coinage Law of 1897 halved the gold parity to '1 yen = 0.75 grams of pure gold'.

When the Bank of Japan issued convertible banknotes, it entered the gold or silver bullion or coins for specie reserve as assets on its balance sheet and the banknotes issued as liabilities. The Bank of Japan convertible notes were negotiable certificates of obligation (IOUs) and were credit money. However, since Nixon's cancellation of direct convertibility of US dollar into gold in 1971 and the transition to a floating exchange rate system in 1973, all national currencies, including the US dollar, are no longer guaranteed to be convertible to gold. The central banks of each country now issue inconvertible banknotes that are not guaranteed to be convertible into specie. That is fiat money, legal tender, or cash, and there is no longer specie. The exchange rates that fluctuate daily in the foreign exchange market merely indicate relative exchange ratios between national currencies, and do not represent any absolute real value. From a postmodern philosophical point of view, modern money is just information that displays only 'differences'.

However, the Bank of Japan kept on making an entry of the balance of central banknotes issued as "banknotes issued" in the liabilities section of its balance sheet, just as it did when it issued convertible banknotes. Included in the assets section are not gold or silver coins or bullion for specie reserve, but government bonds, loans, Exchange Traded Funds (ETFs), Real Estate Investment Trusts (REITs), and stocks paid with BOJ banknotes and current deposits.

According to the financial statements for FY2019, Japanese government bonds (JGBs, Japanese government securities in Fig.4) account for the largest portion of total assets at 485,918.1 billion yen, followed by loans and bills discounted at 54,328.6 billion yen, ETFs at 29,718.9 billion yen, foreign currency assets at 25,966.2 billion yen, equities at 727.7 billion yen, REITs at 575.3 billion yen, gold bullion: 441.3 billion yen cash: 205.1 billion yen etc. It should be noted that JGBs, ETFs and REITs have grown significantly. On the other hand, in the liabilities section, banknotes issued, and deposit increased up to 109,616.5 billion yen and 447,076.2 billion yen, respectively, while government deposits decreased to 12,633.8 billion yen, which is probably due to an increase in extraordinary spending for corona virus countermeasures.

ETFs and REITs, which are assets other than JGB, have been rapidly growing among assets since 2010, when the Bank of Japan began buying them to help the Japanese economy escape the Subprime financial crisis and promote stable growth after it. They are not stocks of specific industries or companies, or specific buildings or land, but rather indices that represent the weighted average of the market value of Japanese stocks and Japanese real estate listed and traded on the stock market, so the Bank of Japan is, so to speak, an anonymous holder of stocks and real estate for all of Japan. If you closely look into the ETFs owned by the Bank of Japan and add up the shares that make up the ETFs, you will find that there are more than 200 companies in which the Bank of Japan owns 5% or more of the shares, and about 50 companies in which it owns 10% or more. The Bank of Japan not only influences the stock market, but also has a great deal of influence over these private companies as an indirect major shareholder, although it is the asset management companies that exercise the voting rights.

Why is the balance of central banknotes issued listed as a liability on the balance sheet? In the Bank of Japan's view, this is because the stability of the value of Bank of Japan notes is due to the Bank's appropriate monetary policy, which makes them "like" certificates of obligation. It is also claimed that such a dealing of central banknotes issued is the same as major central banks of foreign countries. However, we do not understand the logic behind the Bank of Japan notes' "debt-like" status[2]. For, whether inconvertible central banknotes are debt instruments or not is irrelevant to the appropriateness of the BOJ's monetary policy and public confidence in the BOJ. Since fiat money has no obligation to be redeemed in the first place, the question of debt repayment does not arise whatever happens. If this is the case, then there should be no need to correlate the amount of banknotes issued that are recorded in the liabilities section of the BOJ's balance sheet, with the amount of government bonds, stocks, and real estate purchased with banknotes that are recorded in the assets section.

If the plunge in JGBs, stocks, and real estate were somehow attributable to the Bank of Japan's monetary policy failures rather than to exogenous natural disasters or the global financial crisis, the Bank of Japan would be held accountable and would lose the confidence of the public, corporations, and investors. In such an event, if the outstanding Bank of Japan notes would remain as liabilities, the Bank would be at risk of becoming insolvent as its liabilities exceeded its assets as the value of its assets declined. However, in the case of the central bank, even though it becomes insolvent, the government would certainly provide capital injections and other bailouts, so it is unlikely that the bank will go bankrupt anytime soon.

Such risks, even if they are the result of monetary policy failures and a loss of confidence, are independent of the fact that Bank of Japan notes are certificates of obligation. Rather, by maintaining such an interpretation, the risk of insolvency has seemingly increased. What the BOJ is doing now to support the private sector in the fight against the new coronary infection is unlimited purchases of JGBs and increased purchases of CP, corporate bonds, etc. Accordingly, the BOJ's issuance of

[2] https://www.boj.or.jp/announcements/education/oshiete/outline/a23.htm/

banknotes and its balance sheet are expanding further. Therefore, the insistence that identification of Bank of Japan notes as debt certificates can work as a break against excessive issuance causing hyperinflation may be incorrect.

There is no small possibility that the Bank of Japan's ultra-easy monetary policy stance will create significant risks in the future. What would be more consistent with such monetary policy would be to gracefully recognize "banknotes in issue" as capital and record them in net assets. If the government changes this conventional practice retained from the age of convertible banknotes and declares that it will change the items listed in its financial statements from now on, the banknotes it issues, which account for nearly 20% of liabilities, will disappear in an instant, and its net assets will increase by that amount, which should prevent it from falling into insolvency even if the value of its assets, including JGBs, is severely damaged.

5. Bank of Japan Notes are not "Certificates of Obligation" but "Equity Securities"

First, we must deeply consider what exactly is a "debt" without obligation to repay. Modern fiat central banknotes are not issued as negotiable certificates of debt obligation to be redeemed in specie when it is refunded to the central bank after circulating among economic agents other than themselves as asset "cash", as was the case with earlier convertible banknotes. Therefore, we must admit that it is no longer credit money. Of course, it is also not material money that retains its intrinsic use value. Then, what exactly is a "debt" that does not have to be repaid? In fact, the expression "debt" without obligation to repay is a literal contradiction. There is no such thing as a debt without an obligation to repay it. What it simply means is a situation where there is no more debt and no more repayment.

The Bank of Japan was established with a capital of 100 million yen, but it has now issued more than 100 trillion yen in Bank of Japan notes, a million times that amount, which continue to circulate as fiat money with no obligation to repay. To understand this curious reality, we only need to reconceptualize Bank of Japan notes not as certificates of debt obligation or IOUs but as equity securities, a means of raising funds on a massive scale. The modern central banknote is conceivable as an equity security issued by the central bank in the name of "cash." We thus reinterpret it as a quasi-security or utility coupon without voting rights nor dividends, not as IOUs.

ICO (Initial Coin Offering) is a popular way to raise funds by ‘presale' of new tokens to investors in exchange for contributions in-kind of such cryptocurrency as Bitcoin or Ether before they are listed on an exchange. There are two types of tokens issued through ICO: security tokens that come with revenue sharing rights, and utility tokens that are a means of payment like service vouchers or gift certificates. Since Bank of Japan notes do not hold any rights for interest or revenue, they provide such services of ‘money’ as payment and purchasing power to buy anything. So, it can be considered as a utility token. In recent years, financial regulators around the world have been trying to regulate crypto-asset tokens by regarding them as the latter. But what if the central bank notes can be also regarded as utility tokens? It surprisingly resembles the way in which fiat central banknotes are issued as equity for financial institutions’ contribution in kind of government bonds as we have just seen even if it has no risk of rip-off as in ICO.

Then, what changes if we understand fiat central banknotes as securities of contribution? First, it changes the meaning of central banknotes as money: fiat central banknotes are neither material money nor credit money, but a third kind of money: ideational or symbolic money, in other words, utility token. By recognizing this, it can be clarified that modern money, including national currency as well as non-national private currency such as cryptocurrency and community currency, shares such unique characteristics that were not present in earlier material money and credit money.

Second, in the balance sheet, capital/ equity is distinguished from liabilities and is entered as net assets in the same credits of a balance sheet. If the Bank of Japan reinterprets "banknotes issued" as capital/ equity, then "banknotes issued" will disappear from liabilities and be recorded as net assets/ shareholders equity, eliminating almost all fears of insolvency even if the value of current holdings such as government bonds, real estate, and stocks were to collapse significantly.

It is self-evident from the outset that the principle of self-responsibility does not apply to central banks which are certain to be bailed out by the government even if they become insolvent. Rather, it may be more appropriate to clarify beforehand in principle that central banks are capitalized by the banknotes they issue because they play a public role in finance, and therefore the risk of their failure becomes extremely small compared to that of private entities. When Japan's bubble economy collapsed in 1990s and the U.S. fell into a financial crisis after the Lehman Shock, the government broke the universal principle of self-responsibility by bailing out major financial institutions with capital injections using taxpayers' money as a stopgap measure. However, if such an event took place to central banks, it would be much better to fundamentally solve the problem by changing the monetary and financial principles rather than executing ad hoc bail-out with public funds.

If we assume that a financial institution receives Bank of Japan notes as equity securities, how can we understand trading in JGBs for "cash"? The financial institution would be seen as making contributions in-kind of the JGBs, rather than monetary contributions, and receiving the Bank of Japan notes as capital contribution securities. In other words, it is not a sale of a commodity for money, but an investment in kind in the form of JGBs for the delivery of investment securities. In such a case, the entities contributed in-kind are not goods and services, but rather securities such as government bonds, corporate bonds, CPs, bills, corporate bonds, ETFs, and REITs, which are exchanged mainly by the Bank of Japan and financial institutions as assets. Since modern capitalism has reached the ultimate stage of free investment, then considering central bank notes as equity securities is not particularly strange, as it places the principle of investment at its core. If the Bank of Japan were to actually record "banknotes issued" as capital/ equity rather than liabilities on its balance sheet and make such information widely available, the perceptions and actions of the government, financial institutions, corporations, and the public would not remain the same, but would change dramatically.

First, how would the government view it? The government's budget deficit has been increasing, with the outstanding amount of government bonds issued at the end of FY2019 (end of March 2020) reaching a record high of 997.9 trillion yen, and the outstanding amount of long-term debt for the national and local governments combined standing at 1,125 trillion yen, or 197% of GDP. The Bank of Japan's JGB holdings at the end of the same period were also 486 trillion yen, so almost half of all JGBs held by the Bank. If Bank of Japan notes are recorded in net assets as capital instead of liabilities, the risk of the Bank of Japan becoming insolvent would be significantly reduced and it would be able to hold even more government bonds even if long-term interest rates were to rise sharply and government bond prices were to plummet accordingly. The central bank's underwriting of new government bonds is currently prohibited by Article 5 of the Fiscal Law. But the situation is that the nation eventually contributes new government bonds in kind and provides capital/ equity to the central bank, in exchange for receiving 'legal tender' as security of investment from the Bank of Japan. Eventually, it would be the exchange of debt certificates as JGBs and equity securities as Bank of Japan notes. Then the central bank should not be specifically prohibited from doing so, since the risk is ultimately borne by the government as the investor.

This may sound similar to MMT's argument that unlimited issuance of government bonds is possible. MMT sees the government and the central bank as a single integrated entity and argues that no matter how much government bonds are issued, there will be no problem because the central bank can finance all of them, because fiat central bank notes are guaranteed to be valid by the state's authority to levy taxes. This arises from the incorrect notion of money that modern fiat central bank notes are a form of credit money based on 'chartalism'. It is completely different from our claim that modern money is no longer material money nor credit money, but ideational or symbolic money. We consider that MMT' concept of modern money is outdated and its policy implication is mistaken.

The relationship between the central bank and financial institutions has long been thought of as a one-way hierarchical relationship, with the central bank assisting and bailing out financial institutions and supervising and regulating them, as seen in the "bank of banks," the "lender of last resort," and the reserve deposit system. If, however, Bank of Japan notes are explicitly stated to be equity securities for capital contributions by private financial institutions to the Bank of Japan, then the opposite effect of financial institutions jointly supporting and assisting the central bank is clarified, and this would create a more interactive and equal relationship between the two. If financial institutions are investors in the Bank of Japan, there will be risks associated with investments in kind rather than trading in money. However,

even if the value of assets such as government bonds, stocks, and real estate were to be severely damaged, the risk of the Bank of Japan becoming insolvent would be significantly reduced, which would simultaneously reduce the risk to financial institutions of investing in the Bank of Japan.

Financial institutions that hold current accounts with the Bank of Japan would not only view the cash, Bank of Japan notes as certificates of contribution in the Bank, but would also view their current accounts as the same securities they receive on withdrawal of their deposits. For the Bank of Japan, the current account is a liability, but the Bank of Japan only have to repay the financial institutions for the securities for their investment under the name of 'legal tender.' So, theoretically, issuing an unlimited number of such securities will not cause the Bank of Japan to become unable to repay its debts. Although the author does not agree with it, the unlimited supply of monetary base, which the Bank of Japan has already implemented as QQE (Quantitative-Qualitative Easing), should be more consistent with this logic. This is also true of MTT.

However, this is subject to the condition that there is no possibility of the other party refusing to accept the note due to the side effect of hyperinflation. Even though Article 46, Paragraph 2 of the Bank of Japan Act stipulates that "banknotes issued by the Bank of Japan shall be accepted without restriction as legal tender," it does not necessarily mean that the other party can be 'forced' to accept the banknotes because physical commodities of necessary use value such as rice and eggs become material money with a much higher purchasing power in such a hyperinflationary situation, as was seen in Germany after the defeat of WWI. It is not always possible to force the other party to accept paper money.

The value of modern money is spontaneously formed and automatically maintained by the inertia and conventions from the past and the expectations and anticipations for the future that people unconsciously or consciously rely on in their daily receipts. In other words, the value of modern money is formed and grown by self-fulfilling notions. In this sense, the modern money since the 1970s is neither material money nor credit money, but rather purely informational money that should be called 'ideational money' or 'symbolic money.'

If individuals and companies recognize that cash and deposits are also risk involving investment securities, the traditional monetary mindset that holding money is secure and that money has no risk will change[3]. We will be forced to realize that we are investors who choose portfolios of various assets on our own initiative and responsibility, while constantly being aware of such risks, and the nature of free investment capitalism will be strengthened[4]. However, 'investment' is not just quantitative 'speculation' aimed at increasing the volume of one type of national currency. As private currencies other than legal tender become more diverse, individuals and companies will become to consider their main objective more comprehensively and, by selecting multiple currencies to match their own values and lifestyles while taking various risks into consideration, eventually aim at not only quantitative expansion but also qualitative improvement of their possibilities and world in the future by utilizing these currencies.

6. What is good money? Hayek's principle of choice in currency in terms of 'quality' realizes that 'good money drives out bad'

6.1 Gresham' law: Bad money drives out good

In this era of diversification and evolution of money, we can no longer see money as given, ready-made, and top-down. We should regard it as being bottom-up created and selected by users. Therefore, in the creation and selection of money, the question of what kind of money becomes "good money" is crucial. It's not just convenient, efficient, and stable. What exactly is "good money"? It is the most fundamental question. The answer is not something anyone can give, but something we have to find by ourselves.

[3] The "liquidity preference" that Keynes introduced in his The General Theory (Keynes 1936) assumes that the interest rate of money is zero compared to positive interest rate of bonds, but the reason why he assumes so is because the risk of holding money is zero unless there is no accelerating inflation. This may have reflected the normal monetary attitudes of the British rather than the Germans, who experienced hyperinflation after World War I.

[4] In my view, it is "free investment" rather than "free trade" that characterizes modern global capitalism. For more on this, see Nishibe (2020).

Let us first check ‘Gresham’s law’ that is one of the famous monetary principles in economics claiming that "bad money drives out good".[5] The 19th-century Scottish money and credit theorist Henry Dunning McLeod had given the name after the 16th century Tudor Treasury Secretary Sir Thomas Gresham. However, there are many precedents for the law since the Ancient Greek era (Mundell 1998; Selgin 1996, 2003). Nicolaus Copernicus, who is famous for advancing the theory of heliocentric system, is one of such precedents who accurately acknowledge the law (Ziffer 1957)[6]. Accordingly, this law is currently sometimes called ‘Gresham- Copernicus’ law.’

The meaning of this law is as follows. Let's assume that there are two gold coins (silver coins make no difference). The face value of a gold coin is the denomination of the unit of measure, e.g., Pound, and the real value of a gold coin is its content of gold. When the real value of one gold coin is lower than the face value of the other due to debasement, including the issuing body's mixture of base metals and users' clipping or scraping, which one will you use to pay first? Assuming users behave selfishly, they are supposed to use "bad money" with low content of gold first and try to keep "good money" with a high content of gold. Then bad money will be circulated, and good money will be hoarded. Thus, Gresham’s law originally meant "Gresham’s law of coinage" in the case of the debasement of minting coins. In general, in the case of any material money (commodity money) in which the material has an intrinsic value, good money with the small difference between the face value and real value will be preserved as an appropriate asset, and, as a result, bad money will gradually prevail in the market.

However, if we expand its substantial meaning of the law to bimetallism where both gold and silver are adopted as a standard of value with the fixed exchange rate, the relatively lower evaluated one will circulate among users. Gresham’s law is also valid for the case where gold coins with the same unit of denomination (e.g. yen) and convertible paper money that can be converted into gold coins coexist. For people would tend to keep on hand the gold coins with higher real value and try to use the convertible paper money with lower real value first. Furthermore, even in the case of inconvertible paper currency, Gresham’s law still holds. If there are two inconvertible paper currencies with different inflation rates due to the difference in the amount of currency issued, bad money with a low real value caused by high inflation rate drives out good money with a low inflation rate.

Gresham’s law tells us that it is a very convenient law for minters and issuers of money. If the issuer reduces the gold content of gold coins and reduces the casting cost, the difference between the face value and the commodity value can be obtained as Seigniorage (profit from minting) while bad money continues to circulate. Besides, as a result, if the real value of money decreases and the inflationary trend progresses, inflation has the actual effect of substantially reducing the nation's fiscal deficit. Because of these dual benefits, the government tends to mint and issue bad money that incessantly causes inflation. And if there is no legitimate choice for users but to use a coin bearing the king's seal, such bad money will be forced to circulate within the nation, which will be a big nuisance for users.

Next, let's apply this to the present day. Today, neither standard money such as gold or silver coins nor convertible paper money is in circulation. Inconvertible banknotes issued by the central bank and subsidiary coins minted by the Mint Bureau of the Ministry of Finance are legally designated as legal tender. The production cost of a 500 yen coin is only about 20 yen at most. Then, the seigniorage for the central bank on minting a 500 yen subsidiary coin would be 480 yen. Its real value is only 4%, negligibly small compared to a gold coin. Similarly, the production cost of a 10,000 yen note is only about 10 yen at most. Its real value is now only 0.1%. Then, we would like to say that the seigniorage for the central bank on issuing a 10,000 yen central banknote would be 9,990 yen. But be careful. It is a controversial point. As we have just seen above, in the current institutional setting of accounting, the central banknotes are not regarded as asset but liability on its own balance sheet. So, they say it cannot be seigniorage. But, as we discussed earlier, if the central banknotes are to be shifted from liabilities to

[5] The full survey article on history of precedents and transition of theoretical meanings of Gresham’s law is found in Verde (2008). The author expalined three refinements of Gresham’s law in history, but he mentioned Akerlof’s discussion on the lemon’s market of the asymmetric information, but he doesn’t mention the theoretical implication of Gresham’s law for diversifying modern money including community currencies and cryptocurrencies as well as modern monetary policies.
[6] Copernicus’s *Monete cudende ratio (On the Coinage of Money)* is his third version of his treatise on money and coinage written in Latin in 1526 (). Nicholas Oresme’s *On the origin, Mature, La, and Alteration of Money* is found more than century earlier works (Mundel 1998)

capital in net assets, we may say once again that 9,990 yen is the seigniorage. Inconvertible legal tender potentially become a real 'bad money'.

From some time after WWII in Japan, the yen could be exchanged for dollars at a fixed rate of '1 dollar = 360 yen', and dollars could be exchanged for gold at a rate of '1 ounce of gold = 35 dollars'. Therefore, we could say that the yen was indirectly convertible into gold. However, President Nixon stopped the conversion of dollars to gold in 1971 due to the shortage of gold reserves, and all developed countries shifted to floating exchange rates in 1973. Since then, the legal currencies of each country have lost their anchor based on the value of physical commodities such as precious metals and commodity baskets. The floating exchange rate system merely indicates the relative exchange rate between legal currencies and doesn't show the absolute value as in the gold standard system. Therefore, it often fluctuates greatly depending on the speculation of investors in the foreign exchange market.

In the Asian currency crisis in 1997, investors who expected the asset bubble to end flowed out of the country from Asian countries such as Malaysia, Thailand, and Korea. As a result, in these countries, the real economy fell into a recession by the collapse of currency and assets, and people's living conditions deteriorated rapidly. Modern money is not only a means of circulation and a measure of value for buying and selling goods but also a store of value and liquidity as a shelter from volatility for investment. In the case of FX (foreign exchange margin trading), money itself is the subject of speculation to make profits from trading. Thus, modern money suffers not only quantitative deterioration due to a tendential decline of real value but also qualitative deterioration due to large value fluctuation accompanied by the nullification of real value.

The Bank of Japan, under its Abenomics policy, has continued QQE, or an unlimited supply of cash currency with negative interest rates, in an attempt to achieve an inflation target of 2%. The weaker yen improved the performance of exporting companies and boosted stock prices. However, inflation has not occurred as expected because banks do not increase their lending to supply deposit money to the market. This situation occurs because banks consider that they do not have borrowers considering the risks involved. The government's inflation targeting policy aims to improve the economy by raising nominal prices through an increase in money stock despite the lack of favourable investment opportunities. It assumes the extreme assumption that people's expectations of inflation based on the illusion of money will continue. In reality, the rise in wages has been slow, and households whose real purchasing power has declined have tightened their purse strings. The Bank of Japan governor, Kuroda, has now stopped short of mentioning a deadline for achieving a 2% inflation rate and seemingly has given up on that goal. Centralized issuance of cash by the central bank under the national managed currency system has made such unsound economic policies possible.

Modern legal tender as an inconvertible currency is bad money not only in the quantitative sense that its real value is tremendously smaller than its face value in contrast to gold coins, but also in the qualitative sense that it has become an object of the speculation as a financial asset like a stock and a derivative commodity so that it shows an extraordinarily high degree of capital function and that it also serves an instrument of current arbitrary and risky monetary policy by central banks. We could say here was the culmination of evil. In such a pathological situation of the modern money system, it was significantly expected that Bitcoin, which differed from the centralized issuing legal tender, would potentially become a new original currency based on the decentralized issuing by utilizing blockchain or DLT. However, once cryptocurrencies began to be exchanged with legal tender on the exchanges, Bitcoin and other cryptocurrencies rapidly became speculative. They rose in prices sharply, especially in 2017, as their public recognition of names increased, but made a sudden plunge in 2018. The price fluctuation was tremendously huge, compared with legal tenders such as the dollar and euro. It seemed that cryptocurrencies had become financial instruments with high risks and high returns, just like FX with quite high leverage by a factor of 10, rather than ‘money’ that transacts goods and services. Disappointingly, cryptocurrencies have become indeed ‘bad money’.

6.2 Hayek ‘s Denationalization of Money and the the Principle of “Choice in Currency”

The Austrian School economist Hayek, in his book "The Denationalization of Money" (1976b), stated that a desirable currency can be found as a "good money" only when multiple currencies of different quality mutually compete. For that purpose, the principle of ‘choice in currency’ for “Good money drives

out bad" should work instead of Gresham's law stating, "Bad money drives out good". If only monopoly currencies and their simulacrums exist, that is, currencies can be differentiated only by the quantity of real value, amount of issue, and interest rate when they have the same face value or the fixed exchange rate, the Gresham's law will come into effect.

For example, in Scotland and Hong Kong, several private banknotes with the same standard of measure circulate alongside the legal tender, which is the central banknote. Private banknotes are different from legal tender, but they use the same name and unit of measure, i.e., "pound sterling" or "Hong Kong dollar. This creates the possibility that such private banknotes will be refused by some stores, but in most cases, they will be circulated as having the same value as central banknotes. Thus, they will be substitutive currencies of legal tender. In this case, legal tender and substitutive currency are apparently different currencies, but they can be used as money with the same name and unit of measure.

Even if the central bank properly adjusts the amount of legal tender issued so as not to impair its real value, i.e., so as not to cause inflation, if private banks, which issue private substitutive currency with the same name and unit of measure, issue too much of it, the supply of such substitutive currency will increase, its real value will decline, and inflation will occur. In this way, the legal tender with the same real value as before will be hoarded as "good money" because people will try to use the "bad money" that has the same nominal value but has a lower real value first. In other words, even if legal tender and substitutive currencies are outwardly distinguished, if the exchange ratio between them remains fixed at one to one, the substitutive bad currencies will drive out the legal tender good currency. This is the result of what Gresham's law works.

In order for a competitive relationship between multiple currencies of different quality to be established, a situation must be created in which this Gresham's law does not hold, and Hayek's principle of 'choice in currency,' "good money drives out the bad" must come into play (Hayek 1976a). This is the case when multiple currencies of different quality enter a competitive relationship of "monopolistic competition". The following two conditions are necessary for it, 1) multiple currencies should have different denominations (names) of the unit of measure, the types of reserve assets and reserve instruments so that they can be distinguished not only in such quantities but also in qualities such as users' trust on the stability of value of money, and 2) the exchange rates between currencies must not be fixed entirely, but they must be somewhat changeable reflecting users' evaluation of the differences in quality.
In a capitalist economy, as a result of such monopolistic competition, the principle of commodity selection, "good commodity drive out bad commodity," is at work. This is the merit and strength of the capitalist market economy. Monopolistic competition, which is applied to heterogeneous goods and services with slightly different quality and design, rather than perfect competition, which is applied to completely homogeneous and perfectly substitutive goods and services, is the reality of competition in a market economy. Monopolistic competition is by no means an exceptional situation, but represents a universal situation. The principle of commodity selection brought about by such monopolistic competition is the outstanding characteristic of a market economy, which does not exist in a planned economy. In other words, markets are better appreciated because they make goods not only cheaper, but also better, not because they realize efficient allocation of scarce resources.

Monopolistic competition thus generally refers to an oligopolistic situation in which there are incompletely substitutive commodities supplied by heterogenous firms and they differ in quality and design, even though they form a market for roughly the same kind of commodities, and in which both price and non-price competition among firms occur simultaneously. Hayek tried to apply the concept of monopolistic competition that is usually used in terms of commodity differentiation to the differentiation of money. He thought that money differentiation through monopolistic competition bring about 'better money' that have better quality of money. The principle of "good money drives out bad money" is a principle that begins to operate only when the issuer of money innovates its currency service to enable competition in quality. The "denationalization of money," as Hayek called it, was a dynamic process in which multiple private currencies of differentiating quality would create this complex and intricate process of "monopolistic competition" or, in other words, "rivalry". It does not mean perfect competition that is a condition for Pareto efficiency of resource allocation as in neoclassical microeconomics. It is important to note that other economists' criticisms of these ideas of Hayek often do not fully understand this point.

The principle of choice in currency does not work under the current situation where currencies are monopolized by the state and legal tender is dominant. This is because the "one nation, one money" institution of modern money must be changed for it to be applicable. However, if multiple currencies of the same quality are issued freely, as is the case in Scotland and Hong Kong as free banking theorists insist, the Gresham Law, which states that "bad money drives out good money," will come into play.

Since cryptocurrencies obviously met these two conditions, the principle of choice in money began to function. The next problem was whether cryptocurrencies could pass the test of users' choice in money in search for good money. Hayek defined the currency with 'a stable value of money' to mitigate uncertainty as "good money" (Hayek 1976b, Ch.13). The prices of the current cryptocurrencies to legal tenders are so volatile that they are by no means good money from the viewpoint of Hayek. However, it is not clear whether the condition of good money should be based only on the stability of currency value. If the result of the selection made through inter-currency competition is seen as "good money", the criteria should be continuously discovered and innovated through evolution. For cryptocurrencies to escape from the present state in which they seem just objects of speculation and to become "good money" usable in actual transactions, the stability of currency value with the formation of consumer goods market for them is at least indispensable.

Currency stability usually means that hyperinflation, causing a sharp decline in value of money, never take place. But Bitcoin is programmed to continually increase its scarcity and value over time by mimicking the 'mining' of gold with limited reserves. In that sense, speculation in bitcoin is inevitable. Still, the critical issue of unstable currency value arises because cryptocurrencies have been in sale for legal tender at real-time floating rates on hundreds of exchanges all over the world. The floating exchange rate system similar to FX quickly enabled speculation aiming at a trading margin by using value fluctuation. In fact, without this factor, bitcoin would not have been as globally popular as currently. However, it is the very factor which prevents bitcoin from becoming good money.

Currently, bitcoin is only available for a small portion of all merchandizes, and altcoin and tokens have to be converted into bitcoin to use them for purchase of goods and services. Even at shops where bitcoin is available, users have to pay by converting the list price in legal tender into bitcoin. If you expect the price of bitcoin to go up, you better to hold it than to pay it for taking appreciation profit. On the contrary, if the price is expected to drop, it will be better to use it than to keep it, but the seller may refuse to accept it. Because of violent price fluctuation of bitcoin, such speculation depending on expectation is always easy to occur, and the factor of speculative investment always mixes in the consumption. It is mainly international hedge funds, investment banks, and corporate and individual speculators who buy and sell these cryptocurrencies globally. Since cryptocurrencies are convenient tools for foreign remittance, illegal transactions such as money laundering, tax evasion, and drug dealings are inevitably involved. It is a world far from the vast majority of ordinary people.

6.3 The precondition of good money: ordinary people in an actual socioeconomy

To reconsider what criteria of good money are, we should return to the right image of the human nature of ordinary people who daily use good money in an actual socioeconomy. It must be the real precondition for the criteria of good money.

We live by consuming the basic goods and services necessary for food, clothing and housing with the income obtained by working, and decide the lifestyle based on our sense of values, carry out hobbies and activities depending on our interests, and acquire knowledge and information. Because of emotional and psychological biases, we cannot make the best choice. Nor can all options be known in advance. Not only is there a limit to rationality, but there is also a limit to ability in all aspects such as information gathering, decision-making, and action-taking.

Therefore, the place that ordinary people buy consumer goods by money is not a vast global market but a common local market which spreads in the vicinity of one's own life. In addition to blood relation, regional ties, and neighbourhoods, the communities as the active fields of life, labour, and hobby as well as the community as the sharing field of language, value, and interest are considerably related to the local market. A human being is not a rational fool who can make globally optimum decisions all the time, which is actually the image of rational agents assumed in orthodox economics. Instead, it is a decent

but emotional animal that judges based on the bounded knowledge and information that are framed by its own value and interests in the local region, and lives belonging to various communities. Thus, we should consider that good money is the money that ordinary people need to live their daily lives.

There is an inevitable impression that cryptocurrencies have become far from ordinary people because only speculative capital functions have become independent. To convert such cryptocurrency into good money that enriches people's lives, a strategy to positively introduce such multi-layered sets of territorial locality and virtual community will be effective. Here we need to learn from the present situations of DCCs that are in practice in local communities, seeking a good hint for criteria of good money.

In order for such DCCs to become a good currency, it is essential to create a market for consumer goods. In addition, it is important for merchants to use it to pay for purchases and wages. As a result, if the circulation of the currency can cover not only the market for consumer goods but also the market for production goods and investment goods, the local economy will be revitalized through local production for local consumption. To achieve this, DCCs need to form a new local currency market that fuses two seemingly incompatible areas: the "volunteer" area, such as mutual help and sharing within the community, and the "business" area, such as shopping in shopping malls and business-to-business transactions. To do this, we need the support of the local government, but we also need to bring together the various groups, organizations, and citizens who are currently scattered and disparate, such as local governments, economic organizations, shopping malls, schools, welfare councils, and hospitals, to reestablish the community itself.

In Japan, DCCs are spreading in local communities, such as Sarubo Coin in Hida Takayama City and Aqua Coin in Kisarazu City. The question is whether they will be able to create a local virtual currency market rooted in the local community and achieve regional development. We should also pay attention to whether any good money would emerge out of such new waves as CBDCs and citycoins as well as web3 and metaverse acompanied by Defi, DAO and NFT with smart contracts on various types of blockchain (DLT). That is the issue for the future.

7. Conclusion

This paper depicted the outlook of diversity and evolution of money from the past to the present and then gave an answer to the central question for understanding modern money under the myth of “one nation, one money,” which is the enigma of what fiat central banknotes are.

Differently from the view of MMT, they are neither material money nor credit money, but purely informational “ideational money” or “symbolic money” regardless its present status as “liability” on the balance sheets of central banks. To correctly understand such real nature of modern money is crucial. It is because both national money as legal tender and non-national money as crypto currencies and community currencies share the property as the root, on which other derivative forms of money as stablecoins and tokens depend.

We must release ourselves from the stereotype of a single national currency to seek a new way of adequately understanding the diversity and evolution of modern monetary systems and find a new bottom-up approach for evolutionary theory and policy with a diversity of money, different from conventional top-down approaches found in micro theory without money as well as a macro policy with single money[7].

Besides, we cannot merely be satisfied with describing such ongoing events of the plurality of money. We should be concerned with theoretically explaining how money diversifies and maintains itself; in other words, monetary systems dynamically change with its diversity kept. To the end, we need to consider how participants or users select from many alternatives of currencies so that some of them can only survive in the evolution of money. It is also necessary to focus on diverse monetary and social exchange systems, such as schemes that contribute to economic diversity, social cohesion, democratic participation, and environmental sustainability, as in community currencies and

[7] On plurality and diversity of money, see Gomez (2018), and on the diversity of community currencies, see Nishibe (2018).

cryptocurrencies[8].

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[8] We have constructed the theoretical model of institutional ecosystems to explain and describe the evolutionary dynamics of currently observed diversified money (Hashimoto and Nishibe 2017). In the model, an institution such as money is a game constrained by given game rules, and a variety of institutions such as diversified money constitute a complex institutional ecosystem subject to a meta-rules composed by players' value consciousness as criteria to evaluate multi-games. Refer to the article if interested in such theoretical aspects of this topic.

Social & Sustainable Finance

Smoothing Away the Stagnation Problem of Community Currencies with "Customized Communities" based on Satisfaction Prediction by Neural Network

Maen Alaraj[*], Makoto Nishibe[**]

Keywords: Customized Community, Community Currency Stagnation, Neural Network, Natural Language Processing

ABSTRACT: Every community, no matter how money poor, has a wealth of abilities and capability to stimulate the local economy. From this point, the idea of community currency (CC) emerged. This new type of currency was proposed as a tool to achieve sustainable development in the local economy. We learned that creating a CC was not enough to energize the local economy without addressing the stagnation problem. Thus, in the current research, we proposed a new framework or sequence of steps to build a "customized community" where the needs of members were met with the offered market to solve the stagnation problem. In this study we used real data recorded by a CC-based platform called C.C.Wallet to better estimate the degree of satisfaction of the members of the community to be used thereafter as a bridge to build "customized community". Considering this, the backbone of the proposed framework is estimating the degree of satisfaction of the members of the community by utilizing a Neural Network (NN) and this degree of satisfaction was used as an index to determine the members who would be given thereafter a "preference" in terms of bonus premium points to be added to their initial purchase of the CC with legal tender. The proposed index was created based on the number of purchases of the same products and services as well as by analysing C.C.Wallet users' messages (text-based comments and impressions) regarding the offered products and services after completing the transactions in the Japanese language. Thus, to analyse the comment text recorded in C.C.Wallet, it was necessary to use the technology of Natural Language Processing (NLP) where those comments were tokenized into tokens by using a python language-based module. In the current study, the engagement of the members with the provided market was monitored by computing a visual map of Shannon Entropy (*SE*). Our main findings suggest that the proposed framework should be considered as a tool to construct the concept of a "customized community" where the circulation of CCs is accelerated with the result of further boosting the local economy.

1. Introduction

Money can be defined as a stand-alone information medium of exchange or a measure of value and the important condition of it is to be accepted by a group regardless of its size whether big or small groups (Kichiji, Nishibe, 2012). In regard to this, shopping points, electronic money, mileage, exchange coupons and community currency are all a form of "money".

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In evolutionary economics, community currency (CC) can be defined as a currency that organized and managed by a local community or a community of interest, which involves the exchange of products and services. There are two main purposes of CC. (1) Socio-cultural Purpose: the cooperation between community members is reinforced and mutual aid is promoted. (2) Economic Purpose: CC is used to increase the local production for local consumption (i.e., improve the self-sufficiency rate) of resources, energy, and services, this helps protect the local economy from any regional economic shock and enhances resilience and autonomous decentralization. Thus, since CC unlike legal tender in pursuing a socio-cultural purpose and an economic purpose, it is becoming an "integrated communication medium" that mediates between the social culture and the global economy, and hence it goes beyond the classical meaning of "currency" as defined in economics (Nishibe, 2012, 2021).

Based on the characteristics of the participants of the community, the above-mentioned purposes will have varying degrees of impact to the community. To clarify further, if the community has a strong socio-cultural aspect, such as neighborhoods, the socio-cultural purpose's impact will be greater. If the economic aspect is stronger, such as a community with financial institutions, commercial and industrial organizations, and/or shopping districts, the economic purpose's impact will be greater. Although the proportion of the two purposes depends on the characteristics of the members of each community, CC is unique in that it fuses the two purposes.

In Japan, various types of CC were widely practiced for about ten years from the end of the 20th century, but the boom quickly ended due to some problems and shortcomings.

The cost (labor and funds) was high, and there were major operational problems such as the inability to survive without government subsidies.

Since then, many types of CCs have been set up and proposed, but it seems that those CCs have also some drawbacks in terms of stagnation. For instance, "Eco-money" which was proposed by Toshiharu Kato (Kato, 2001) as a special type of CC was used in volunteer activities among citizens to activate mutual aids and stimulate social welfare services.

Eco-money was designed to be used in volunteer activities and social welfare services. Eco-money was accumulated in the hands of participants (especially younger generations) who significantly contributed to the volunteer activities.

However, they could not find desired services and products in the market to spend their "Eco-money" and hence stagnation occurred. The double triangle system (DTS) was proposed by Makoto Nishibe (Nishibe, 2004) to cope with the stagnation issue.

As shown in Figure 1, DTS tried to make a bridge between non-commercial (volunteer related activities) and commercial transactions to stimulate the participants to buy products and services in the local markets. To prove the effectiveness of the DTS as a CC system, the currency circulation of DTS was examined theoretically and empirically by applying it on a community whose members were selected from Tomamae-cho city located in the prefecture of Hokkaido in Japan (Kichiji, Nishibe, 2006, 2008). The effectiveness of DTS was determined because the volume of commercial and non-commercial transactions increased. However, some Tomamae-cho CC was accumulated at specific business partners and could not circulate smoothly due to the limited market (Kichiji, Nishibe 2008).

On the other hand, numerous reports have been compiled that shows the ability of CC to foster the social sustainability and have been assessed by Arnaud (Arnaud, Marek, 2015). Arnaud showed that economic benefits of CCs are limited due to their small scale. To understand this limitation, we need to give an overview about LETS which stands for "Local Exchange Trading System". LETS is one of the account type Community Currencies for whoever wants to use it and was initiated in 1983 by Michael Linton in Comox Valley, Vancouver Island, Canada (Kichiji, Nishibe, 2012).

Transactions using LETS are recorded in each participant's account. Participants can buy and sell products and services from each other with specific terms of price and quantities on a peer-to-peer basis. LETS can only circulate within finite physical or virtual domains. If you have a positive deposit in your account, you will not gain any interest from your savings.

In contrast, if you have no money and you want to buy something, you still can buy it by going below zero in your account by creating money units. The money in LETS can be created by individuals to buy products or services without any limit or with a certain upper limit according to the rules of each LETS and this is the advantage of LETS. However, this is completely different from conventional money issued based on the value of commodity as money or the authoritative power of governments as issuers.

By conventional money, the seller will accept credit from the buyer and hence, the buyer incurs a debt to the seller. Considering this, the debt is generated on the side of the payer. When the

central bank issues central banknotes, it gives a certificate of indebtedness stating that I (the central bank) owe you (a recipient), and this is called an “IOU”.

However, a buyer is not directly in debt to a seller in LETS. Rather, the buyer is thought to be in debt to the community, composed of all the participants in the LETS. The buyer should have an ethical responsibility to repay the debt to the LETS community. In such systems as LETS, debts and credits do not bilaterally but multilaterally balance out. In other word, LETS do not adopt bilateral netting but multilateral netting. Then we call this kind of money as in LETS, not an “IOU” but an “IOC”, which signifies “I owe Community”. Considering this, the larger the community of LETS becomes in terms of the number of participants, the more the degree of anonymity will become, and under such circumstances, it’s hard to maintain trust among the participants of the community and the stagnation related issue may arise again.

Over the past few years, various CC platforms have been developed using smartphone applications. Digital regional currencies such as “Takayama City Sarubobo Coin” and “Kisarazu City Aqua Coin”, which are digitalized prepaid payment, are famous, but most of them are exchanged at stores, and the smooth circulation of the currencies was not realized.

Considering this, since LETS-type IOC digital currencies, which cannot be converted into legal tender, are likely to circulate more than digitalized prepaid payment, a new platform was proposed and this platform is called C.C.Wallet (Maeda, et al., 2019).

Over the past two years, Global Communication Planning Co. Ltd (called GCK). which is a company located in Chiba prefecture in Japan, used C.C.Wallet to set up a community of employees, and used an onsite “internal mall” (called GC Mall) to exchange products among the employees. All the transactions were investigated and analyzed in the current research.

Apparently, to accelerate the circulation of CCs among the participants of the community, stagnation related problems need to be addressed. Thus, in our previous study (Alaraj, Nishibe, 2019, 2020), we showed through random network simulation that the concept of “customized community” can be used as a tool to solve the stagnation problem, but in the current study we will introduce a computational framework or sequence of steps to build such customized communities by estimating the degree of satisfaction of the participants using Neural Networks. Thus, the main purpose of this paper is to propose a computational framework (or sequence of steps) based on real data to build the “customized community” where the needs of members are met with the offered market.

The framework was created by applying a neural network to estimate the degree of satisfaction of the members who will be given thereafter a “preference” in terms of bonus premium amount to add to their initial purchase of the CC with money.

Entropy maps were then computed to monitor the engagement of the members with the provided market to achieve our goal that related increase the circulation of CCs among the members of the community and hence, the stagnation related problems will be reduced as a result.

For the practical purpose of improving the sustainability of CC, we will introduce the theoretical framework of the customized community, and we will also talk about random network models and Shannon entropy in section 2.

Next, in section 3, we will not talk only about the proposed approach to build such customized communities by estimating the degree of satisfaction of the participants through applying a neural network, but also, the methods of building neural models will be explained as well.

Section 4 we will discuss the proposed approach and clarifies the link between estimating the satisfaction of the participant and customized community.

Finally, the conclusions and the possible extensions of the current work will be exposed in section 5.

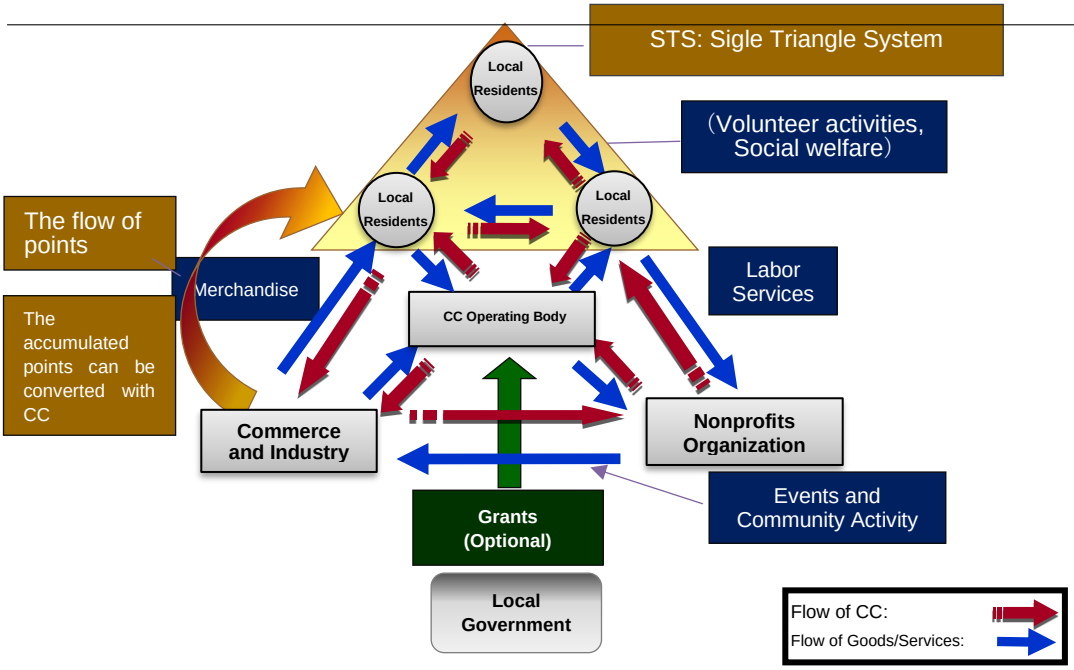


Figure 1 Double Triangle System (DTS) (Kichiji, Nishibe 2006)

2. Theoretical framework of customized community

Currency stagnation occurs when the circulation of currency in specific areas become less than other areas due to many factors such as small number of participants or dissatisfaction with the local market.

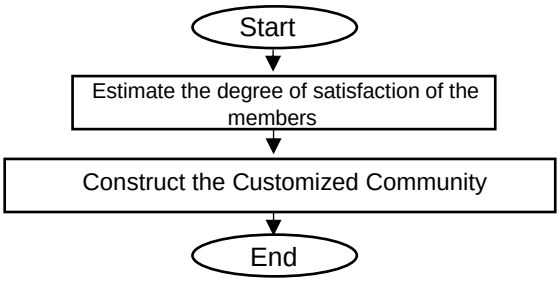


Figure 2 The proposed framework

Thus, to revitalize the local economy by using CCs, we don't need only to increase the number of persons who would like to join the community, but also, we need to increase the number of transactions using CCs. Such increasing in terms of number of participants and number of transactions will assist us to revitalize the local economy as the circulation of CCs among the members of the community will be increased.

Such increasing is important because it will reinforce the cooperation among those members of the community as the earned CCs from performing non-commercial transactions will be "absorbed" by its subsequent commercial transactions and prevent CCs from stagnating halfway through the circulation as shown in Figure 1. Thus, we need to construct a market where the demands matched the offered services and products of the other members. For example, if the number of members who are raising children in the community is few, child-related merchandises will not be likely purchased by CCs through the community, as there is a mismatch between the demands and the needs inside the community. In such cases, the problem of CC stagnation will occur. Thus, we need a more appropriate market where the demands of the members can be satisfied. To this end, in our previous research (Alaraj, Nishibe 2019, 2020), we clarified through simulation that building a customized market where the demands of

members matched the offered services and products of the other members inside the community would accelerate the circulation of CCs. In this regard, we need to give an overview about customized community.

A customized community is a type of community of interest (COI) based on the commonality of members' preferences for various categories of products and services. If we can identify these preferences of the members by estimating members' satisfaction regarding a particular category of products or services, we can build a customized community.

For better understanding the approach of the current research, we will first explain the concept of "customized community" and then we will discuss how to build such communities. However, in practical cases, we need to reverse the order of execution as shown in Figure 2.

2.1 What is Customized Community?

As stated above, to strengthen cooperation among members of a local community by using CC, it is better to increase "commercial transactions" after "non-commercial transactions" such as exchanges and mutual aid among members. The DTS suggests that if the members of the community use the CC acquired from non-commercial transactions in commercial transactions, this will increase the number of "commercial transactions", and the process of "absorption" into the market will be accelerated, rather than remaining in the hands of the members. Here, if any business partners inside a particular community receive CCs and expect that such CCs will be accepted by other shops, even if the business is a for-profit business, the conditions to consider accepting CCs as money can be satisfied. As a result of this situation, the newly created CCs through the execution of "non-commercial transactions", can be called a "currency of trust" issued by the community rather than a "currency of credit" which is issued by banks and such "currencies of trust" will have an effect on the "commercial transactions" and will revitalize the local economy as a result. However, on the contrary, if the number of "commercial transactions" is increased, it will be difficult to distinguish them from ordinary market transactions because of the prominence of commercial activities for the purpose of legal tender, and as a result, there is a strong risk that cooperative relationships based on trust among members will not be formed or will be lost.Therefore, by reshaping the CC-based market to meet the demands of the members as much as possible and avoiding the problem of currency stagnation in the middle, the "commercial transactions" will be increased.

Customized community can be constructed by giving specific members who has a frequent transaction a kind of "preference" in the form of a bonus premium amount added to the purchased CCs with legal tender (e.g., Yen, USD, Euro etc.) to be used with business partners inside the community. Such a kind of "preference" can be considered as a strong incentive not only for the people who are inside a community, but also to induce other people from outside the community to join the community and contribute significantly in it. Thus, in this regard, we would like to demonstrate that we used the term "customized community" rather than "customized market" to highlight the importance of participants who have high participation rate in performing transactions within the community.

Customized community needs some parameters and rules to "filter out" who can join the community, and such rules can be determined based on information about members who frequently participated in the transactions of the community. For example, if we can select members who frequently trade in baby products, we can form a community customized with the "commonality" of "child-rearing". This would include not only fathers and mothers who are raising babies, but also grandparents, relatives, and other blood relatives who are interested in their grandchildren and cousins.

Also, "commonality" can be identified in terms of the estimation of the satisfaction degree of the members based on two factors as shown below:

1. The impressions of the member who wrote his/her impression in text form, after finishing the transaction using a CCs based computational platform called C.C.Wallet.
2. The number of purchases for a particular service or product by a member in the community and hence, some concerns will be arisen due to privacy-related issues and such issues can be addressed by setting up a privacy policy and term of services in advance for the community.

2.2 The Simulation of the Customized Community

The simulation of customized community was examined throughout a random network applied using python and the details of the development environment is shown in Table 1.

Table 1 The Development Environment of The Simulation

Application Name	Version
Jupyter Notepad	6.0.3
Python	2.7.17
Anaconda	4.5.4
Gephi	0.9.2

The efficiency of the principle of "customized community" was examined throughout a simulation using a random network. This simulation was performed by assuming that the community size consisted of 100 members (nodes) and the transactions were done among them randomly by selecting a buyer node and a seller node through generating an asymmetric adjacency matrix (*Adj*), where each value in this matrix represented the volume of transactions between each buyer and seller in the community.

$$Adj = \begin{bmatrix} a_{11} & \cdots & a_{1j} \\ \vdots & \ddots & \vdots \\ a_{i1} & \cdots & a_{ij} \end{bmatrix}, \; i = 1, \dots, 100 \;\; and \;\; j = 1, \dots, 100 \qquad a_{ij} = 0 \quad when \; i = j$$

The principle of "customized community" was founded by calculating the entropy map of the transaction participation rate of all members of the community. Thus, it is needed to track the transaction history of community members over a period, and this period was assumed 50 days as shown in Figure 3.

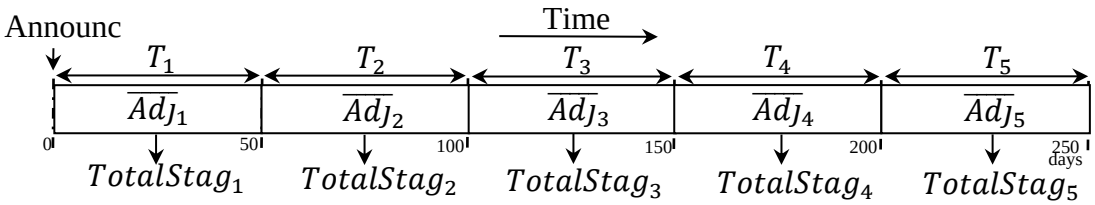


Figure 3 Schematic representation of the duration of CC simulation

Figure 4 represents the asymmetric adjacency matrix (*Adj*) where the rows represent the buyers (consumers), while the columns of *Adj* represent the sellers (providers). The flows of CCs from the buyer to the seller was represented by using arrows in the directed graph, as shown in Figure 4.

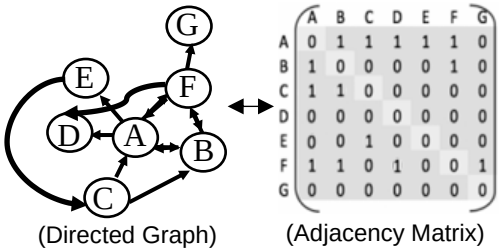


Figure 4 Example of Asymmetric Adjacency Matrix (Rows are buyers, columns are sellers)

This matrix is "asymmetric" because member *X* is a buyer, and another member *Y* is a seller, and it does not necessarily mean that the reverse is true: one member *X* is a seller, and another member *Y* is a buyer. For example, Figure 4 does not only show the case where *A* is the buyer and *B* is the seller (the corresponding element in row *A*, column *B* is 1), but also when *A* is the seller and *B* is the buyer (the corresponding elements in row *B*, column *A* is 1).

Also, Figure 4 does not only show the case where *A* is the buyer and *E* is the seller (the corresponding elements in row *A*, column *E* is 1), but also when *A* is the seller and *E* is not the buyer (the corresponding elements in row *E*, column *A* is 0).

Considering this, the adjacency matrix (*Adj*) indicates that each member wants to purchase the product or service offered by another member, but this does not necessary mean that the transaction was realized as it depends on the balance of CC that the buyers (consumers) had.

Next, the entropy map, as we will see later, represents a prototype for building a customized community based on the "commonality" of the offered products and services from the perspective of sellers and buyers.

2.2.1 The Assumptions of the Simulation

The execution of this simulation was based on the following nine assumptions. In the start of the simulation, we assumed that there were 100 members in a virtual community and the initial amount of CC was 10000 CC per person. This means that the total money stock was 1 million CCs, as shown in Figure 3. The period of simulation was assumed to last for 250 days divided into 5 periods （T_n, *n* = 1,…,5）.

1. It is assumed that the product initial price (*PCom*) is randomly generated within the range of 50 <*PCom* ≤ $Ini_n, \forall n = 1, \ldots, 5$, where *Ini* is the initial amount of CC. Products and services provided by each seller (provider) were not bartered and should be exchanged with CCs. As Figure 3 shows, the amount of CC, which was not used in community transactions for 50 days (T_n = 50, $\forall n$ = 1,…,5), was considered to be the stagnation amount.
2. It was assumed that the provided products and services can be categorized, and the members of the community who make bilateral transactions can buy and sell products and services using CCs. Any transaction can be realized if the member has an amount of CCs more than the price of the product or service (*PCom*) that they want to buy. If this condition is satisfied, the price of product or service will be deduced from the CC which is held by the member.
3. It was assumed that the transaction is executed randomly. That is, a pair of buyer and seller was randomly selected using an asymmetric adjacency matrix. The Shannon entropy (*SEn*) was computed after a certain period of time(50 days).
4. The buyer executes the transaction using the CC given at the initial stage. However, there will be some members in the market who do not use CC and hold some or all of it. If the remaining amount of CC was not used until the end of the period (50-day), this amount of CC was considered as a "stagnation". Considering this, when the participation rate (*PR*) decreases, the flow of CC among the members of the community will decrease as a result and hence, stagnation will occur. In the current study, the "participation rate" was defined as a "willingness to purchase" which was represented by the "buyer-to-seller" arrow in the network, where the buyer who was represented in the rows of the adjacency matrix, wants the seller's product or service which was represented in the column. The realization of such "willingness" was based on the CC balance that the buyer has, and if this balance exceeds the price of product/service, the transaction would be realized. Thus, from this perspective, the term "participation rate" rather than "transaction rate" was used in this research.
5. As shown in Figure 3, it was assumed that the CC-based market was open for 250 days. The amount of CC stagnation in each group and the total amount of CC retention in all groups were calculated every 50 days T_n). Therefore, the stagnation amount every 50 days (T_n= 50, $\forall n$ = 1,…,5) was defined by ($Stag_m, \forall m = 1, \ldots, 6$), and the total amount of stagnation was defined by ($TotalStag_n, \forall n$ = 1,…, 5), as shown in Figure 3.
6. As shown in Table 2, the participation rate in each group (Group *A*, *B*, *C*, *D*, *E* and *NS*) was described in Table 2 and was assumed to be constant throughout the whole simulation.
7. Also, the number of people in each group and the participation rate (*PR*) of the entire group was assumed to be constant throughout the whole simulation, as shown in Table 2.

8. As shown in Figure 4, the transaction was performed throughout the following steps.
    a. Set the adjacency matrix.
    b. The commodity price was randomly generated in the range of *PCom*, 50 <*PCom* ≤ $Ini_n, \forall n = 1, \dots, 5$.
    c. Randomly select a pair of members to be sellers and buyers. For example, select *A* and *B*, and randomly decide "A is the seller and B is the buyer".
    d. The transaction was realized when the generated commodity price (*PCom*) was below the CC balance. If the buyer ran out of their, CC balance, the transaction could not be performed if the commodity price was higher than the balance of CC and the rest of the CC would become stagnant.
9. The adjacency matrix was assumed to be calculated twice a day within 50 days. The average of those two times was calculated and represented as $\overline{Adj}$, as shown in Figure 3.

Table 2 The Groups of the Simulation

	Stagnation Group					Non-Stagnation Group
Index of Group (*m*)	1	2	3	4	5	6
Symbol of Group Name	A	B	C	D	E	NS
Participation Rate (*PR*) (%)	90	80	70	60	50	100
Number of persons (*Nr*)	10	10	10	10	10	50

2.2.2 The Formation of Customized Community Concept

The concept of "customized community" was implemented in the simulation by creating a market in the community by gradually redistributing the resulted stagnation amount during a 50-day period to the members who were frequently engaged in the transactions in the subsequent 50-day period. This was achieved by giving a bonus premium amount when those members purchased CC. In other word, the premium amount to be awarded was calculated by the initial amount of money (*Ini*) of the previous period of time (*T*) plus stagnation amount from the previous period of time divided by the total number of members who were engaged frequently in that period. Thus, the initial money at the beginning of each period of 50-day period will be defined by Eq. (1), as shown below:

$$Ini_{k+1} = \frac{TotalStag_k}{Nr.of\ members\ in\ NS_k} + Ini_k \text{ where } Ini_1 = 10000\,, \forall k = 1,\dots,4, \qquad (1)$$

As can be noticed in the denominator of Eq. (1), we used the number of members who were involved in the non-stagnation group (i.e., *NS* Group) because those members have the highest participation rates for transactions within the community.

2.2.3 Random Network Simulation

The simulation was developed using python. As mentioned in the previous section, the price of the products and services (*PCom*) was randomly generated in the range of 50 <*PCom* ≤ $Ini_n, \forall n = 1, \dots, 5,$ as shown in Figure 3. This simulation was performed by assuming that the community size consisted of 100 members (nodes) and the transactions were done among them using an adjacency matrix (Adj), where each value in Adj represents the volume of transactions between each buyer and each seller in the community, as shown in Figure 4.

Since that Adj was generated two times per a day within the 50-day period, the average of Adj was calculated as shown in Eq. 2.

$$\overline{Adj}_n = 0.5 * (Adj_1 + Adj_2)\,, \forall n = 1, \dots, 5 \qquad (2)$$

The stagnation amount was defined as an amount of CC which was not used in the transactions of the community during a period of 50 days. To determine the amount of stagnation, we assumed the buyer who is the member of the community is interested in the offered market, and he/she will buy the commodity whose price is *PCom* (*PCom* is generated randomly). Amount of stagnation ($Stag_m$) that corresponds to each group was computed using Eq.3

$$Stag_m = Nr_m \times (1 - PR_m) \times Ini_n \quad \forall m = 1,\ldots,5 \text{ and } \forall n = 1,\ldots,5 \qquad (3)$$

Table 3: Stagnation amount in terms of CC for each group in T_1

Group Name	Group Index (m)	The initial amount (*Ini*)	Participation Rate (*PR*)	Amount of Stagnation ($Stag_m$)
Group A	1	10000	90%	10000
Group B	2	10000	80%	20000
Group C	3	10000	70%	30000
Group D	4	10000	60%	40000
Group E	5	10000	50%	50000
Group NS ※	6	10000	100%	50
Total of Stagnation ($TotalStag_1$)				150050

※As shown in Table 3, the *NS* group with $m = 6$ has retention amount of 50. This is because commodity price *PCom* > 50, so if the CC balance becomes 50 or less, the transaction cannot be realized, and that amount will remain.

By contrast, if some members in the community are not interested in the offered market as much as others, they will keep some or all of CC and this amount of CC will also be considered as stagnation. Thus, the participation rates (*PR*) of the members will be reduced and hence different ratios of stagnations will result and the flow of currency among the members of the community will slow down accordingly.

The total amount of stagnation which resulted from the amount of stagnation from each group was computed using Eq.4, and then used thereafter to compute the ratio of stagnation relative to overall money stock as shown in Eq. 5.

$$TotalStag_n = \sum_{m=1}^{6} Stag_m, \qquad \forall n = 1,\ldots,5 \qquad (4)$$

$$StagRatio_n = \frac{TotalStag_n}{Aggregation\ Money\ Stock}, \quad \forall n = 1,\ldots,5 \qquad (5)$$

2.2.4 Shannon Entropy (*SEn*)

Shannon entropy (*SEn*) is a measure of predictability and is closely related to the probability of a random variable. The higher the participation rate, the lower the entropy, and the lower the participation rate, the higher the entropy. This is because if the probability of a specific variable is small, the predictability will be small, and the entropy value will be high.

Conversely, if the probability of a specific variable is high, the predictability will be high, and the entropy value will be low. Calculating a network map of participation rates for transactions among all participants in the community will give us an idea of how often buyer and seller transactions are taking place. This was because the stagnation problem was considered as a result of a decrease in the participation rate in transactions within the community, so the retention location can be visualized as shown in Figure 5.

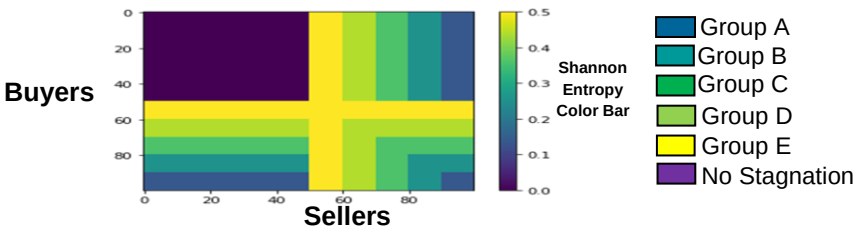


Figure 5 Color map of Shannon entropy for all the transactions during the simulation (Alaraj, Nishibe, 2019, 2020)

The *SEn* of the random variable *X* can be defined as in Eq. 6. Here, P_i was defined by Eq. 7, x_i indicates the *i-th* possible value of *x* among the *r* symbols, and $P_i$indicates the possibility of $X=x_i$.

$$H(X) = H(P_1, \ldots, P_r) = -\sum_{i=1}^{r} P_i log_2 P_i \quad (6)$$

$$P_i = Pr(X = x_i) \quad (7)$$

Figure 6 represents the schematic representation of the "customized community", while Figure 7 represents the flowchart of the overall method of creating the "customized community".

2.3 The Results of the Simulation

The stagnation amount of CC of the six groups in T_1 was calculated using Eq 3.Then, the total stagnation amount of CC was calculated using Eq 4, while the stagnation ratio was calculated using Eq. 5. As a result, the stagnation ratio in T_1 will be $\frac{150050}{1000000}$=15%.Thus, after increasing the (*Ini*), the stagnation amount of CC in subsequent time sections (i.e., T_2, T_3, T_4, T_5) showed that the stagnation ratio decreased due to the above-mentioned redistribution of the premium amount. As shown in Table 4 below, implementing the customized community concept reduced retention rates from 15% to 3% after 250 days.

Table 4: Stagnation amount after implementing "customized community" concept

#	Passage of Time (T_n) (days)	Initial amount (*Ini*),	Ratio of Stagnation ($StagRatio_n$)
1	50	10000	15
2	100	13000	9.5
3	150	14900	6.2
4	200	16150	4.2
5	250	17004	3

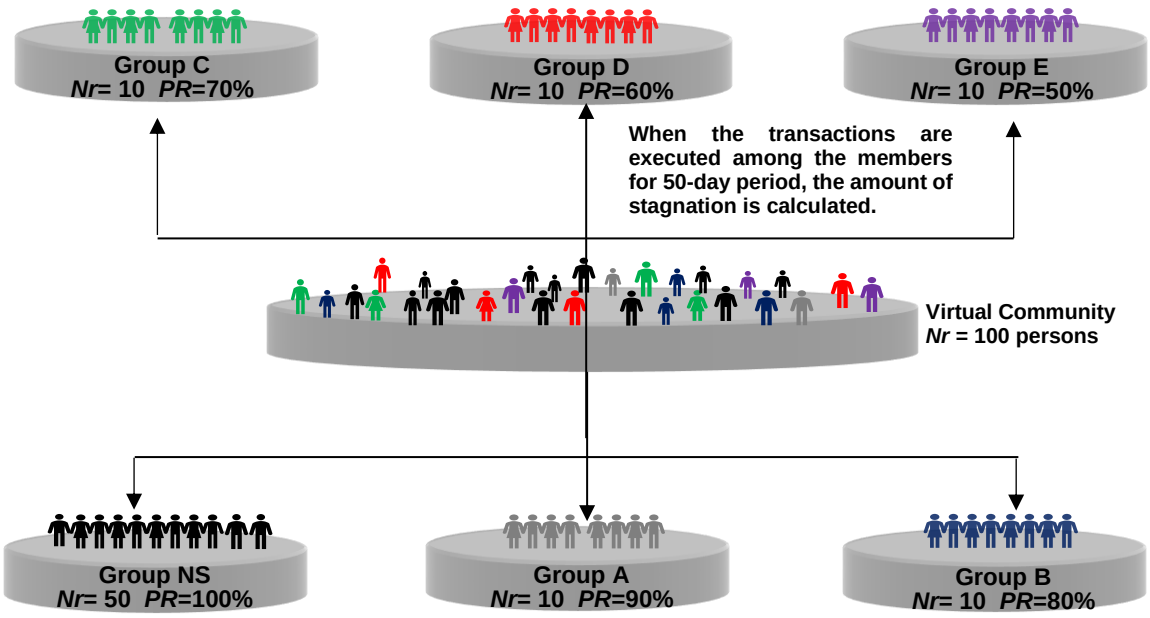


Figure 6 The schematic representation of the "customized community" during the simulation

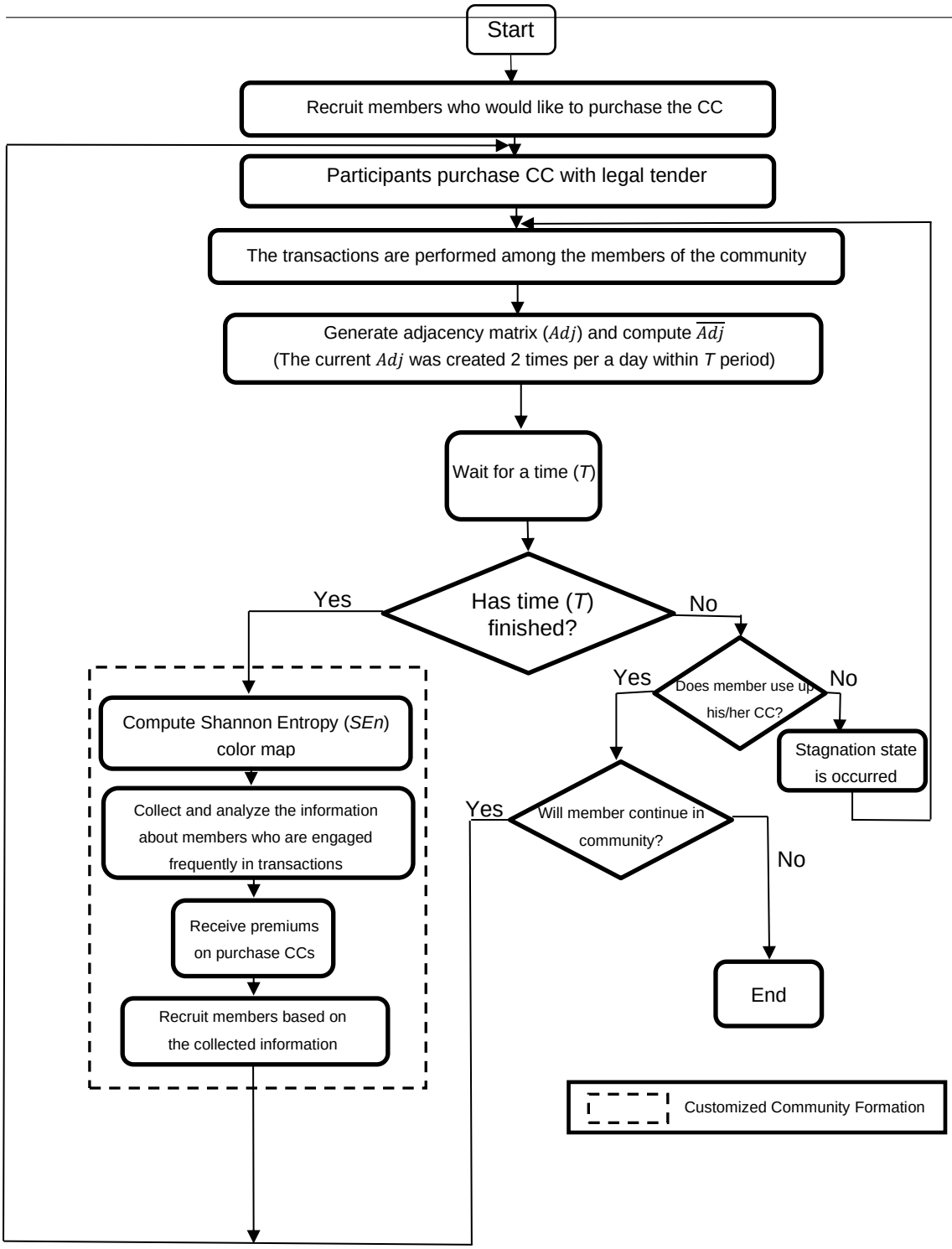


Figure 7 Flow chart of the overall method of creating "customized community"

3. The Estimation of the Degree of Satisfaction

3.1 C.C.Wallet Platform

C.C.Wallet is a platform provided for members by the General Incorporated Association Community Currency Research Consortium for a Sustainable Society (3C3S: https://www.3c3s.org/project). It enables the design and management of LETS on real/virtual communities according to its characteristics and has already been adopted by several regions and organizations. For example, in March 2021, the Society for Evolutionary Economics

established an intra-society currency, called JAFEE, for the purpose of promoting mutual exchange and mutual aid (e.g., journal review/editing, various committee activities, etc.) among members.

In the current research, all the data was obtained from the C.C.Wallet platform. C.C.Wallet is a CaaS (Currency as a Service) platform where users can issue and manage various community currencies. This platform enables regional development organizations and communities to design and manage depreciating currency and LETS-based metric currency based on the related communities organization's characteristics and needs by using a mobile application to create a new sustainable society. Additionally, this platform is low cost and/or free of charge and is equipped with the following functions:

(1) Transmission Function for QR codes.
(2) Messaging Function.
(3) History Function.

This platform has been examined by using it in various regions and organizations in Japan (Maeda, et al. , 2019), and we will report the main operation of these local currencies.

Figure 8 Community Currency Smartphone Application (C.C. Wallet) Screenshots (Maeda, et al., 2019)

The main screen of the C.C. Wallet application is shown in Figure 8 (a), where any region, shopping district, company, or any organization can request to set their own currency, issue, and operate it. Also, we can also see in Figure 8 (b), the currency amount (i.e., number of points), message and textbox for the addressee of the destination. In Figure 8 (c), we can see different skills/activities that the user has registered on the application like Herbology Class, 800pt, Chest Art Experience, 1500pt, Haircut, 2000pt, and a pick-up from some place, 1000pt. Finally, the QR code which is used for transmission can been seen in Figure 8 (d). C.C.Wallet is available and can be download from Apple's App store or Google's Play store. The full details about C.C.Wallet as well as the implementations of this platform are reported in (Maeda, et al., 2019).

3.2 Transaction Data

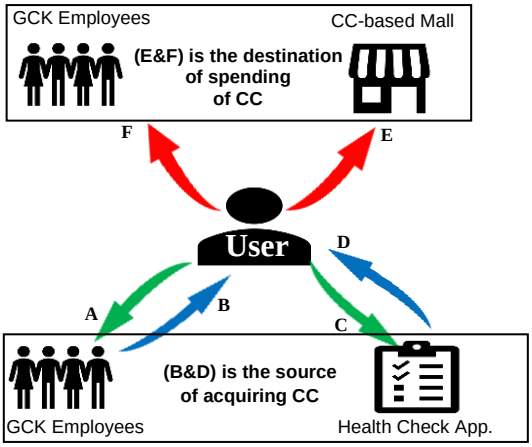
All the data was obtained from Global Communications Planning Co. Ltd. (hereafter abbreviated as GCK). The data was generated by C.C.Wallet as a CSV file form and the template of the file is shown in Figure 9.

1	2	3	4	5	6	7	8	9	10	11
A	B	C	D	E	F	G	H	I	J	K
Currency Code※1	Time Stamp	C2C	GPS Data	Trans. Point	Seller Name	Seller Balance	Seller Message※2	Buyer Name	Buyer Balance	Buyer Message

※1：00112: Currency of Chiba Prefecture
※2 ：Almost null

Figure 9 Template of CSV file generated by C.C.Wallet

The data file generated by C.C.Wallet platform was not only related to bilateral transactions of products and services which were purchased by users of C.C.Wallet (members of the community), but also from the transactions at CC malls (CC-based malls) as shown in Figure 10.



A. Offering products or services
B. Receive CC regarding products or services
C. Performing health check daily
D. Receive CC regarding performing health check
E. Purchasing the offered products through CC-based malls
F. Purchasing the offered products or services through bilateral transactions

Figure 10 CC flow paths

Table 5 Transaction Data

Total # Transactions	Total # Nodes	Period of Transactions
27968	738	2019.5.9 ～ 2021.3.16

The flow of CC is shown in Figure 10, while the details of transaction data is shown in Table 5. Specifically, the direction of blue arrows was used to represent the sources of CC where the CC can be earned throughout the bilateral transactions or regarding user's cooperation in recording his/her health status before starting work on a daily-basis as one of the countermeasures against Covid19, In this regard, the employees of GCK earned 5 points of CC every day when they record their health conditions such as body temperature or complied with the rule of washing their hands for 30 seconds or more etc. and inputted this in the terminal where health check application is installed in, as shown in Figure 11. On the other hand, the direction of red arrows was used to represent the destinations where CC can be spent. The green direction points to the products and services which were provided by the user.

Figure 11 The graphical user interface of health check application in GCK

Since C.C.Wallet does not have numerical data that directly indicates the satisfaction of the user, such as five stars for indicating the fully satisfaction regarding the offered products or services, so it is necessary to predict user satisfaction in numeric form to determine the most popular products and services within the community to be used thereafter as a tool to construct the “customized community”.

Thus, it was first necessary to grasp the name of the purchased products and services not only from what was written directly in the comments of the member (i.e., Direct Transaction Trust “*DTrust*”), when he/she finished the transaction, but also, we need to calculate how many times that a particular product or service was purchased (i.e., Indirect Transaction Trust “*InDTrust*”). In the current research, the *DTrust* and *InDTrust* could be obtained when the user finished the transaction with another user through C.C.Wallet. As a result, *DTrust* and *InDTrust* could be used as indicators for the estimating the degree of satisfaction of the user regarding the offered products and services, while *InDTrust* could be obtained only when the user purchases a particular product from a CC-based mall.

The network of transactions can be represented by a directed graph as shown in Figure 12 where each node represents a user and each edge represents a transaction. All the details of this network are shown in Table 5.

In Figure 12, the source of the arrow represents the “buyer” and the target of the arrow represents the “seller” (i.e., “buyer” → “seller”). In graph theory, the number of edges pointing out from a particular node is called the “out degree” and hence, the user who has more “out degree”, he/she has purchased more products/services than other users. Considering this, since GCK gives CC for each employee who records his/her health status almost everyday, the out degree of GCK will be more than any other ordinary user as shown in Figure12.

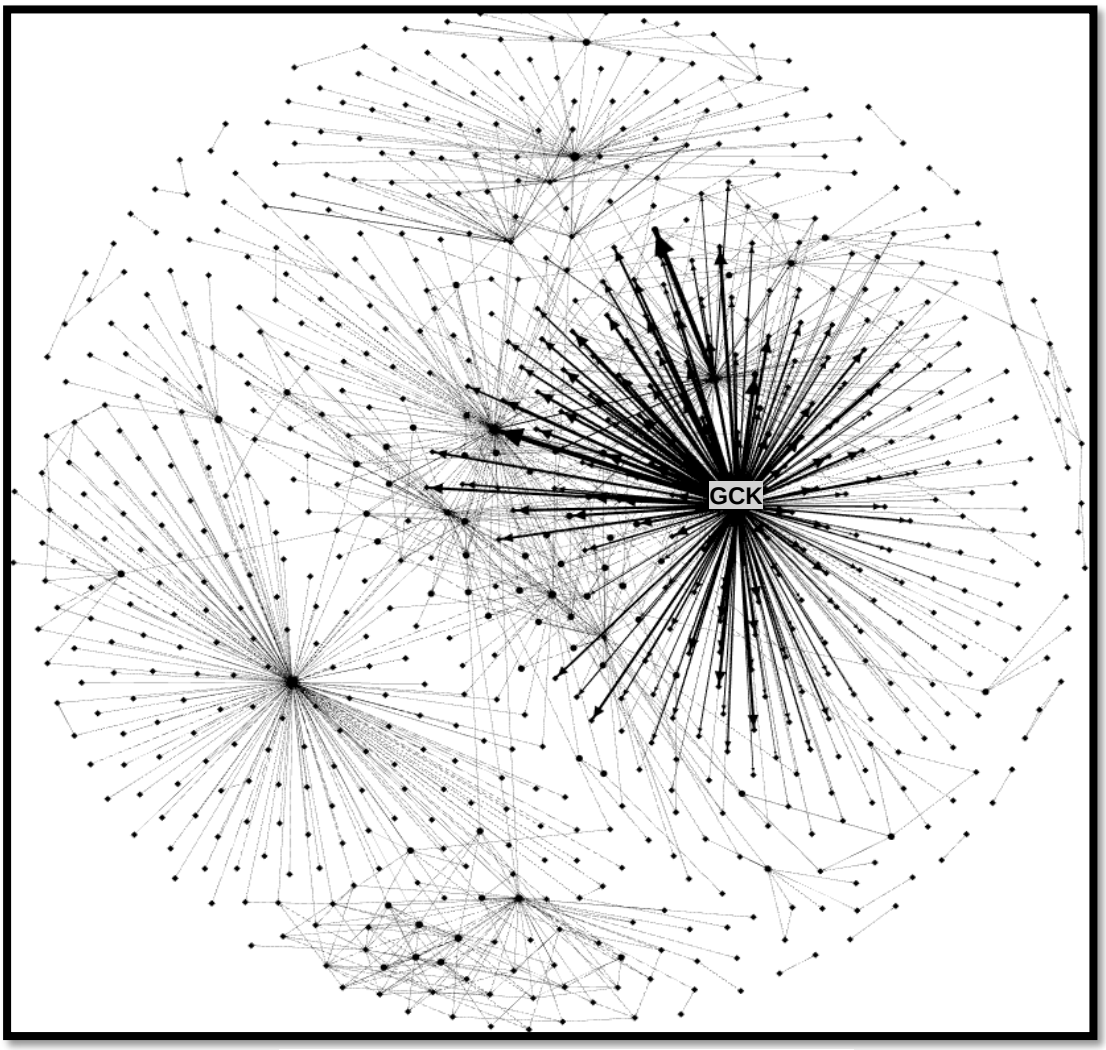


Figure 12 The network of the transactions of C.C.Wallet

3.3 The Analysis Method

To analyze the comment text entered in C.C.Wallet, it is necessary to use the technology of Natural Language Processing (NLP). NLP is a scientific discipline that aids computers to understand human languages seamlessly. The ultimate objective of the NLP techniques is to extract meaningful information from human languages. Thus, to extract the meaningful information from the comments which were entered using Japanese language by the users (members of the community), those comments are needed to be tokenized (i.e., divide) into tokens by using python language-based module called “nagisa”, as shown in Figure 13.

Next, based on the entered impression and the number of purchased of the same products or services, we can estimate the satisfaction degree of the user using 5-stars scale from “5” stars to “1” star, as shown in Figure 14. However, when the user did not evaluate the purchased products, “0” was used as an index indicating “no evaluation” instead of satisfaction degree.

The analysis process was focused on the 11th field of CSV-related template as shown the Figure 9 where the user (member of the community) records his/her message regarding the purchased products or services when the transaction was done between user and another user.

On the other hand, since CC-based malls are registered as users in C.C.Wallet, the sentence in 11th field of the generated CSV-related template was consisted of the following format:“User *X* purchased product *Y* at the mall.”, where *X* represents the name of the user while *Y* represents the name of the product. Thus, the name of the buyer and the name of the purchased products (products) were extracted from the 11th field.

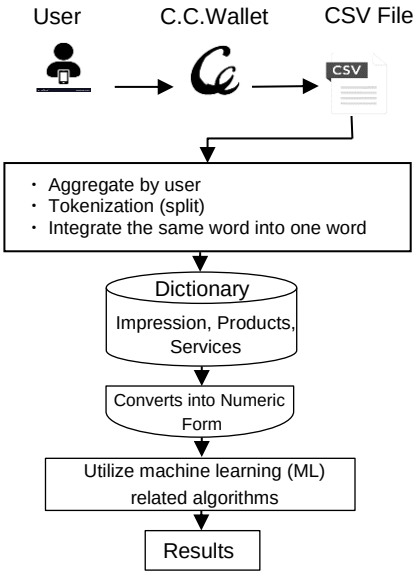


Figure 13 Overview of the analysis process

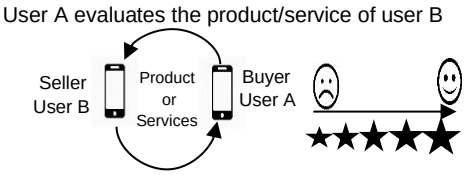


Figure 14 The evaluation process

Contrary to what happens in the negotiated transaction between one member and another within the community, the member cannot record his/her impression when he/she bought a product from the CC-based mall.

In the current study, we did not consider the price of the products/services as purchasing something expensive does not necessary mean that the user is satisfied with that product or service however repeatedly purchasing the same product or service does reflect that the user was satisfied, therefore to predict the degree of satisfaction of the purchased product, the number of times that the user repeatedly purchased the same product (*InDTrust*) was considered as an indicator of the degree of satisfaction which was evaluated on a five-point scale from a “5” star rating to a “1” star rating.

For example, if the same product is purchased only once, the degree of satisfaction is set to “1”, if the same product is purchased twice, the degree of satisfaction is set to “2”, and if it reaches 5 times or more, the degree of satisfaction will be set to “5” and so on.

Table 6 The list of impression-related words in Japanese with its translations

Highly Satisfied	Satisfied	Relatively Satisfied	Not Satisfied	Not all Satisfied	No impression
5	4	3	2	1	0
広め:Wide	ありがとう: Thank you	ごめん: Sorry	恐喝: Extortion	くそ: (foul language)	
わざわざご足労: Take the trouble to work	よろしく: Thank you	すみません: Sorry	できない: I can not	やだ: I don't like	
わざわざ: Take the trouble	宜しく: Thank you	すいません: Sorry	何となく: Some how		
本当にありがとう: Really Thank you	有難う: Thank you	あげる: give			
礼: Thank you	サンキュ: Thank you				
世話: Looking After	楽しん: have fun				
嬉しい: Happy	楽しみ: have fun				
甘く: Sweet	美味しい: Delicious				
さすが: As expected	美味し: Delicious				
心遣い: Thanks for consideration	美味しかっ: was Delicious				
大好き: really like	美味しく: Delicious				
ちそう: Hospitality	めでとう: Congratulations				
馳走: Hospitality	疲れ:Effort				
Go※ ※it means「Let's Start CC」	久し: After a long time				
貴重な経験: Valuable Experience	頑張っ: Do your Best				
親切: Kindness	お試しに協力してくれてありがとう: Thank you for your cooperation				
良い: good	確認が取れました。ご協力ありがとうございます！: Thank you for your confirmation				
面白い: Interesting	おいしかっ: It was delicious				
感謝: Appreciated	立派: fine				
もう一つ: Another one					
ウインナー: Wiener					
最高: Best					
やりたいなぁ: I want to do it					
早速: Immediately					

3.3.1 Regression Analysis and Machine Learning

Regression is a method used in statistics to investigate the relationship between independent variables or features and a dependent variable or outcome. In this research, we use it with machine learning to predict the outcome of a continuous variable. Regression analysis measures "how an increase in one variable *x* affects another variable *y*". In regression analysis, for a given two variables *x* and *y*, it is necessary to make a clear distinction between *x,* the "explanatory variable", and variable *y* which is called an "objective variable".

Since the "explanatory variable" is used in the learning process to generate the objective variable, we need first to determine which variables are the "explanatory variables" and which are the "objective variables".

The "explanatory variable" is determined from asking the following question, "What should we use to predict something?", while the "objective variable" as its name implies, is the variable that determines the degree of satisfaction which we want to predict in this research.

Table 7 AI-based Learning Data Model

Name of Variable	Meaning of Variable	Type of the Data	Type of Variable
Satisfaction	The satisfaction of the user※	Numeric	Objective variable
Repetition	repetitions of purchases for the same category product/service	Numeric	Explanatory variable

※When products are purchased through normal negotiated transactions, the satisfaction degree is calculated based on Tables 8 and 9, but when purchased at the C.C.Wallet mall, the satisfaction degree is calculated based on Eq. 8.

To use "objective variables" in the model, "impression-related words" (i.e., words expressing satisfaction) which was recorded as comments in the Japanese language (*DTrust*) after finishing the transactions in C.C.Wallet, was extracted as shown in Table 6. Those impression related words were linked to the satisfaction degree which was set to 5 levels ("5": highly satisfied, "4": satisfied, "3": relatively satisfied, "2": not satisfied, "1". not all satisfied, "0": No satisfaction-related words).

The full list of Japanese impressions-related words was classified in terms of degree of satisfaction. This is shown as a five-point scale above in Table 6.

In the current study, we considered the category of the product rather than the offered product itself as well as the category of the service rather than the offered service itself as described in Tables 10 and 11.

If multiple "impression-related words" was recorded regarding multiple product or services where each of which was purchased throughout different transactions as well as classified in the same category, and those "impression-related words" had different degrees of satisfaction, the average of those degrees of satisfaction was calculated.

For example, if the impression of a particular user (member of the community) regarding a particular product as "I really like it" which has a degree of satisfaction of "5", and then in another transaction, the impression of the same user regarding a particular product whose category was the same of the previous purchased one, was "thank you", which has a degree of satisfaction of "4", the average of the degrees of satisfaction was calculated and hence, "4.5" was considered the degree of satisfaction regarding the purchased product's category.

However, since the impression-related words cannot be grasped through the transactions of the CC-based mall, we calculated how many times each user bought the same product (*InDTrust*) from the CC-based mall, and we considered such repetitions of purchases for the same category product as an indicator of the user's degree of satisfaction regarding the purchased product.

Thus, the fixed format sentence "User *X* purchased the product *Y* in the mall" where *X* represents the name of the user (member of the community), while *Y* represent the name of the product's or service's category was recorded when the user of C.C.Wallet purchases a product from the CC-based mall in the 11th field of the CSV file. This field was extracted and evaluated on a five-point scale from a "5" star rating to a "1" star rating according to the number of purchases of the same product (*InDTrust*), and the degree of satisfaction of the user who purchased from the CC-based mall can be computed by the following Eq. 8.

$$The\ satisfaction\ degree\ of\ user = the\ number\ of\ parchases\ of\ same\ product$$
$$\forall InDTrust \quad (1 \leq InDTrust \leq 5) \qquad (8)$$

In the current study, the number of purchases of products and services was extracted per user as shown in Tables 8 and 9.

Table 8 The 1st explanatory variable (number of products) (*InDTrust*)

Product Name	$User_1$	$User_2$	$\cdots$	$User_n$
Pro_1	For $User_1$ Pro_1 *and* 「$impression - related\ word$」 is extracted	For $User_2$ Pro_1 *and* 「$impression - related\ word$」 is extracted	・ ・ ・	For $User_n$ Pro_1 *and* 「$impression - related\ word$」 is extracted
Pro_2	For $User_1$ Pro_2 *and* 「$impression - related\ word$」 is extracted	For $User_2$ Pro_2 *and* 「$impression - related\ word$」 is extracted	・ ・ ・	For $User_n$ Pro_2 *and* 「$impression - related\ word$」 is extracted
・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・
Pro_m	For $User_1$ Pro_m *and* 「$impression - related\ word$」 is extracted	For $User_2$ Pro_m *and* 「$impression - related\ word$」 is extracted	$\cdots$	For $User_n$ Pro_m *and* 「$impression - related\ word$」 is extracted

Where *m* represents the total number of products and *n* represent the total number of users who purchased the products.

Table 9 The 2nd explanatory variable (number of services) (*InDTrust*)

Service Name	$User_1$	$User_2$	$\cdots$	$User_q$
Ser_1	For $User_1$ Ser_1 *and* 「$impression - related\ word$」 is extracted	For $User_2$ Ser_1 *and* 「$impression - related\ word$」 is extracted	・ ・ ・	For $User_q$ Ser_1 *and* 「$impression - related\ word$」 is extracted
Ser_2	For $User_1$ Ser_2 *and* 「$impression - related\ word$」 is extracted	For $User_2$ Ser_2 *and* 「$impression - related\ word$」 is extracted	・ ・ ・	For $User_q$ Ser_2 *and* 「$impression - related\ word$」 is extracted
・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・	・ ・ ・
Ser_p	For $User_1$ Ser_p *and* 「$impression - related\ word$」 is extracted	For $User_2$ Ser_p *and* 「$impression - related\ word$」 is extracted	$\cdots$	For $User_q$ Ser_p *and* 「$impression - related\ word$」 is extracted

Where *p* represents the total number of services and *q* represent the total number of users who purchased the services.

3.3.2 Neural Network Model

Typically, there are various types of neural networks (hereinafter abbreviated as NN), but the simplest form is a three-layer feedforward neural network as shown in Figure 15.

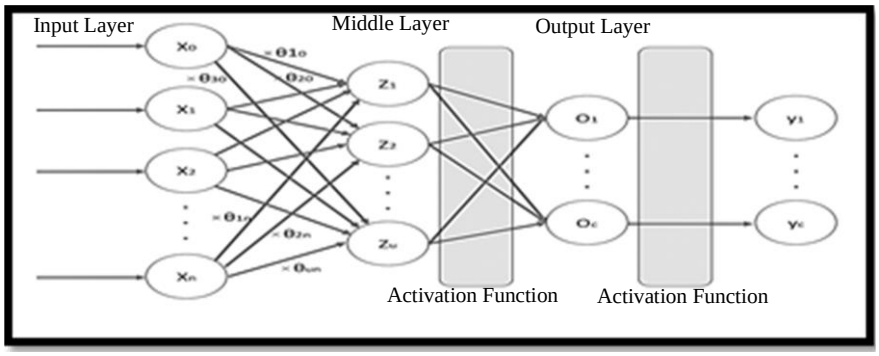


Figure 15 Three-layer feedforward neural network

3.3.3

In the current study, learning process of NN model was performed on the hypothesis that the degree of satisfaction regarding the offered productservice can be predicted based on user's number of purchases and hence, the goal of learning is to derive a model that can make such predictions.

3.3.4 The Necessary Steps for Building NN Model

When building the NN model, a series of processes are executed as shown in Figure 16. In the current study, we will explain those processes as shown in the next section.

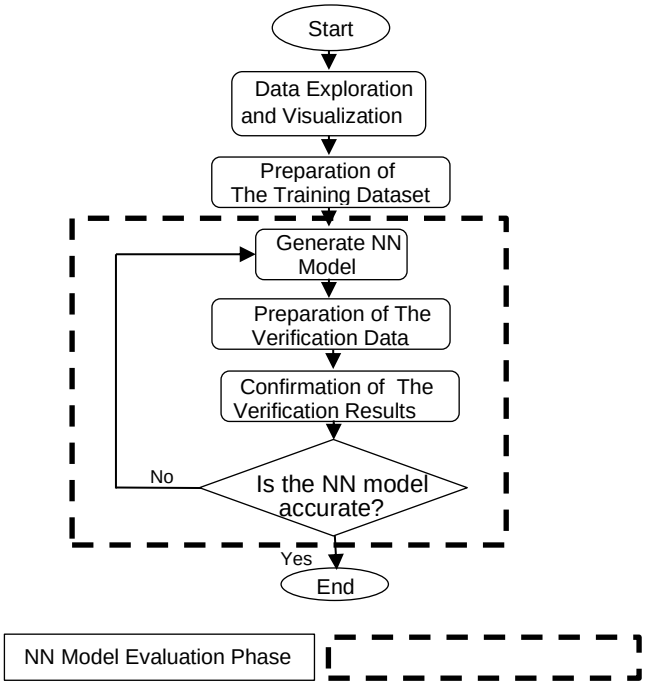


Figure 16 The process of building a NN model

3.4 Results

3.4.1 Data Exploration

The obtained data includes some of billing-related information and such data was excluded from the analysis as it is not related to the scope of the current research.

Each participant (node) trades as a “seller” or “buyer” and the number of sales and purchase transactions does not always match. In addition, some participants purchase and sell a large amount of products and services of various types, while others purchase and sell only a small amount of products and services and the number of transactions performed by each participant was not equal.

Since that there were many products and services, we tried to categorize the products with almost the same contents and meanings into the same category. For example, all items written in various expressions such as “pan price”, “pan”, and “pan help” as the names of products are put in the “pan” category and so on, as shown in Table 10. Similarly, services names like “drinking party”, “dining party”, “banquet”, “evening party”, “dinner” and “second party”, etc. , were categorized as “Social Gathering” and so on, as shown in Table 11.

Table 10 Example of the Extracted Products in Japanese with its Translations/Phonetic Spelling

#	Product Item	Category
1.	あすばら Aspara	アスパラ Aspara
	Aspara	
	アスパラガス Asparagus	
2.	パン代 pan price	パン pan
	ぱーん Pan	
	フラパン Fry Pan	
	プラパン Plastic Pan	
	Bread	
	パソヘルプ Pan Help	
3.	. . .	. . .

Table 11 Example of the Extracted Services in Japanese with its Translations/Phonetic Spelling

#	Service Item	Category
1.	運転手 Driver	運転 Driving
	運転 Driving	
	運転資金 Driving Fare	
2.	飲み会 Drinking Party	懇親会 Social Gathering
	食事会 Dinner Party	
	夜会 Evening Party	
	晩御飯 Evening Meal	
	二次会 After-Party	
3.	. . .	. . .

Japanese language had 3 writing systems: Kanji, Hiragana and Katakana, and all of them can be used to write the same word. Since that some of the names of the products and services were written in Kanji, while the others whose had similar names were written in Hiragana, we need to unify them into one category. It is worthy mentioned that to reduce the computational time of the processing, it is important to unify and categorize the products and services into one category.

3.4.2 Data Visualization

To better understand the data, we used the python language to generate statistical graphs related to the products and services. The data identified 107 types of products (including products provided by the mall) and 68 types of services.

The average purchases for the products and services were shown in Figures 17 and 18 respectively. In other words, such graphs can indicate how popular those products and services were among all the members (whose real names were replaced with animal names for anonymization and keeping privacy) of the community.

Also, a function to display the number of purchases for a particular product or service for the member after writing the user's name (i.e., animal name) was developed as well. As an example, Figure 19 is a graph showing the number of products purchased by a specific user ("fin whale") at a mall, while Figure 20 is a graph showing the number of products purchased by a specific user ("fin whale") at a CC-based mall and throughout the bilateral transaction.

3.4.3 Generating NN Model

To set the learning process of NN by using python language, we used 2 patterns of NN as shown below:

1. "1st pattern": the values of the parameters were set as below:

```
nn = (hidden_layer_sizes=(2),
      activation='relu',
      max_iter = 10000,
      verbose=True,
      learning_rate='constant')
```

2. "2nd pattern": the values of the parameters were set as below:

```
nn = (hidden_layer_sizes= [(2), (3), (4), (5)],
      'activation':['relu', 'logistic'],
      max_iter = 10000,
      verbose=False,
```

The explanation of the parameters is shown in Table 12.

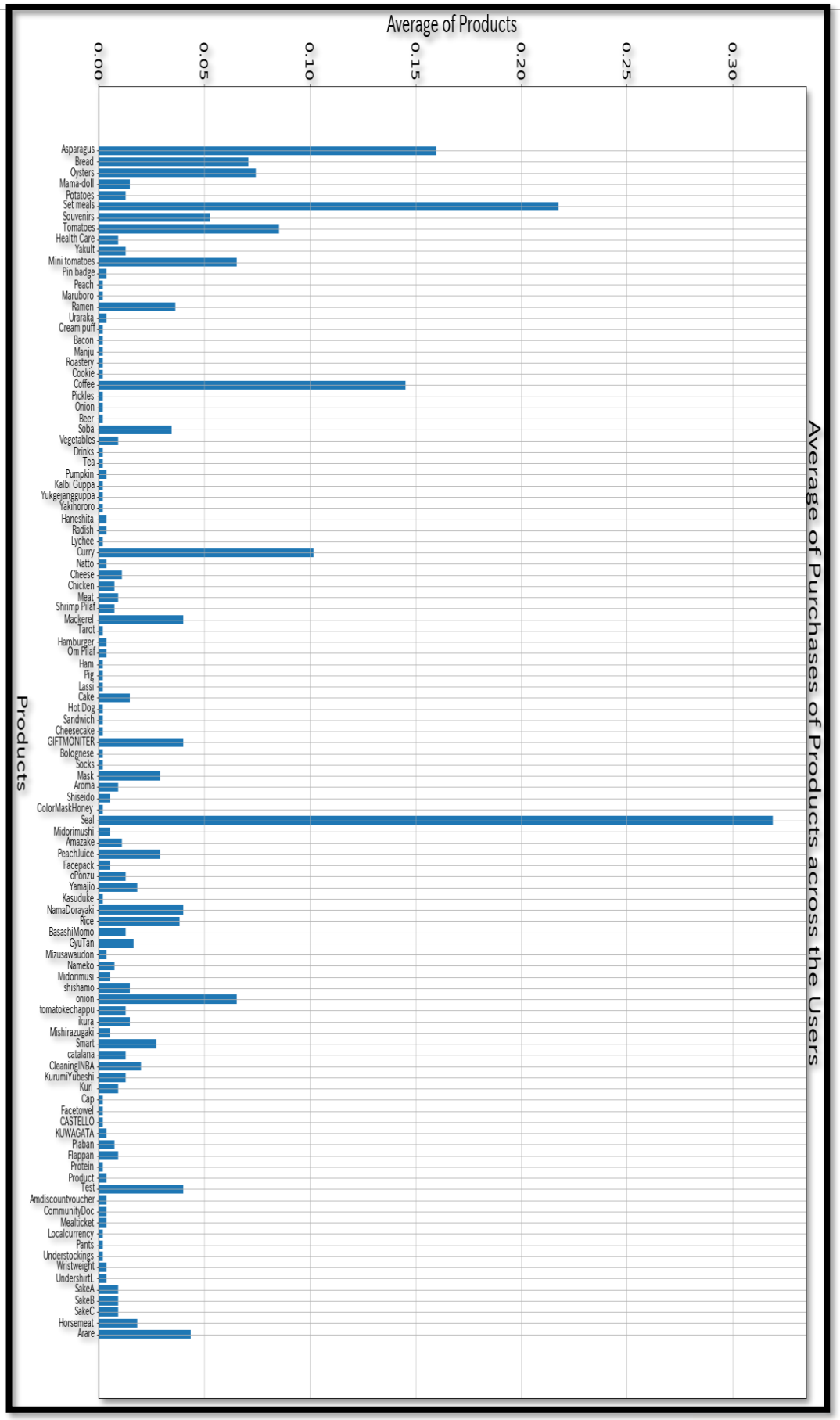


Figure 17: The average of purchases of the goods across the users

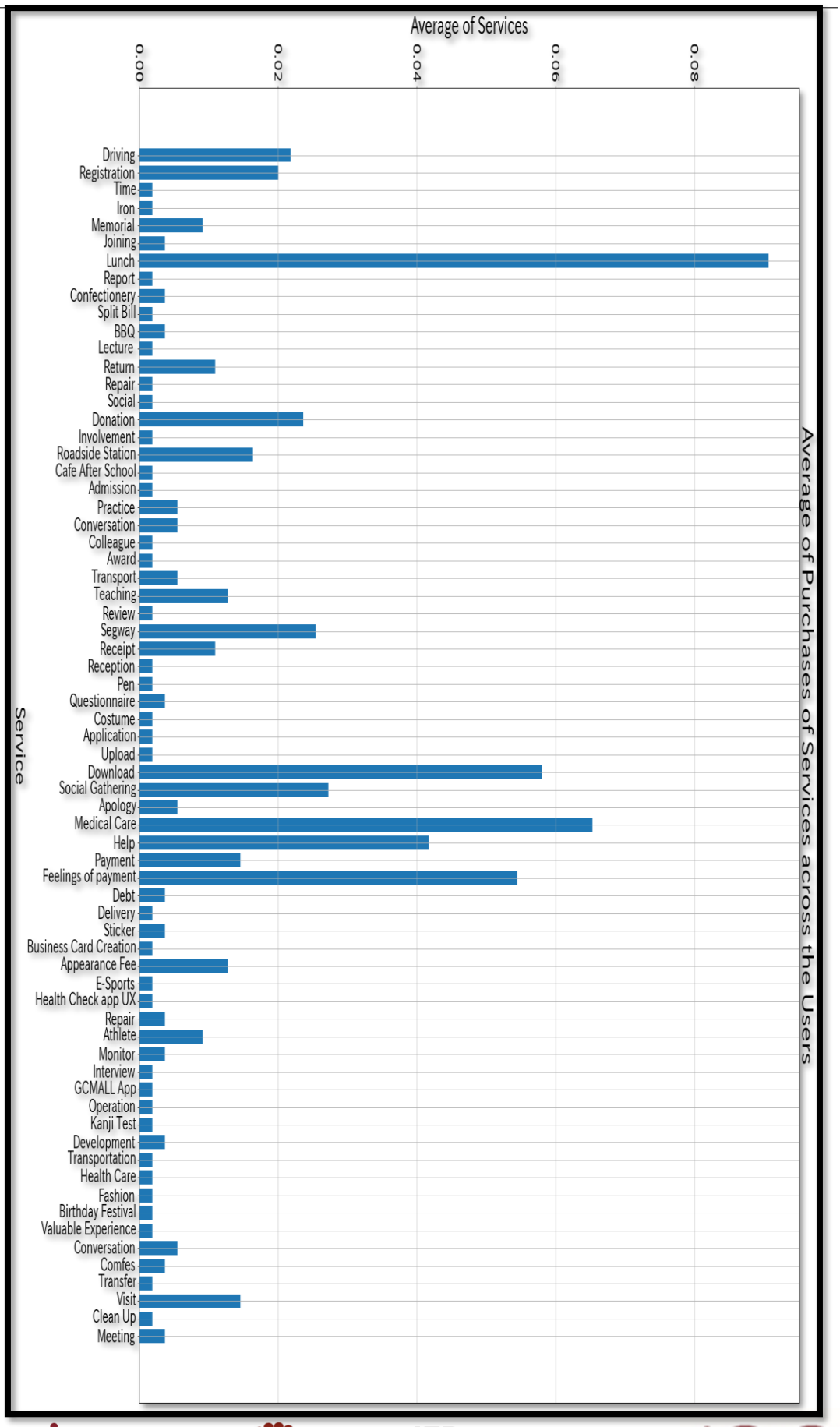


Figure 18: The average of purchases of Services across all users

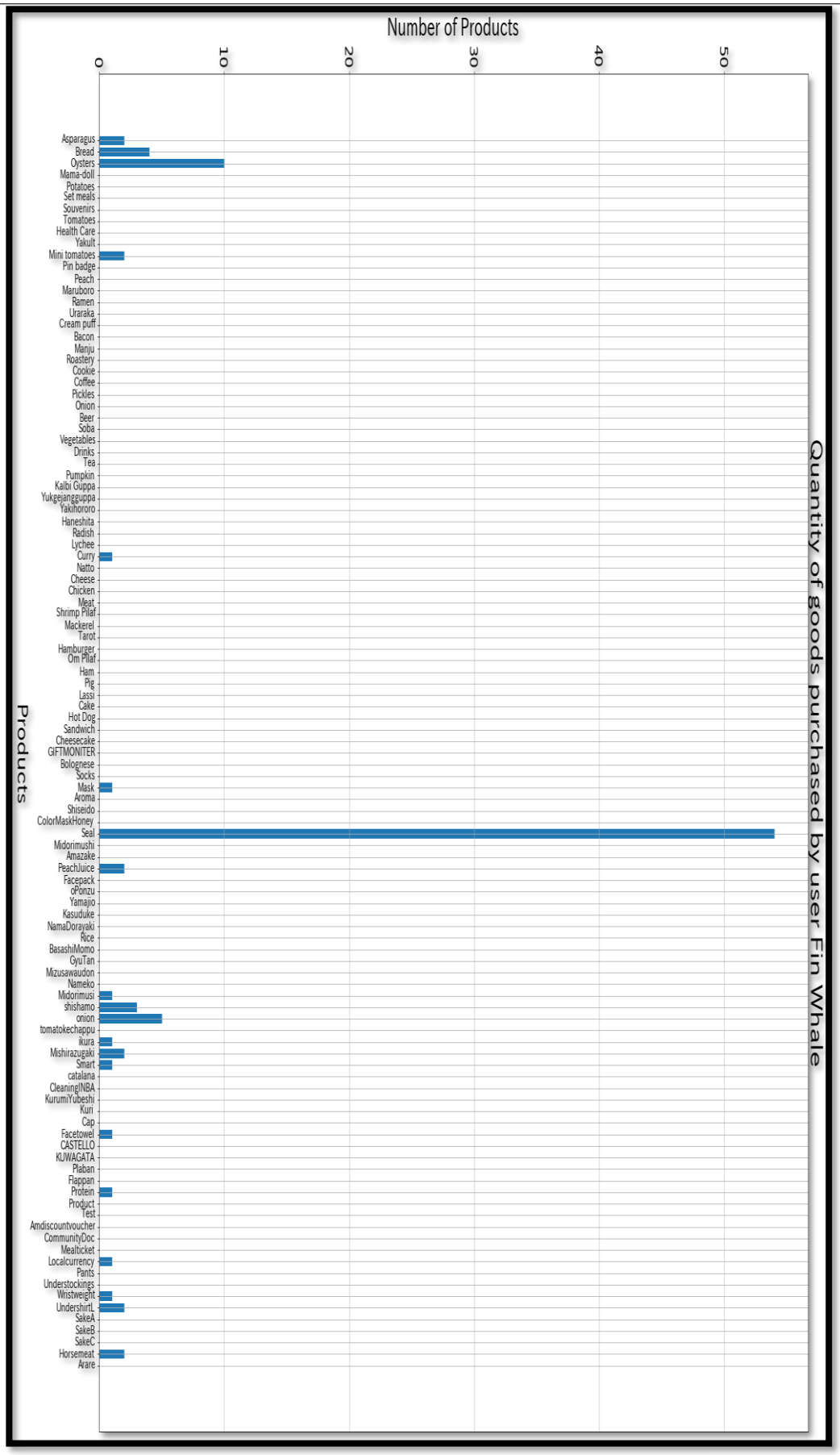


Figure 19: The number of products purchased by user "Fin Whale" at Mall using C.C.Wallet

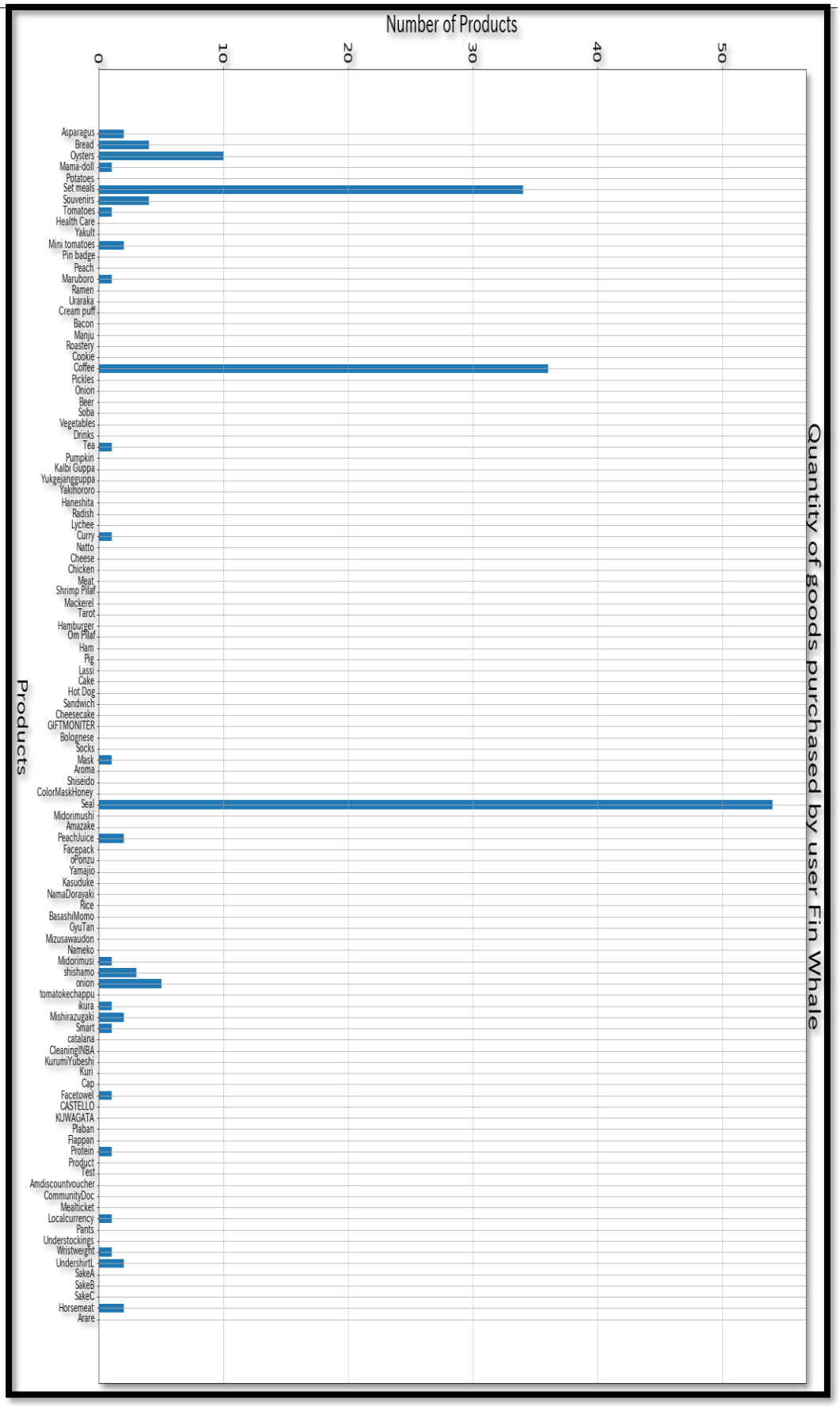


Figure 20: The number of products purchased by the user "Fin Whale" in both regular bilateral transactions and CC-based MALL

Table 12 The Explanation of NN Parameters

The Name of Parameter	Meaning	The Meaning of Values
hidden_layer_sizes	**Number of Elements:** Number of calculations in the middle layer **Value of each Element:** number of neurons in each middle layer	・Two in the first layer ・ 2 in the 1st layer, 3 in the 2nd layer, 4 in the 3rd layer, 4 in the 5th layer. Since the number of calculations in the middle layer is two or more, this learning is called [deep learning].
activation	Specifying the activation function	・relu：ReLu Function (If the input value is 0 or less, it becomes 0, and if it is larger than 0, the input is outputted as is). ・ logstic: Logistic Function (calculates the probability value and classifies it according to whether it is above the threshold value.
max_iter	Maximum number of searches when searching for the optimal solution If -1 is specified, it repeats until it converges.	The optimum model search process is repeated up to 10000 times.
verbose	Specify whether to output a message in the process of model generation	・ ”True”: Message will be displayed. ・”False”: Message will not be displayed.
learning_rate	Update the Weight Learning Rate	・The learning rate is a fixed constant variable. The default is used here.

3.4.4 Prepare the Validation Dataset

After evaluating the prediction results of the above "1st pattern", the prediction results of the "2nd pattern" were evaluated as well. For evaluation, it is necessary to prepare a validation dataset. Basically, NN was trained using a training dataset or learning dataset and evaluated using a validation dataset. Therefore, it is important to divide the obtained data into a training dataset and a validation dataset.

Since the number of transactions in which product transaction data is entered differs for each participant, we used the history data of participants with 10 or more transaction records as a learning dataset. However, when the history data of participants is small, the validation dataset cannot be prepared and hence, it was necessary to synthesize a validation dataset. That is, participants with low participation rates had to be trained using a learning dataset and evaluated using a synthetic dataset (i.e., the validation dataset).

3.4.5 Evaluation of NN Model

At the current stage, we used the number of transactions to teach the NN model, and then compare the predicted degree of satisfaction which was generated by the NN model that corresponded with the participant's actual satisfaction as described in his/her transaction comments. In other words, to confirm the predicted satisfaction degrees are coorect values or not, we compare them with the actual degrees of satisfaction and

hence, the "sum of squared deviations" (i.e., the value obtained by squaring the difference between the correct value and the predicted value of the degree of satisfaction) was calculated.

The larger the value of this difference, the greater the deviation between the correct value and the predicted value, indicating that the answer is incorrect. Using the above differences, the average size of the difference (the degree of divergence from the correct value) for the entire data was obtained using Eq 10. Thus, in the current research, *RMSE* (Root Mean Square Error) was calculated.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \hat{x}_i)^2}{N}} \qquad (10)$$

On the contrary, it is considered that the smaller the *RMSE* value, the smaller the divergence between the predicted value and the correct value, and the more correct prediction the target model can make. *RMSE* is defined in Eq. 10, where the observed value is x_i ($i = 1, 2, 3, ..., n$) and the calculated value (predicted value) calculated from the model is $\hat{x}_i$.

Table 13: The value of *RMSE* when the satisfaction degree of "Fin Whale" is estimated using "1st pattern"

Type of Transaction	*RMSE*
Products	1.173
Services	1.380

3.4.6 Regenerating NN Model

The second NN pattern was then used to rebuild the NN model using similar training dataset to improve the accuracy of predictions. In order to adjust the accuracy of the model we have to "tune" the values of the parameters of the NN-model. This "tuning" process was performed using *"Grid Search*" which is a method to find the most accurate model by setting a range of values that can be handled (e.g., 0, 1, 2, 3, etc.) for a parameter used for model generation called *α* (alpha).

Specifically, it is a method of executing the process of generating a model by sequentially substituting numerical values in a specific range into *α* and using the most accurate model among those models as the final model.

When performing a "*grid search*" in the Python language, we used a module called *GridSearchCV*. In the following processing, the parameters (setting values used for model generation) for generating the optimum model were obtained. For example, in the case of "fin whale", the value of the parameters necessary to generate the optimum model were obtained, but such values were different for each participant.

Verification with validation dataset was also performed using the newly generated model. Root Mean Square Error (*RMSE*) was used as an index to measure the efficiency of the "*grid search*" algorithm and the value of *RMSE* is shown in the below Table 14.

```
from sklearn.model_selection import GridSearchCV
parameters={
    'activation':['relu', 'logistic'],
    'max_iter':[10000],
    'verbose':[False],
    'random_state':[4],
    'hidden_layer_sizes': [(2), (3), (4), (5)]
}
cv = GridSearchCV(estimator=MLPRegressor(),param_grid=parameters)
```

```
'activation': 'logistic',
'hidden_layer_sizes': 2,
'max_iter': 10000,
'random_state': 4,
'verbose': False
```

Table 14: The value of *RMSE* when the satisfaction degree of "Fin Whale" is estimated using "2nd pattern"

Type of Transaction	*RMSE*
Products	0.722
Services	1.380

4. Discussion

So far, a community currency based monetary system has been proposed to strengthen cooperation between members by repeating non-commercial and commercial transactions among community members, but sometimes the members cannot find the desired products or services.

Consequently, the CC acquired as compensation for non-profit activities stays in the hands of the members and does not circulate in the system. If such a situation occurs frequently, a stagnation problem will arise, and a new mechanism is needed to circulate CC more smoothly and quickly among the members of the community.

Therefore, we proposed a method so that the feasibility and sustainability of the CC as a monetary system can be enhanced by introducing the concept of a "customized community" where commercial and non-commercial transactions can be integrated.

In the current research, all the data was obtained from the C.C.Wallet platform and by analyzing the recorded evaluation message in terms of linguistic expression (i.e. the impression of the users), the degree of satisfaction was estimated by using NN to be used thereafter as a tool to build the "customized community".

A manual dictionary was created by using C.C.Wallet users' messages (evaluation comments) where satisfaction-related words (i.e., impressions) regarding the offered products and services are recorded after completing the transactions in Japanese language. Thus, when new data that did not exist before, it was necessary to update the dictionary.

Moreover, if there are mistype-related mistakes in the evaluation messages recorded by members, it is necessary to manually correct those words before using them in the dictionary (e.g., "pin batch" should be "pin badge"). Thus, as can be noticed, creating this dictionary takes time, but from the viewpoint of privacy protection, we did not use cloud-based services.

To use the NN model as a tool for predicting participant satisfaction, it is necessary to validate the results obtained by deep learning using data that is different from the training dataset. In this way, the obtained data needs to be divided into two sets, a training dataset and a validation dataset. With reference to the obtained data, the users of C.C.Wallet were divided into three groups according to the number of transactions: Group A, Group B, and Group C.

Users in Group A had enough transactions, and we were able to divide the data into training dataset and validation dataset to build an NN model. Users in Group B did not make many transactions as participants in Group A and hence, only validation dataset was synthesized (i.e., not actual data).

On the other hand, Group C was the group of participants whose number of transactions was insufficient to divide into a training dataset and a validation dataset (see Figure 12 for members with a very small number of transactions), and an NN model could not be constructed.

Typically, the NN model does not have a general format or optimal values for the parameter of NN in the intermediate layers (hidden layers). Since the purchasing behavior was related to the number of purchases for the same products/services which differs from one user to another, it is necessary to specify the appropriate NN parameters for each user.

In the current research, the degree of satisfaction of the member was defined in terms of number of purchases of the same products or services as we assume that the member will repeat the purchase process if he or she is satisfied with the offered product or service. Also, such satisfaction was expressed explicitly in the evaluation message in terms of linguistic expression.

Also, the price of the product or service was not considered as an indicator for the degree of satisfaction of the user because buying something cheap does not necessarily mean that he or she

was satisfied with the offered product or service and thus, the price of the product or service was not used as an explanatory variable of the degree of satisfaction in this study.

In this study, some of the validation dataset was synthesized for two reasons. First, there are many transactions where the name of the products and services as well as the member's expression (i.e., impression) were not expressed explicitly in the evaluation messages of the C.C.Wallet platform and such data could not be analyzed. Second, many of the participants were not engaged frequently in the transactions and hence, the number of transactions of those participants was insufficient to be divided into a training dataset and a validation dataset. Thus, we need new methods to attract new members to engage and participate effectively in the community and this task was left for future work.

It is worthy mentioned here that the concept of "customized community" was based on idea of "commonality" among the members of the community and this "commonality" was identified by the estimators in terms of the estimation of the degree of satisfaction of the members of the community, as we stated above in the section of "What is Customized Community?".

In other words, without estimating the degree of satisfaction, we cannot form a customized community with a "commonality". For example, without estimating the degree of satisfaction regarding a particular category of child-related product, we cannot form a customized community with the "commonality" of "child-rearing". Thus, since the real data (i.e., transactions) of C.C.Wallet where the degree of satisfaction could be estimated was relatively small, we showed the efficiency of the "customized community" using a simulation rather than using real data.

Therefore, to be able to configure a "customized community", it is necessary to estimate the degree of satisfaction using sufficient data (i.e., transactions) to find out the "commonality" among the members of the community, Then, those members will be given thereafter a "preference" in terms of bonus premium amount to add to their initial purchase of the CC with money. Considering this, such a kind of "preference" can be considered as a strong incentive not only for the people who are inside a community, but also to induce other people from outside the community to join the community and contribute significantly (i.e., make more transactions).

In this study, the computational time was shortened by reducing the number of intermediate layers of NN model as much as possible.

Also, in this study, we claim that utilizing neural networks and AI-based techniqiues will help promote the use of CC as it will contrubute to protecting the privacy of the partcipants as this reduces the number of people who directly deal with the personal data of people who are in the community. However, on the other hand, applying such techniques in communites where there is little knowledge of neural networks or AI-based techniqiues may not assist us to promote the use of CC because those communities wouldn't know about those techniques and hence some concerns might be arisen accordingly. Also, as we mentioned above, the neural networks could not be used in cases where a small number of transactions are found and hence such cases will limit promoting the use of CC using neural networks or AI-based techniqiues.

5. Conclusions

This study proposed a new method to accelerate the circulation of CC among the members of the community by constructing a "customized community" through estimating the degree of satisfaction of the members based on a NN model.

First, the degree of satisfaction was predicted by the comment text recorded by the member of the community throughout the C.C.Wallet. Specifically, it was executed by creating a word dictionary from the comment sentences entered by the participants after closing the transaction, thereby converting the meaning-based text into numerical values corresponding to the meaning of each word.

The NN model was constructed to estimate the satisfaction degree where the objective variable was derived based on impression-related words after converting those words from linguistic text to numeric values where five levels of numerical values (i.e., 5-stars scale from "5" stars to "1" star) based on their meaning in Japanese was considered.

On the other side, determining the explanatory variables was rather complicated. It was necessary to determine the explanatory variables after considering various hypotheses because explanatory variables were considered as variables that assist us to explain the objective variable (i.e., degree of satisfaction). Therefore, for each member, the number of purchases of the same category of products and services were calculated. Since the high and low prices of products and

services do not necessarily reflect the satisfaction of the participants, the prices of the products and services were not used as explanatory variables in this study.

In the current study, the estimation of satisfaction of the members was considered as a bridge to build a principle of "customized community" where the circulation of the CC was accelerated based on our simulation. Since the purchase behavior was different from one member to another, we needed to tune the values of the parameters of the NN model so we used the "*grid search*" algorithm. However, some members did not have as many transactions as others, and such situations did not allow us to build a NN model for those members. Also, because some members did not have sufficient transactions, we were unable to divide their data into a training dataset and a validation dataset, so we only synthesized the validation dataset for those participants.

Therefore, if the use of CC is expanded by using various other applications that can acquire CC to purchase products at CC malls, actual data can be increased, and more appropriate results can be obtained.

For example, a new health care application called NUCADOCO as shown in Figure 21, was released for participants who are implementing health management.

To increase the number of participants who use CC in their transactions, we don't only need to use other applications like NUCADOCO, but we also need to offer a wider variety of products in the mall.

In this study, the concept of "customized community" was introduced as a tool to attenuate the stagnation problem in local economics. However, since the obtained data was not sufficient, we decided to utilize simulation experiments to indicate the efficiency of this concept in reducing the stagnation problem.

Thus, building a "customized community" using real data to validate its efficiency is needed to be investigated using actual data obtained from empirical experiments and this task was left for future research.

Figure 21 NUCADOCO Application

Compliance with Ethical Standards

1. **Disclosure of potential conflicts of interests**

   This research was performed based on the mutual research collaboration between Global Communication Planning Co. Ltd. and Good Money Lab at Senshu University.

2. **Authors Contributions**

   All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Dr. Maen Alaraj. The first draft of the manuscript was written by Dr. Maen Alaraj and Prof. Makoto Nishibe commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Central Banks and Climate Change Risks: Potential Monetary Prudential Tools

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ABSTRACT: The negative impact analysis of the climate change on the whole economy is particularly relevant for the central banks since they produce and use data before implementing the monetary policy to ensure the financial and prices stability and therefore mitigate the systemic risk in order to participate to build a healthy and resilient financial system. The goal of this paper is to discuss the development of potential sustainable finance policies in accordance with the central bank's tools and propose some key recommendations at least in the short run to partly overcome the analysis lacuna in this field. After having attempted to capture the notion of sustainability and shortly describe the E.S.G (Environment, Social and Governance) criteria, we justify why the central bank needs to develop sustainable financial tools for their potential monetary policies to fight against the climate change, for instance. From this definition attempt, several significant conclusions have emerged such as the harmonized taxonomy unavailability and the lack of reliable data to gauge with accuracy the climate change impacts on the financial and economic sectors, for instance. In addition, the risks related to climate change are likely difficult to evaluate given their complexity and uncertainty natures. However, this data lacuna should not prevent central banks from developing more sustainable tools based on usual and unusual monetary instruments such as capital requirements or green interest rate in taking into consideration the three climate change risks (i.e., transition, physical and liability risks) exposure.

1. Introduction

Several climate reports warned governments about risks to continue to finance real sphere without controlling for the CO2 emissions, for instance. The most important decision was to reduce the high carbon production to limit the climate change and to ensure an optimal ecological transition. Since the COP21, the climate target is to reduce the increase in global temperature by 2100 (below 2°C above pre industrial levels and even further to 1.5°C according to The Paris Climate Agreement, 2016). The Paris Agreement (PA) entered into force on November 4, 2016 and it has been signed by 195 countries. It defines guidelines to achieve the climate targets and it has proposed a calendar. The PA considers that a negative externality, such as pollution is a wheel to the economic growth. The increased interest in sustainable finance translates the international concern about the climate change, loss of biodiversity, social inequalities and various determinants that may undermine the economic resilience as underlined by the recent Covid-19 sanitary crisis. Soon, it is obvious that financial sector could contribute to play an essential role in the development of the economic sustainability.

Remind that during years central banks have saved the financial system by using and defining traditional and non-conventional tools, namely quantitative easing; low (even negative) interest rate policy etc. They have also enlarged their missions after the last financial crisis by guaranteeing the financial stability (Goldman and Zhang, 2021). Given the history and the mission of the central banks during the financial crisis, it may be logical that the central banks tackle the climate change; however, their actions should be completed by public policies, for instance. Despite the numerous debates on the central banks' functions, all converge towards the following conclusion: central banks play their role of regulators (Dikau and Volz, 2021; D'Orazio and Popoyan, 2022) as underlined by Frank Eldernson, member of the executive board of the European Central Bank (ECB), "the ECB's environmental action is fully in line with its mandate". Moreover, the last 2021 IFC report relative to the sustainable data for central banks concludes that central banks have actively participated to improve the relevant sustainable finance statistical framework and therefore underline indirectly the necessity of central banks to partly take up the climate change issues.

This paper starts by examining the concept of sustainability and climate change risks (i.e., transition, physical and liability risks). Soon, we face the difficulty to define the socially responsible finance and therefore to define with accuracy the climate change risks. Given the impact of the climate change on the whole economy and particularly on the prices and financial stability, central banks - as prices and financial stability guarantor - should play a key task in the climate change struggle. The next section is dedicated to analyse the potential tools assumed to promote the sustainability. The last section concludes.

2. Definitions of sustainability and climate change risks: An impossible mission?

The aim of this section is to provide more clarifications on the sustainability concept and climate change risks, especially the transition, liability and the physical risks.

Sustainability

To apprehend the notion of sustainability two approaches are often used: the definition and the taxonomy.

- Definition

Several definitions have emerged since decades and most of them have similar points. As a matter of fact, they all emphasized on the necessity to promote the development of ESG (environment social and governance) criteria as displayed in Table 1. The ESG scores are more and more necessary to inform the public and particularly the financial actors (like asset managers) on the sustainability concept (Ehler et al, 2022).

Table 1 ESG issues

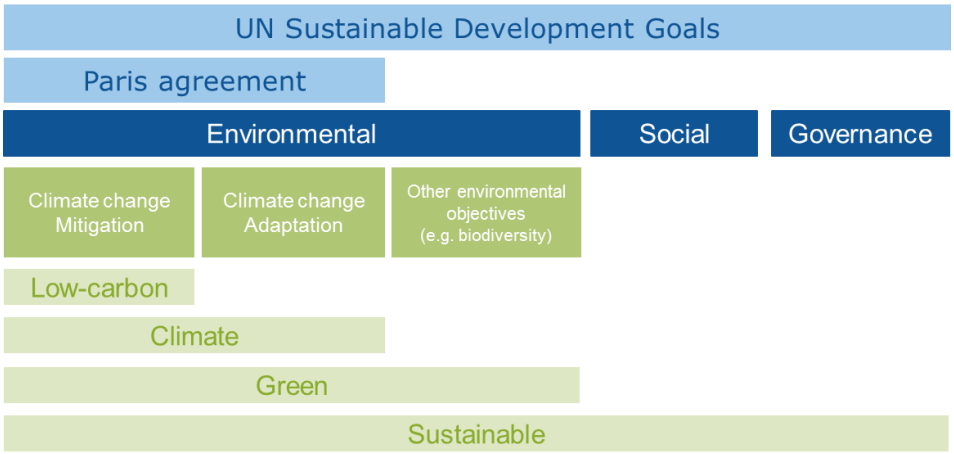
Environment Issues	Social Issues	Governance Issues
Climate change and Carbon emissions	Customer satisfaction	Board composition
Air and water pollution	Data protection and Privacy	Audit committee structure

Biodiversity	Gender and Diversity	Bribery and Corruption
Deforestation	Employee engagement	Executive compensation
Energy efficiency	Community relations	Lobbying
Waste management	Human rights	Political contributions
Water scarcity	Labour standards	Whistleblower schemes

Source: Chartered Financial Analyst (CFA) Institute, Environmental, Social, and Governance Issues in Investing, A Guide for Investment Professionals, 2015, Page 4, Retrieved from: https://www.cfainstitute.org/-/media/documents/article/position-paper/esg-issues-in-investing-a-guide-for-investment-professionals.ashx

Given the high number of ESG components, it may be delicate to invent a unique definition of the sustainability assumed to resume all the characteristics of this concept (Lindenberg, 2014; Gueddoudj, 2022). However, to keep on studying within sustainability framework, the UN taxonomy is often utilised.

Figure 1 EU Taxonomy - Main concepts-



Source: F. Tamburrini, A. Melo, A. Giovaninni, "The EU taxonomy and the European green deal", an internal ECB presentation, January 2020.

The UN Sustainable Development Goals (SDG) have taken into account several items related to the ESG criteria and are assumed to define general guidelines on the notion of sustainability, in addition they have emphasized the climate change issues and their corollaries. Starting from this template, the EU taxonomy is built.

- Taxonomy

Before, exposing the EU taxonomy version, it may be useful to define the general taxonomy function (Table 2).

Table 2 Taxonomy approach

IS	IS NOT
A list of economic activities and relevant criteria	A rating of good or bad companies
Flexible to adapt to different investment styles and strategies	A mandatory list to invest in
Based on latest scientific and industry experience	Making a judgement on the financial performance of an investment – only the environmental performance
Dynamic, responding to changes in technology, science, new activities and data	Inflexible or static

Source: European Commission, Retrieved from: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-using-the-taxonomy_en.pdf

Several works have underlined the necessity to develop such classification tools to deal with the sustainability concept (Ehlers et al., 2021; Gueddoudj, 2022). One of the advantages is its flexible nature since the criteria continuously evolve with the environment and the knowledge state. Nevertheless, the taxonomy given its simplicity does not take into account all risks. Moreover, generally it does not cover all economic institutional sectors either.

In line with European Commission (EC) Reports, to be environmentally sustainable, activities have to be in conformity with EC regulation. The EC taxonomy reports different variables related to environment. To be qualified for a "sustainable passport" in accordance with the EC, several conditions are required:

- Intensively participate to the one or more environmental objectives defined by the Proposed Taxonomy Regulation (climate change mitigation; climate change; sustainable use and protection of water and marine resources; transition to a circular economy, waste prevention and recycling; pollution prevention and control; and protection of healthy ecosystems)

- Respect other objectives by avoiding to harm them significantly and to be informed about the technical screening for the notion of Doing No Significant Harm (DNSH)

- Respect the minimum social safeguards (i.e., the eight fundamental International Labour Organization (ILO) conventions).

These points constitute the architecture of the EC taxonomy and provide guidelines to converge towards more sustainable activities. The EC report published in March 2020 shed some light on informative issues. The Technical Expert Group was asked to elaborate recommendations on technical screening criteria for countries. The expert group has hence defined a European flexible taxonomy regulation. The EC instructions consider only activities related to climate change mitigation or adaptation and to the DNSH's notion. In fact, the taxonomy content is based on a questionnaire sent to firms related to climate change; the survey, sent in September 2019, took into account 67 activities. Only 830 responses have been reported and "the vast majority of respondents were based in Europe, and 48% were private individuals, 24% were from the general business sector and 10% were from the financial business sector". (EC Report, March 2020, p.11). It is obvious that the coverage is insufficient. Moreover, the survey is climate change targeted, which is not suitable since the climate change is the tree that hides the forest. Today, the loss of biodiversity is also a great challenge for all countries and may deserve a great attention. It is clear that a more global vision of the environmental damages is more appropriate. The final version of the European commission taxonomy will be available in 2022, however, in the meanwhile several changes appear; recently gas and nuclear sectors are considered as non-polluting since they do not increase the CO2 emissions level. According to Thierry Breton, European Commissioner for the internal market, "Gas is not the best to achieve our goal because you generate some CO2 but at least it's better as a transition than coal … We need to have the right financing in the taxonomy, including nuclear energy." (Financial Times, 01/04/2022).

Given the difficulties to delimit a unique and accurate perimeter for the sustainability, it is clear that the literature on this topic will be flourishing and will provide evolving information. Nevertheless, it will not sure to get consensus on definitions or concepts given the complexity and the geographical aspect of the climate change, for instance.

Despite the lack of definitive and harmonized taxonomy, the risks relative to climate change are already present such as the physical, liability and transition risks.

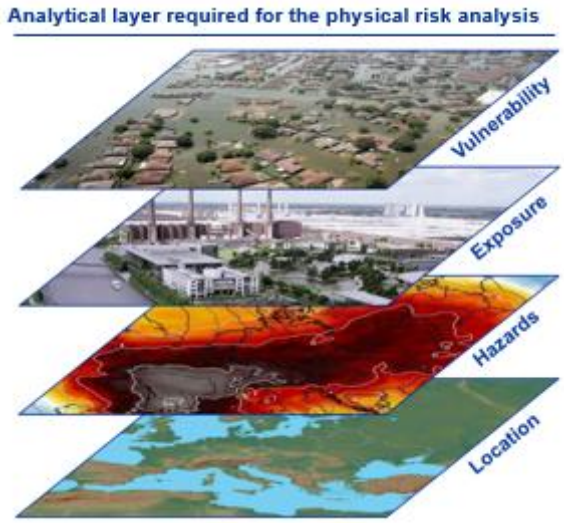
Climate change risks

Starting from the Carney's discourse in 2015 that pointed out three risks: physical risk, transition risk and liability risk, this subsection explores these risks and their difficult measures.

- Physical risk

The physical risk is related to the physical consequences of the climate change on both the short-term and the long-term scopes. The short-term (acute) physical risk refers to the extreme natural catastrophes like floods or earthquakes. The long-term risk is related to the sea-level rise or the rise in temperature. The consequences are at both local level and at world level. The physical risk has direct and indirect consequences on the economic growth and the financial stability. The following paragraph synthetizes the components of the physical risk and the major effects lead by this risk. To fully understand and acutely measure the physical risk, several approaches, and especially the layers approach (cf. Schema 1), are necessary given the complexity of climate risk.

Schema 1. Layers approach



Source: ECB, 2021 Report.

The layers approaches are taken into account several items: Vulnerability (V, degree of severity related to the occurrence probability), Exposure (E, financial lost related to the risk), Hazards (H, probability of frequencies and severity of the natural events), and location (L, city, countries). All these items allow defining and measuring the physical risk. The equation assumed to portray the physical risk (PR) is:

$$PR = V \times E \times H (1)$$

The relationship (1) is calculated within a location framework. However, the huge limit of such approach is the availability of the database and the quality of the available database. Moreover, some questions related to the aggregation algorithm to elaborate synthetic indices have emerged. As already underlined, the location is essential and it may be useful, soon or later, to calculate a global indicator of the physical risk for each country and interconnectivity indicators to evaluate the independence between the countries risk since the climate change is global.

The impacts of the physical risk (PR) affect direct and indirect all economic sectors, and particularly real estate. The PR touches both at micro and macro levels and obviously, it hurts financial and non-financial institutions. The loss calculations are currently available on different national and international institutions (Antofie et al. 2020; ECB/ESRB, 2021).

Concisely, the physical risks cut across all sectors and warrants a comprehensive, coordinated, integrated and sustained response.

- Transition risk

The second type of risks is the transition risk. This latter is more complicated to gauge since it refers to climate change dangers linked to qualitative variables like consumer preferences or reputation. During years, several policies promote the development of more sustainable action aiming for instance to limit pollution. The Paris Agreement has participated to raise awareness about the climate change; hence, changes in the production process consuming lots of energy are currently welcome and more suitable to resolve partially the climate change emergency. Given the nature of the transition risk, the uncertainty is omnipresent and the assessment of such a risk is very delicate. Table 3 displays the main components of the transition risk.

Table 3 Transition risk's components

Risks	Definitions
Technology risk	Technical progress through lower carbon innovations permitting the ecological transition.
Reputation risk	The reputational risk is related to the customers or community perceptions of any institutions (financial and non-financial) assumed to contribute to a lower-carbon economy transition.
Market risk	The impact of climate change on the market is obvious, complex and varied. The market may react to the demand-supply shift for certain commodities because of the impacts of the physical risks.
Policy and legal risk	The implementation of greener policies has created risks since the shift towards green production process for instance is surrounded by uncertainty.

Source: Authors

The main components of the transition risk displayed in Table 3 are all complex to size; the uncertainty prevails given its characteristics. It is manifest that to evaluate with accuracy the potential consequences of the technical process or the promotion of greener policy is quite delicate. The more uncertainty prevails the more difficult is the forecasting impacts exercises (Semieniuk et al., 2021). For such a framework, qualitative variables are required and they are not always optimal. Moreover, some threats depend on the model's parametrisation and some empirical estimations like the consumer preferences.

The impacts of transition risks on the financial stability are undeniable and complex since they are interlinked. In fact, the market risk is likely interconnected to the reputation risk as some goods/services demands would change because of the change in consumer preferences. If the market collapses, the financial stability is in danger because of the interconnection between the market and the banking and insurance systems. The prices stability is also threatened by a shift in consumer preferences; thus, it is suitable that central banks play a key mission in the struggle against the global warming and develop sustainable tools to promote the sustainability as defined by the UN.

- Liability risk

The last risk is the liability risk that is defined as the climate change loss suffered by a third party. This latter could sue the allegedly responsible party and exercise civil remedies. Chart 1 sets out briefly the liability risk and its content.

Chart 1 Liability risk

Source: Prudential Practice Guide, 2021[1]

[1] https://www.apra.gov.au/sites/default/files/2021-11/Final%20Prudential%20Practice%20Guide%20CPG%20229%20Climate%20Change%20Financial%20Risks.pdf

This third risk is currently integrated in the other risks. In practice, the liability risk could be included in the physical risk in case of people who have suffered from floods or earthquakes (or any other physical events) sue the firms responsible of this situation. To avoid any duplicates, only two risks are often cited and analysed in several works.
As strengthened, the climate risk is difficult to fully understand given its nature. The existence of tipping points and non-linearities makes empirical works more complicated and the challenges are to overcome these difficulties (Basel Committee on Banking Supervision, 2021a).

Besides, risks (physical, transition and liability), which are interrelated, have impacts on the financial and prices stability because climate risk drivers are omnipresent in traditional financial risk categories such as credit, market, operational and liquidity risks (Basel Committee on Banking Supervision, 2021b; De Bandt et al., 2021). The next section describes the potential tools assumed to be implemented to guarantee the social welfare (through the financial and prices stability).

3. Potential climate change risks and monetary policy activation

Without radical actions, the planet will experience an increase in temperatures, from +3.7 to +4.8 degrees Celsius by the end of this century. The impacts on earth are obviously dramatic. A rise in temperature has a direct implication in the agricultural sectors and the availability of water (IPCC report, 2022[2]). As early as 2013, the World Bank commissioned work to analyse the potential impacts of a 4 ° C increase in temperature (World Bank reports, 2012 to 2019). The results and conclusions are alarming. In summary, in many cases, extreme heat waves, rising sea levels, more intense storms, droughts and floods will more frequently threaten the world especially the poorest and most vulnerable people. Remind that in 2015, the Governor of the Bank of England delivered a speech entitled “Shattering the Tragedy of the Horizon - Climate Change and Financial Stability”. He echoes Hardin's “Tragedy of the Common” (1968) and highlights the overexploitation of common resources. As already previously exposed, the three types of risks associated with climate change are harmful and hence endanger economies. However, risks, corollaries of those already described, will also emerge. Refugees will no longer be economic or political but climatic. These flows of population will give rise to tensions, unlawful acts and even wars. The supply of water, food, breathable air etc. are likely to be permanent questions that will lead to rationing to manage shortages (of water or food, for example), supposing that these variables are in the government hands. If they are the responsibility of large private companies, violent social conflicts will likely erupt everywhere as well as an explosion of poverty.

To date, climate risks do not yet have found their place in the tools for controlling the formation of imbalances within regulatory bodies. It is clear that risks must be properly analysed to avoid or contain systemic risks (Carney et al, 2019; Guindos, 2021). Climate change threatens financial and economic stability. Recognition of the climate emergency has led to the creation of different EU working groups, analysis centres or workshops. For illustration, the initiative of the Financial Stability Board (FSB) in 2015 is in line with the ESG concerns. The FSB, at the request of the G20, created a task force dedicated to the study of climate change (Task Force on Climate-related Financial Disclosure or TFCD). This group has provided recommendations and information to economic agents, such as investors, insurers, lenders, etc. In 2017, the Network of CBs and Supervisors for Greening the Financial System (NGFS) was created and in April 2019, it released a report that made six recommendations to green the financial system. Four recommendations are geared towards supervisors, and policy makers. They are related, overall, to the integration of green micro- and macro prudential tools in their missions and to the development of a database, harmonized, precise and reliable. Information transparency and data / knowledge sharing are also required to improve the data quality and the cooperation between institutions and countries. Decision-makers should also develop a taxonomy of green activities and actively participate in the publication of reliable public reports on the climate and on the environment, and ensure compliance with climate rules (Alessi et al, 2021). This taxonomy is at an embryonic stage and its current construction is far from meeting the requirements of ecological issues. Today, several efforts are realised to improve the data quality and the data disclosure (NGFS, 2021-2022); nevertheless, there are many obstacles and until now, crucial matters are not resolved.

In December 2019, Christine Lagarde (CL) stressed the need to recognize the importance of climate-related risks. She also detailed three areas (macroeconomic perspective, banks and financial portfolio) in which the ECB should intervene. The ECB should introduce green variables for forecast growth

[2] https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_SummaryForPolicymakers.pdf

exercises. It should advise banks on how to compute properly the risks associated with climate change. Stress testing exercises for banks are crucial for financial stability (Budnik, 2021). The ECB should also prioritize green assets in its asset portfolios. On March 18, 2020, CL announced a new Pandemic Emergency Purchase Program (PEPP) following the health crisis that has raged in Europe since the first quarter of 2020. The amount of this operation was 750 billion Euros. On June 4, 2020, the Board of Governors decided to increase the envelope of the pandemic emergency purchasing program (PEPP) by 600 billion euros for a total of 1350 billion euros. In response to the downward revision of inflation linked to the pandemic, the expansion of the PEPP will thus further ease the general stance of monetary policy, supporting financing conditions in the real economy, especially for businesses, and households. Purchases will continue to be made in a flexible manner over time, across asset classes and across jurisdictions. In June 2021, CL has promoted a green and digital recovery[3]. On a regular basis, she pronounces discourses to warn us about the disastrous financial impacts of climate change[4].

All these initiatives have shown that the urgency of climate-related risks is publicly recognized. However, the facts do not illustrate this seriousness. Indeed, there is a kind of ratchet effect. For illustration, we are aware of the ecological risks but CO2 emissions are not reduced drastically. “The dataset (EDGARv5.0_FT) shows that global CO2 emissions of fossil and therefore anthropogenic origin increased by 0.4% in 2016 compared to 2015 and by 1.2% in 2017 compared to 2016 for reach 37.1 Gt of CO2”. There is an indisputable upward trend thus the ecological transition appears to have fallen off the agenda. Only a powerful institution could change the situation and put again economies on the rails of ecological transition, boosting a dynamic that encourages other players in finance. In our opinion, the ECB has an important role to play; it should face up to such a challenge.

The functions of CBs have continuously changed over the years (Ugolini, 2018 and Goldman and Zhang, 2021). Today, with climate change, they must adapt their policies to promote responsible finance. ECB President Christine Lagarde continues to promote environmental protection. Remember that during the 2020 health crisis, the ECB intervened to support European economies. It proposed a 750-billion-euro emergency purchase program (PEPP) to reduce borrowing costs and expand lending in the euro area. This shows that over the years, the CBs have actively participated in avoiding a global economic crisis. Therefore, central banks have the power to promote sustainable policy at both macro and micro-prudential levels to combat climate change (Pfister and Vallat, 2021).

Moreover, the role of CBs in sustainable growth is compatible with their primary mission, which is price stability and later financial stability (because of the financial crisis related to the US subprimes). Besides, Dikau and Volz (2019) have analysed 133 central banks. Only 12% of central banks explicitly report in their missions the support of socially responsible activities ("sustainable economic growth / sustainable growth / sustainable contribution to economic growth / sustainable economic growth / balanced and sustainable economic development / achieving and sustainable growth"). This indicates that many central banks will need to better define their legal framework to implement sustainable policies in the near future.

From a prudential point of view (micro and macro), variables such as liquidity, capital, reserves and loan thresholds are emphasized. Note that Crockett (2000) and Borio (2003, 2006) made a precise distinction between macro-and micro-prudential approaches. The macro prudential tools are integrated into the requirements of the Basel texts (I, II, III).

The objective of what follows is to show how CBs could contribute to moving from a traditional financial system to another system that would respect Objective 2 as specified by the Paris Agreement. However, the success of environmental policies would require a fundamental questioning of the Basel recommendations.

Climate change creates both risk and uncertainty and therefore makes the financial system vulnerable. Uncertainty is the root of instability and particularly the financial instability (Minsky, 1998; Phan et al, 2021; Danisman and Tarazi, 2022). The "Minsky moment" is when the financial world changes from optimism to pessimism. According to Jeffers and Plihon (2019, 2020), climate risks could lead to a Minsky moment to a systemic crisis.

3 https://www.ecb.europa.eu/press/key/date/2021/html/ecb.sp210629~e6458f8392.en.html
4 https://www.ecb.europa.eu/press/key/speaker/pres/html/index.en.html

The instruments of monetary policy (convention or not) are plural (Goldman and Marinova, 2022). We start by presenting, the interest rate tool.

Numerous theoretical and empirical papers have attempted to explore how the interest rate should optimally orient financial flows towards sustainable sectors (Mésonnier et al. 2017; Kempf 2017; Muller, 2019; Chavez et al, 2021). In line with these works, it may be suitable to set an ecological interest rate because climate change has negative impacts on the natural interest rate and economic growth. Nevertheless, the current level of the interest rate is fundamental for the policy success; if the present interest rate is close to 0, the policy will not have the expected results.

This adjustment variable should take into account the externalities produced by greenhouse gas emissions (GHS). This instrument should be lower when the project is sustainable and higher in the case of brown projects. The sustainable interest rate is a useful tool in a context of "rate normality". It is therefore not certain that its implementation will be feasible in an environment of low (or even negative) interest rates. Indeed, this climate-friendly policy is not suitable in the case of an unconventional monetary policy (negative rates) since, most often; a CB uses it because the interest rate instrument is no longer effective. Some papers have attempted to demonstrate that during a long period of low (even negative) interest rates, QE has failed to relaunch the economic growth due to "headwinds" that would typically arise in the wake of recessions and effects of non-linearity of interest rates. A part of the financial literature deals with the question of whether the transmission is different when the rates are low. The effectiveness of monetary policy can vary across different phases of a recession. In the initial phase, expansionary monetary policy can be very effective in countering uncertainty and the risks of an economic collapse. After this first phase, the conditions of opposing supply and demand reduce the stimuli and these headwinds inherited from the past (uncontrolled expansion of credit, increase in the prices of financial assets, reckless risk-taking by agents, etc.) counteract the effects, beneficial policy actions (Borio 2014a, 2014b). The debt accumulated during good times and the loss of the gross domestic product make repayment difficult –even impossible- since the future revenues of the time were overestimated by economic agents. The financial sectors, in particular banking, tend to reduce their credit offers in order to protect themselves despite the interventions of regulators. Uncertainty is pervasive and threatens the economic equilibrium. In such environment, when the interest rate is close to its floor limit (i.e., Effective Lower Bound (ELB)), this has costly effects on the financial stability (Borio and Hofmann, 2017; Borio and Zabai, 2018; Goldman, 2021). Lhuissier et al. (2020) found, by using Structural Vector Auto-Regression (SVAR) modelling, that in some cases, monetary policy could have a positive impact on growth even during periods when the interest rate is close to from 0. A Midas-VAR model provides similar conclusions (Goldman et al., 2021).

Overall, macro-prudential instruments are based on reserves, capital, credit control and liquidity. For this latter, several tools are defined in the Basel III requirements: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR is supposed to provide information on short-term liquidity while the NSFR takes into account the long-term outlook. These two ratios should be modified to develop sustainable activities because, as they are currently calculated, they penalize long-term projects and favour short-term investments. Socially responsible activities require long-term investments and therefore lower liquidity ratios are necessary (European Banking Federation, 2018; Barmes and Livingstone, 2022). For credit, priority should be given to sustainable projects. A classification of credits linked to ceilings according to priorities should be established (Fry, 1995; Volz, 2017). Support of environmental credits to the detriment of brown credits should be an obligation for financial institutions (Fry 1995; Schoenmaker et al., 2015; Schoenmaker and Van Tilberg, 2016). Capital Ratio (CR) requirements should also be reviewed on the basis of sustainable activities since CRs encourage brown activities because of their short-term scope. The risk-weighted assets needed to calculate CR should introduce climate risks. In addition, differentiated reserve requirements (DRE) in favour of banks that finance sustainable projects should be put in application (Volz 2017; Jeffers and Plihon, 2019 and 2020; Goldman and Marinova, 2022). Finally, it is quite possible to green the countercyclical capital buffer (CCB) by introducing counter-cyclical capital buffers in times of excessive non-ecological credits, for example. Thus, banks will be more resilient during phases of cyclical downturns and more sensitive to environmental requirements. Remember that the CCB rate is based on the difference in bank credit granted to households and non-financial companies compared to the gross domestic product (Basel definition), a questionable variable as mainly discussed by experts, this variable excludes parallel production, ESG concerns, leisure time, and the household production.

Furthermore, all of these adjustment tools can promote a sustainable transition if they are calibrated optimally and if they use reliable databases. However, we need more qualitative statistics, studies and

hindsight to appraise correctly the impacts of green tools on economic growth and financial stability. It is therefore pressing to develop metrics and stress tests including the risks climatic at the earliest.

Regarding the micro-prudential perspective, according to Dikau and Volz (2018), regulators should propose regulatory standards geared towards sustainable activities, provide strict disclosure rules and define an unambiguous legal framework to protect consumers (depositors and investors).

With regard to unconventional monetary policy, namely Quantitative Easing (QE), it may be interesting to implement a program of buying "green" debt to promote sustainable sectors and stop to finance brown activities. In the debate on the greening of the financial system (cf. the work of the NGFS) and the promotion of climate-related financial publications (cf. the studies of the TCFD), increasing attention is being paid to Quantitative Easing via its Corporate Sector Purchase Program. (CSPP). Various articles have sought to identify the sectors supported by the CSPP. They conclude that there is discrimination between polluting and non-polluting sectors. Buy-back policies create distortions in favour of carbon-intensive sectors (Matikainnen et al. 2017; Monnin 2018; Schoenmaker and Schramade 2019). In addition, the work of Battiston and Monasterolo (2019) based on 1557 securities issued by 282 companies concluded that more than 60% of the shares purchased financed brown companies (production and distribution of fossil fuels, automotive sectors, production of electricity). The same paper also found that the Bundesbank and Banca d´Italia are the most exposed to automotive companies and other CO2 emitters. These findings should be taken into account in the next round of the ECB's private debt purchases.

Nowadays, it is essential to determine what can really be expected, in the very short term, from this type of green macro-prudential tool.

It should therefore be stressed from the outset that the green instruments as proposed appear insufficient and certainly doomed to failure. A complete overhaul would be the solution most in line with the climate objectives of COP21. The approach should be both quantitative and qualitative, although this represents an additional difficulty in accurately capturing the nature of the non-quantifiable variables. A return to planning in the noble sense of the term should be a prerequisite. Economic players should be forced to focus their projects on the long term even if the accuracy of forecasts would be tricky.

Before discussing the methodology for promoting green finance, the following issue should be dealt: why the macro-prudential instruments described above are not efficient or even dangerous with regard to the loss of time and credibility of regulators.

The capital requirements are represented by ratios defined in the framework of Basel II and III (Pillar 1). The current versions of capital constraints raise strong reactions. The unfounded nature of the weights supposed to quantify the creditworthiness of loans is often questionable. A total opacity of the calculations linked to the weighting coefficients reigns. Besides, they are often the result of heavy statistical programs incomprehensible and unverifiable by auditors / regulators. The development of artificial intelligence and big data will bring more complexity and make verifications difficult. Good regulation requires good supervision. Today, the regulatory body has no supervisory organ able of deciphering all business plans. Such a mission requires titanic logistical resources. It would therefore be useful to impose business plans defined by supervisors on financial entities.

The counter-cyclical buffer is not to be outdone. Many limits invalidate this cyclical tool based on the credit-to-GDP[5] ratio gap. The choice of this variable is closely linked to the works of Drehmann et al. (2010, 2011, 2013, 2014), who developed the argument according to which the credit reported to the GDP would be the most adequate indicator to predict financial crises (leading indicator of crisis). Credit is broadly defined, ranging from resident bank credit to all other sources of credit, regardless of country of origin and type of lender. It is quite surprising to put a simple report on a pedestal to evaluate such a complex and evolving concept, like the financial cycle. Activation of the cushion is based solely on this ratio. The approach is strictly univariate. It is obvious that this quotient is not able to optimally capture the financial cycle. This latter is a plural concept and difficult to model. It is clear that the credit / GDP, as defined by the Basel accords, is insufficient to reproduce the phases of the financial cycle. In addition, as already noticed, the current GDP is not sustainable. The negative impact of pollution on economies is *de facto* excluded. Finally, it is quite surprising to consider this variable as a reliable leading indicator of crisis when it does not take into account in its calculation the

5 Gross domestic product (GDP)

expected variables based on surveys (the business climate and consumer confidence). Beyond the limits linked to the variables, it is possible to highlight the problems inherent in the very choice of the filter and its calibration. Indeed, the gap is calculated using a unilateral HP filter (Hodrick-Prescott (HP) filter). This metrics is not without drawbacks in measuring the credit to GDP gap. The estimation is founded on the observed Credit-to-GDP gap and its trend, but it totally excludes credit factors. The structural approach is completely overlooked. The technical limits of the HP filter have been sufficiently described by the empirical literature (Kaiser and Maravall, 2001). There is no question here of exposing them all. We only highlight the choice of the smoothing parameter, which is not unanimous among statisticians. This constant, estimated at 400,000, is unlikely to be adaptable to all European financial cycles. The pioneering work of Hodrick and Prescott showed a coefficient of 1600 for quarterly time series. Logically, a higher value smoothes the time series more. Thus, the duration of the cycle is artificially longer and it almost impossible to detect structural changes (Detken et al., 2014; Dell'Ariccia et al. 2012 and 2019). It would therefore be more appropriate to determine the value of this parameter endogenously in order to respect the properties of the time series. In general, there is little chance of obtaining congruent results when one imposes upstream (and sometimes downstream) parametric constraints on the selected time series characterizing a phenomenon. In addition, in practice, financial cycles are not always of long (or identical) durations and imposing such assumptions may be ineffective or even dangerous for some countries. At last, the HP filter is sensitive to the number of observations. In view of all these criticisms, it is time to revisit this macro-prudential instrument flagship supposed to prevent economies from a systemic crisis (Geršl and Seidler, 2011; Bendoratyte and Kaupelyte, 2013; Wezel, 2019; Chavey et al, 2021; Gueddoudj, 2022).

Hence, it is major to rethink the foundations of the economic framework to annihilate the spectre of ecological crises and their disastrous consequences. The green tools listed below have already demonstrated a great weakness in their potential uses and efficiencies. Actually, they simply exclude ecological variables while it would be useful to back some instruments to ecological variables. In order to have a clear vision of environmental priorities, it would therefore be desirable to implicate scientists who will determine the variables to be monitored and the sectors to be favoured in order to define an imminent ecological risk by using a synthetic and/or a sectoral indicator. To date, regulators obtain information via scientific reports. Presently, it is rare for specialists in earth and in life sciences to participate in the creation of dashboards (dashboards or monitoring panels) or heat maps (maps of heat) relative to macro-prudential subjects. Anticipating natural disasters (including the emergence of viruses) is a cornerstone of financial stability policies.

One of chief tasks of CBs is to monitor the formation of imbalances, mitigate or even eliminate risks and manage crises. In principle, monitoring activity makes it possible to plan and anticipate the policies to be implemented. The European Systemic Risk Board (ESRB) is in the process of putting together a dashboard including green variables. However, its June 2020 report introduced an indicator called systemic risk linked to the COVID-19 pandemic. It highlights the probabilities of default in the productive and financial sphere and the negative effects of the virus on the economy as a whole. On the other hand, there are still no ecological variables, such as changes in temperature, the carbon footprint, the propensity for extreme climatic events, degradation of health, or even the loss of biodiversity, etc. The focus is on the health of banks, markets, insurance companies etc. and rarely on the health of the earth and its hosts as a factor of growth. Human disease is a cost for our societies and global warming is already having an international negative impact. Ecological data is essential for regulators, but it is underestimated or even ignored when it comes to determining alert thresholds that will or will not activate the CCB, for example. An ESRB report, entitled *Positively Green: Measuring the Risks of Climate Change on Financial Stability* in June 2020, outlines the main drawbacks for studying this type of issue. It underlines the difficulty of obtaining quality and harmonized green databases ("climate change reporting by banks and firms alike remains patchy"). However, it is also important to take into account the uncertainty surrounding these issues.

From the 1970's onwards, the process of undertaking the building of a dashboard was the fruit of the work of the OECD. In 1974, a set of environmental indicators was created. Currently, these variables are not sufficiently crossed with macroeconomic variables. Since 2021, the NGFS has proposed a dashboard oriented towards the impact of the climate change on the financial system, which is one of the drawbacks (NGFS, 2021).

In addition, diverse interrogations have emerged during the recent period; the most salient one is the following: are the current macro-financial variables selected by the supervisory bodies still relevant?

It may be more rational to implement macro-prudential tools, based on a heat map describing the various degrees of environmental risk. The table below summarizes the conditions for activating or not the macro-prudential tools. This is only a rudimentary illustration of considering ecological variables as a leading indicator in activating green instruments. For simplicity, we will assume that a healthy (poor) economy is characterized by high (low) GDP growth and low (high) unemployment. Several scenarios are considered since the ecological and the economic context dictates CB policies.

Table-4- climate change risks and prudential policies activation

				Synthetic ecological risks		
Financial cycle and Main macro-economic variables monitoring (GDP, inflation, unemploy-ment etc.)	Expansion Phase of the financial cycle	Healthy economy		Preventive sustainable policy	Sustainable policy	Sustainable policy
		Non-healthy economy		Policies aiming to promote growth and unemployment	Sustainable policy	Sustainable policy
	Recession Phase of the financial cycle	Healthy Economy	Without crisis	Preventive sustainable policy	Sustainable policy	Sustainable policy
		Non-healthy economy		Policies aiming to promote growth and unemployment	Sustainable policy + Policies aiming to promote growth and unemploy-ment	Sustainable policy
		Healthy economy	With crisis	Preventive sustainable policy	Sustainable policy	Sustainable policy
		Non-healthy economy		Policies aiming to promote growth and unemployment	Sustainable policy + Policies aiming to promote growth and unemploy-ment	Sustainable policy + Policies aiming to promote growth and unemployme nt

Source: Authors. Notes: Shaded boxes indicate that these situations no longer exist. The green, orange and red rectangles represent low, medium, and high risk, respectively.

The definition of ecological risks should be the result of an estimated exercise emanating from close collaboration between economists and scientists (biologists, physicists, engineering scientists etc.). Given their areas of expertise, they would be able to accurately estimate areas of environmental risk. Scientists select the variables and order them according to the imminence and dramatic consequences of the hazard. The definition of alert thresholds thus makes it possible to better gauge the intensity of the economic impacts and to select the instruments to be activated. The thresholds condition the policies to be implemented. Once reliable database available, the use of artificial

intelligence such as machine learning is highly recommended, since it deals with outstanding database, also called big data.

Regulators in cooperation with scientific experts will develop scenarios and policy actions. The assessment of the different risks (transition (TR), physical (PR) and liability (LR)) is essential. The diagram below is intended to illustrate the selection of thresholds (green, orange, red). The latter is plural. Also, we will only expose the reasoning without specifying the *n* states of nature. Only three states are introduced (E1, E2, and E3) associated with three probabilities ($p_{Ei}; i = 1,2,3.$). The risks are weighted by coefficients which may change over time. The synthetic ecological risk depends both on the state of the planet and on the three risks exposed by the governor of the BoE (whose conditional probabilities are ($p_{Rj/Ei}; i = 1,2,3\ et\ j = T,P,R$. In order not to overload the diagram, three simple cases are reported. To simplify more, we will suppose that one of the risks materialized by traditional colours (green=low danger, orange= medium, red=high) will condition synthetic ecological risk.

Table -4- Sample of risk thresholds according to States (E1, E2, and E3)[6]

		Individual risk according to Ei	Synthetic risk threshold according to Ei
$E1$	TR	$p_{TR/E1}$	
	PR	$p_{PR/E1}$	
	LR	$p_{LR/E1}$	
$E2$	TR	$p_{TR/E2}$	
	PR	$p_{PR/E2}$	
	LR	$p_{LR/E2}$	
$E3$	TR	$p_{TR/E3}$	
	PR	$p_{PR/E3}$	
	LR	$p_{LR/E3}$	

Source: Authors

The table above is a potential approach / methodology to be adopted to improve future green tools and their hypothetic implementation. The assumptions made are deliberately simple. Several more subtle scenarios and thresholds can be introduced. In addition, the rules relating to the definition of alert thresholds require special attention. It is useful to remember that the exercise is complex, as mentioned in previous developments. Besides, there is no consensus on the definitions; the methodologies for measuring them are almost embryonic (or even non-existent). Indicators are lacking and those that exist are too heterogeneous (which prevents comparisons). The very apprehension of the three risks remains thorny given their multifactorial nature and the degree of uncertainty surrounding them (Harrington, et al. 2021). One example is the transition risk, which encompasses various risks ranging from legal risk to technological risk, including reputational risk. It is therefore not easy to define an indicator reflecting such a variety of risks, especially since some variables -few in number- are qualitative. The quantitative approach is favoured to the detriment of the qualitative methodology, although the latter are complementary. This could hamper the proper assessment of risks and their impact on the economy. The risks (TR, PR and LR) are intrinsically linked and evolving, therefore difficult to predict. To date, these risks are poorly understood, although they are not new and it is impossible to obtain quality time series for these risks (BIS Report, 2021)[7].

All these constraints should not be an obstacle to the implementation of green policies, on the contrary. On the other hand, it will be necessary to implement a set of steps based on a prioritization of short-, medium and long-term objectives to deal with the climate change issues.

CBs have a significant arsenal to fight against ecological risks and their negative economic and social repercussions, as well as statistical resources whose quality could be improved as underlined earlier. However, they should not be the only ones to engage in this fight. Its interventions must be accompanied by fiscal and budgetary measures. The battle against climate change is global and it must be orderly, rational and efficient to avoid any disruption.

6 Given the climate risks data gap, it is not suitable to propose a quantitative analysis. Some probabilities calculations are under progress and confidential (Expert Group Climate Change Statistics, ECB)

[7] Climate-related financial risks – measurement methodologies, BIS, April 2021.

Furthermore, there is a huge gap between the facts in favour of the ecological transition and the actions aligned with the objectives of climate change. The final timetables for moving towards a goal of minimal or no pollution have still not been studied or even addressed. The main cause of this misalignment, which represents a systemic risk, is a lack of harmonized definition / taxonomy and a kind of lethargy due to the long-term horizon. Moreover, most European work such as that of the European Commission (EC) sets out guidelines, proposals and recommendations, but no coercive measures. Given the climate emergency, the EC should apply favourable weights to green projects by implementing Article 459 of the Capital Requirements Regulation (CRR) before including them in Articles 128 and 501 of CRR2 (Philiponnat, 2020; European Banking Authority, 2021).

Finally, we have to bear in mind that the lack of reliable data (or data gap) on climate-related financial risks represents a challenge to the application of any prudential policy (FSB, 2021; Elderson, 2021).

4. Conclusion

Climate change raises fundamental questions relative to financial and economic stabilities. This point is the roots for the justification to intervene in the climate change policy management. Starting from this scope, it is obvious that CBs should actively participate in the promotion of ecological transition (Batten, 2018; Volz 2017; D'Orazio and Popoyan, 2018-2021; Matikainen et al. 2017; Jourdon and Kalinowski, 2019; Dikau and Volz 2019, Bolton et al. 2020; Goldman and Zhang, 2021; Goldman and Marinova, 2022; D'Orazio, 2022). The global warming caused by the greenhouse gas emissions (GHS) raises the question of the planet sustainability and economic growth because all sectors are struck by the full force of unexpected and violent events with devastating and sometime irremediable consequences. As already underlined, with the climate change gravity, three risks have emerged (physical, transition and liability risks) and nowadays these risks are costly and become more and more frequent. This means that central banks actions should be both preventive and curative. However, they should not be alone in finding concrete and optimal solutions to climate emergencies. Soon or later, fiscal policies should also support the actions of monetary supervisors. Monetary and fiscal policies, which are complementary, should be coordinated to limit and/or avoid negative externalities created by pollution for instance. The COVID-19 pandemic and the brutal economic crisis that hit all economies hard, while they had not yet recovered from the last financial crisis in 2008, are signals that bear witness to the ecological emergency. Various scientific studies show that the damage inflicted on the planet has given rise to new epidemics. Researchers also warn about the risks of thawing linked to global warming or commonly called permafrost, which is a Pandora's Box. For hundreds of thousands of years, permafrost has harboured bacteria or viruses that we do not know what will look like when released into the air. This argument is debated, but it should not be ignored. The most vulnerable countries will once again be the first victims of the economic drifts linked to a frantic search for short-term profit. These apocalyptic prospects reinforce the idea of coherent and equitable international cooperation.

Lastly, it should be noted that all of the central bank's tools aimed at combating global warming could only be effective if they are optimally calibrated and timely run, thus the existence of qualitative database is an essential requirement.

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The notion of debt in mutual credit systems: some insights from the experience of Moneda PAR

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Abstract

This article explores complementary currencies (CC) that work on the basis of community credit schemes in Argentina, a country often referred to as a laboratory in terms of monetary exploration. In contrast to alternative community-based monetary systems created in the global North, CC developed in the global South usually pursue the creation of supplementary currency circulation in order to address liquidity constraints faced by the middle and low strata of the society. In particular, CC relying on community credit schemes solve two problems at once: liquidity constraints and credit scarcity. Drawing on the case of Moneda PAR, a mutual credit system originated in Argentina in 2017 upon the principles of the social and solidarity economy, we study how users understand debt.

The last quantitative data obtained from Moneda PAR show that only around 20% of the participants have a negative balance; that is, they have effectively used mutual credit. Thus, a large majority of users do only count on the liquidity obtained from their own sales. These figures seem to be in conflict with the theses on which the complementary monetary systems in peripheral countries are founded and, in particular, with CCs that work based on mutual credit systems. Given that, in these systems where money is created by granting credit, a generalized reluctance of the participants to take it could end up being self-defeating, as eventually low levels of liquidity would prevail making the whole system unattractive.

In this paper we intend to investigate the reasons why the participants of Moneda PAR tend to refrain from using the credit facility. Our working hypothesis is that the meaning of debt, both in its symbolic dimension and in the power relations in which it is embedded, may be driving Moneda PAR participants' behaviour, especially those of lower income strata, thereby limiting the capacity of the system to foster the markets where it is used. While the results of this article are useful for Moneda PAR, they can also be extended to mutual-credit complementary monetary systems built on the premise that credit scarcity constitutes an obstacle to the improvement of the material conditions of a community.

1- Introduction

The citizen trend of recent decades towards monetary plurality at the local and regional level is challenging the banking monopoly of the official currency. The communities involved have developed more than 5,000 experiences of complementary/alternative, local, community and social currencies, as estimated by Blanc (2018). These currencies, in general, are used to promote local development through the creation of liquidity and the incorporation of alternative financial instruments to those provided by the formal market, in their fight against the growing social exclusion generated by contemporary financial capitalism.

This article explores complementary currencies (CC) that work based on community credit schemes in Argentina, a country often referred to as a laboratory in terms of monetary exploration. In contrast to alternative community-based monetary systems created in the global North, CC developed in the global South usually pursue the creation of supplementary currency circulation in order to address liquidity constraints faced by the middle and low strata of the society. In particular, CC relying on community credit schemes solve two problems at once: liquidity constraints and credit scarcity. Drawing on the case of Moneda PAR, a mutual credit system originated in Argentina in 2017 upon the principles of the social and solidarity economy, we study how users understand debt.

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2- Principal concepts employed

Several of the concepts used are not univocal or homogeneous, thus we will carry out a short review of their meaning from the study of the Popular Solidarity Economy (EPS).

Solidarity markets with social currency are developed particularly within the so-called "**popular sectors**" where liquidity shortages occur more quickly and frequently at the beginning of a crisis. When we refer to the "popular sectors" we refer to workers who carry out their activities outside the formal salary relationship, and/or receive low incomes, and are object of two types of exploitation: on the one hand, a relationship of exploitation of a commercial nature, and is reflected in a process of permanent devaluation of their work. On the other hand, a relationship of "financial exploitation" that focuses on the idea that workers in the popular economy are insolvent and, therefore, must face usurious interest rates to access credit. The latter are two structural characteristics of the reproduction of this social sector that called itself popular economy (Gago and Roig, 2016).

Considering the "**financialization**" of the popular sectors, this is generally made invisible by the dominant thought, for which they do not go into debt, do not save, do not have a financial life. However, this is not true, since the network of debts that financial capital weaves extends to all social sectors, including the popular sectors, to which financial exploitation fully

reaches through financial instruments that assign them a place of submission through “**debt**”. Then, the creditor-debtor relationship becomes a "power device" that acts on the intimacy of people and their conscience, trying to eliminate any initiative that means an autonomic claim of the subject (Lordon, 1999, Chena, 2017).

The strategy of generating “popular economy debtors” is built on the premise of creating new liabilities that allow the capitalist block to convert access to liquid money into a form of control over that sector, a situation that is verified by the lack of liquidity, faced by the popular sectors at the mere beginning of a crisis, or in the beginning of an orthodox anti-inflationary policy. It is a control over subjectivity, through the morality of “guilt for having debts”.

In this sense, as the material dimension that can be reflected in a usurious interest rate it’s consolidated by a "**subjective dimension**" on money, credit and debt that stigmatizes the worker in these sectors, and conditions them in their behaviour against the possibility of becoming autonomous from that relationship.

We believe that this "**subjective dimension**" may be the cause of the low use of mutual credit in the case of the PAR Currency, as we stated in the introduction and will develop further on.

This "**mutual credit**", granted from a social currency, must be distinguished from those community currencies backed by official currency in a bank, which create confidence in the currency by that backing. In a mutual credit system, the currency that is used in a transaction is created while it is carried out. These systems function as interest-free credit in which the debt becomes credit for the other members of the community and constitutes an alternative for those communities that are excluded from the legal financial system, or as Gago and Roig (2016) suggest, in a situation of “financial exploitation”.

The currencies that are created under a mutual credit system are consistent with the ideas of the German Argentine economist Silvio Gesell (1907), according to whom money should allow communities to make the most of their productive capacities, facilitating the exchange of goods and promoting circulation versus hoarding, mutual credit systems work in that sense. John Maynard Keynes, in the General Theory (1936) values the ideas of free competition socialism proposed by Gesell, and the idea of negative interest -which arises from his thought- in his development of the euthanasia of the rentier.

From this conceptualization, we seek to analyse these basically transactional submarkets (Schroeder, 2015), as a remedy to the fall of popular sectors in the inclusion based on exploitation, or directly in exclusion from the financial market.

The PAR currency is one of these mutual credit systems, which also offers an overdraft as a way to ensure and expand the circulation of the goods and services offered. Based on it and on data obtained from the Blockchain, as well as surveys and interviews, we will analyse mutual credit as a form of financing that would allow access to credit exempt from interests and freed from exploitative relationships.

3- Our experience in study: Moneda PAR

Moneda PAR is a Blockchain-based complementary currency launched in Argentina in 2017, built upon the principles of the popular solidarity economy (EPS). Its goal is twofold: to stimulate the economy of communities with unsatisfied needs due to the lack of liquidity, and to promote more sustainable, cooperative, and friendly interactions between the people. In terms of Polanyi’s classification of the forms of economic integration, Moneda PAR aims at fostering relationships based on the principle of reciprocity.

Moneda PAR is designed as a mutual credit system (along the lines of local exchange trading systems (LETS)), where participants are granted interest-free loans based on their productive capacity. Sales are recorded as positive balances and purchases are registered as negative ones, the sum of all individual balances always adding up to zero. Every time a user makes use of the overdraft facility granted by the community, he is in fact receiving

credit from the rest of the network. Similarly, when a user holds a positive balance, he is granting credit to the rest of the network because the positive balance implies that he has delivered goods or services of his own while not having yet acquired anything for his own consumption. Thus, positive balances are interpreted as a right to claim products from the network (for a value equal to the balance) while negative balances should be interpreted as an obligation to deliver products to the network (for a value equal to the balance).

In order to facilitate adoption, a one-to-one relationship between the Moneda PAR and the Argentine peso was adopted, keeping the peso as the unit of account and giving PAR the role of the medium of exchange. PAR units are not backed up with fiat - otherwise, the money creation process would be tied to the liquidity conditions of the market, which is exactly from what Moneda PAR tried to decouple in its origins. Thus, there is no institutionally guaranteed conversion between Moneda PAR tokens and the Argentine peso.

As a project based on the values of the social and solidarity economy, Moneda PAR promotes the practice of participatory democracy. The project is governed as a Federation of nodes, each of them having its elected representative at the national assembly where all the relevant decisions are made. The nodes, in turn, have their own government structures where all members are encouraged to participate.

4- Methodology

Social research provokes explicit political intervention not only on the field of study but also on us as researchers, constituting the very own reality it is studying at the same time that contributes to making visible initiatives that do not respond to hegemonic values (Gibson-Graham et al., 2013; Burke and Shear, 2014). Relying on forms of direct engagement in organizational practices, this research relies on an engaged ethnographic approach (Lyon-Callo and Hyatt, 2003). As acknowledged by Barinaga (2017), requirements for engaged scholarship in the construction of a fairer society are threefold. It is first situated, as we recognise the effects of our methods and reality as dynamic. Second, it is reflexive as we (researchers) should be constantly aware of the impact of our research practices in the context we study. And finally, it is deliberatively political as it seeks to create a more just and fairer reality, chiming with the goals of Moneda Par.

All the authors are involved in the management and use of Moneda PAR, in line with what is proposed by Alvesson (2003), so we characterize our approach as ‘self- ethnography’, due that our participation in the currency enabled us to gather information from a wide range of sources over the years, contributing to a comprehensive analysis of the different indebtedness patterns in this currency.

According to its interdisciplinary nature, the data sources are multifaceted. We do not only rely on “ethnographic” information or questionnaires, or descriptive statistics but articulate these three types of data.

First, the transaction database freely available using a Bitshares block explorer such as bts.ai allowed us to compute exhaustive statistics about the network’s dynamics.

Second, we rely on ethnographic data, collected through participatory observation and semi-directed interviews with Moneda PAR users. Articulating this knowledge with the transaction database helped us to construct node-based statistics, as we could assign each user to a specific node, an input that could not be found in the blockchain witnessing only the seller’s and buyer’s pseudo as well as the date of the transactions and the nominal amount that passed hands. Ethnographic work provided us with invaluable socio-demographic inputs on the users, along with the symbolic and social networks within which the commodities estimated in Moneda PAR could circulate.

Third, we passed three different questionnaires to the user’s community. Two took place in the second and the third quarters of 2021 respectively. The first one was largely preliminary, focusing on how the members got in touch with the Moneda PAR, and how they would behave in the community, 54 people participate. Between the first and the second quarters of

2021, Moneda PAR had about 314 monthly active users on average. The 54 participants figure amounts to a 17,2% participation rate. The second survey focalized on the relationship that Moneda PAR users had with the financial sector and what kind of monetary and financial practices they could exhibit, both in offline and online sales and shopping. 112 persons participated, which, compared to the about 361 monthly active users on average between the second and the third quarters of 2021, amounts to a 31,0% participation rate. Finally, a last questionnaire was passed between the second and the third quarters of 2022, aimed at understanding better the way Moneda PAR would relate to traditional indebtedness and mutual credit, and how both would be considered by the community. 71 persons participated, which compared to the about 256 monthly active users on average in the second quarter of 2022, amounts to a 27,7% participation rate. Responses for this survey will be further explained below.

Information at a node level relies on participants' responses. Whereas some nodes account with a solid representativity of their populations, others are only represented by a few users in the survey. Thus, nodes with less than 5% of weight in the survey were categorized as 'other'.

5- The results of the survey developed for this paper

The survey was compound of 34 semi-structured questions, whereby 11 had an open field that enabled respondents to go in depth in their meanings and understanding of the phenomenon. The different areas we explored in the survey were the relation that Moneda PAR users stablish with traditional debt, and their relation with mutual credit within Moneda PAR. It was also accompanied by questions in relation to how users became involved in Moneda PAR, and demographic information of themselves and their households. The survey was self-administered online and the link was distributed to all the community of Moneda PAR. We first shared the link and a brief explanation of the study to all the representatives of the different nodes via a group chat, and sent a reminder a couple of days later. After 2 weeks of having the survey alive, we screened the first results, and sent a general reminder through the same group chat, along with specific messages to nodes coordinators with a lower response rate than the node's participation in the currency. Finally, a few days before closing the survey, we sent similar reminders.

a. General results of the present survey combined with qualified informant interviews and participant observation

Regarding the results of the survey, a feature that stood out in the beginning of the analysis was that 3 out of 4 responses received were from women. The larger participation of women in Moneda Par resonates with previous studies on complementary currencies in Argentina (Gomez, 2010) and in other contexts (Fare and Ahmed, 2017). Whereas it is acknowledged in previous studies that participation of women in the labour market is generally more precarious than men, the large majority is self-employed, either in the formal sector or in the informal sector. Moreover, 90% of respondents self-perceive themselves as middle-class, whereas 20% stated to receive benefits in different forms. All in all, we can suggest that respondents of the survey were middle-age educated women who self-perceive themselves as middle-class, however their incomes are not considerably far from the poverty line during at the time of the study.

A first element explaining the subtilization of the credit facilities provided by Moneda PAR is that despite its foundation -the creation of credit rather than money-, most active users in our sample claim that they do not need credit at all (68%). Of those that declare a need for some type of credit, 70% claim to have no access to financing through the traditional financial system. Interestingly, the remaining 30% is given by those who, while admitting a need for credit and the possibility of taking debt, choose not to do it (presumably with the

consequence of suffering from a higher level of unsatisfied needs). The explanations they give for this behaviour are mostly concentrated on economic factors, such as the high interest payments and the uncertainty regarding the capacity of their entrepreneurship to produce the cash-flow required to pay back the debt. Some also point out ideological motives for refraining from taking debts, but they represent a minority in our sample. When asked to identify their feelings toward debt, the “loss of freedom” and “fear of the consequences of not paying back” were the descriptions most widely chosen.

This group, the 30% who need to take formal credit but decide not to, represents, the moment in which the creditor-debtor relationship becomes a "power device" that operates by controlling subjectivity from of "guilt for having debts", Lordon (1999). In turn, they express this limitation on two levels: the material (high interest rates that end up configuring a new form of exploitation, "financial exploitation") and the subjective (through the fear of being excluded from access to symbolic goods, necessary to maintain a certain social hierarchy),

If we analyse by income level, it is also worth noting that 46% of the participants in the group claiming no need for credit had an income level below the poverty line (they earned less than 85,000 ARS) in June 2022, when the survey was conducted. The members of this group, belonging to the popular sectors, exclude themselves from the possibility of taking credit. This would be due, in most of the observed cases, to an installed conception of debt and formal credit, from which they have been systematically excluded for decades and that would have shaped a particular "habitus"[1] on their consideration.

The picture changes when the questions about their attitude towards credit and debt are framed in the specific context of Moneda PAR. While the quantitative analysis, based on the entire population, shows that by May 2022 30,5% of the active users did not have credit, the results from our survey show that 37% of the users in the sample declared not to use the credit facilities of the mutual credit system. This group can be broken down according to the reasons for not using the supposedly most standard element generated by the community, at least seen from the lenses of alternative monetary systems: 38% claims to have access to the credit facility but simply chooses not to use it, 27% admits having rejected the credit granted by the community, 19% states not having been given credit at all, and 15% were not aware that they could have credit in Moneda PAR.

It is worth digging into the reasons that lead the first two categories of users (which make up 24% of those who decided not to use the mutual credit facility) to decide not to take debt in the mutual credit system. Based on the insights obtained from the survey there are, in principle, two factors driving this decision. First, the reluctance to engage in a debtor-creditor relationship may be by the reason they transpose the “habitus” towards formal debt and credit to mutual credit from Moneda PAR, even when they know that in Moneda PAR no-one would threaten them if they cannot pay back a loan, and they don’t have to pay interests. Second, some prosumers seem to not use the credit facility because they do not find anything in the market that they consider worth purchasing, or that given their position in the “economic structure” of the community these users tend to be in a surplus position, thereby not requiring to take debt at all.

Another noteworthy, result of the survey is that the majority of the active participants seem to have a good understanding of the values upon which Moneda PAR has been built, the way the system works and, therefore, its difference from the traditional financial system. Compared to the perceptions declared when reflecting about the latter, users of Moneda PAR hardly ever relate debts in the mutual credit system to a “reduction of my autonomy”, a feeling of guilt, difficulty to face the debt service or fear of the consequences of eventually not being able to pay the debt back. But still, 49% of the respondents prefer not to be in a deficit position, with a relevant number of them (38%) claiming that they feel more comfortable

[1] " The habitus is defined as a system of durable and transferable dispositions -structured structures predisposed to function as structuring structures- that integrate all past experiences and function at all times as a structuring matrix of the perceptions, appreciations and actions of the agents in face of a conjuncture or event and that they contribute to producing" (Bourdieu, 1972).

limiting their expenditures to the positive balances obtained through the (prior) sales of goods and services. This latter result coincides with those who voluntarily choose not to use the credit facility pointed out in the previous paragraph, signalling that despite the fact that a project is built upon the principles of popular solidarity economy in a bottom-up fashion and with a strong participatory imprint, again there can be some notions learned in the traditional market system that are deeply anchored in the subjectivity of the individuals, conforming their "habitus", consciously or not, and are replicated in their attitude and behaviour in Moneda PAR.

Analysing the use of the overdraft facility by the network, it shows wide variations across nodes. Still, no patterns in terms of geographical regions or features of the type rural/urban were identified. Río Ceballos registers 29% of the respondents declaring the use of the credit system, followed by Traslasierra (13%), and Boedo and Gran San Miguel de Tucumán (both with 11%). The results differ when the figures are compared to the size of each node, as defined by the number of survey respondents that identified themselves as members of those nodes. Río Ceballos and Villa Gesell were the nodes that exhibit a higher use of the credit system compared to their sizes (4.6 and 2.8 percentage points, respectively, above their share in the sample), while Boedo and La Plata registered the lowest figures (4.0 and 4.6 percentage points below their share in the sample).

By gender, women exhibit a higher use of the credit facility in absolute and relative terms. Of the 45 participants that declared the use of the overdraft, 36 were women and only 9 were men. This implies that while women represented 73% of the sample, 80% of users claiming to use the credit system belonged to that gender. Finally, no specific patterns related to age were found in using the credit system.

b. Discussion of the results

The two aforementioned drivers that explain the reluctance to use the credit system can be used to build a typology of the scenarios that can arise when a social currency built along the lines of a mutual credit system is implemented. First, there is a "symbolic dimension" that refers to the users' understanding of debt and money, and the extent to which their attitude towards these concepts is aligned with the notions of debt and money that underlie the mutual credit system. This dimension is intrinsically symbolic because the individual's notions of (immaterial) objects like credit and money, and relationships of the type of debtor-creditor, are necessarily mediated through a series of symbolic devices (hegemonic discourses, beliefs, individual and collective experience, etc.) that condition its particular perception about these concepts - it is through the mediation of the symbolic order that the individual becomes a subject.

Second, there is a purely "material dimension" consisting of the size and variety of the market where users participate and the capacity of those markets to satisfy their basic needs in a sustained way. These two dimensions are orthogonal in that they describe two clearly distinct aspects of a mutual credit system, both of which are crucial to its success.

Based on the survey results, two cases (ideal types) can be defined for each of these two dimensions. In the case of the symbolic dimension, there is a first case where participants understand debt, money, and the relationships between them as dominated by the logic of the free market, competition and of the "homo economicus", reproducing the current "habitus" in the formal market to the mutual credit. In those cases, debt is most likely associated with the "fear of losing freedom and autonomy" or the "consequences of not being able to pay back". Hence, people try to avoid being indebted, and the use of the mutual credit system tends to be low. A second case is where participants have acquired (or already had) a sufficient understanding of the use of money and debt in mutual credit systems and the type of relationships cultivated in them. As the results showed, these people are more prone to use the credit facility in the social currency network while they are not willing to do so in the traditional banking system.

In the case of the material dimension, the first case is that of users that participate in markets where they can satisfy their (basic) needs, thereby laying the foundations for broader use of the credit system. A second (and more generalized) case is that of users that participate in markets that have not reached a depth that enables them to satisfy people's needs through the social currency. In these cases, the use of the overdraft facility is expected to be low.

The combination of these two dimensions and their ideal types gives four possible scenarios, each with a specific likelihood of a generalized usage of the mutual credit system. Table X illustrates these cases. The most desirable scenario is the one where users' understanding of debt and money is aligned with the system and the market is attractive enough to encourage them to participate (bottom left quadrant). In this case a generalized and sustained use of overdrafts is expected. On the contrary, the worst-case scenario occurs when users' notions of debt and money are not aligned with the system. Simultaneously, they participate in a market that does not allow them to acquire what they need (top right quadrant). In this case, the most likely outcome is very low or even null use of overdrafts.

Table X: A typology of scenarios that mutual credit systems face

		Material dimension: size of the market where the social currency works	
		Basic needs satisfying	Not basic needs satisfying
Symbolic dimension: understanding of debt and money	Aligned with the conventional system	Intermediate use of the credit system	Scarce use of the credit system
	Aligned with mutual credit systems	Generalized and sustained use of the credit system	Intermediate use of the credit system

It is not easy to state *a priori* which of the two remaining scenarios, where the usage of the credit system is intermediate, will show a higher rate of utilization. This is because the drivers could be different in each case. When users are reluctant to take debt even when they are operating in a mutual credit system with markets where basic needs can be satisfied (top left quadrant) it is still possible that they end up using their overdraft facilities if required to satisfy a material need - even if they would prefer to rely only on their positive balances, there are situations where they might find themselves in the need to take debt.

Even when the material dimension can overcome the symbolic dimension in some cases, the hypothesis about the "habitus" about money and the financial world must still be considered in all the cases where the symbolic dimension remains aligned with the conventional system.

In these cases, we believe it is important to point out the importance of incorporating the time variable, which is necessary to achieve the appropriation of the values that the EPS promotes.

Therefore, we must consider the maturation time of any experience that goes against the "common sense" of the market society. It is necessary to highlight the importance of the comprehension of process of creating and managing these markets with social currency, which is based on the active participation of the community in its management and in the solidarity market on which it operates (Orzi, 2019).

> *The economic sustainability of an economic system based on self-managed work is a medium-term objective and is not defined at the micro level, it*

depends on the variable behaviour of a multi-actor and multi-institutional group. It justifies a subsidized incubation period (Coraggio, 2005).

On the other hand, users whose understanding of debt and money is aligned with those of mutual credit systems but that belong to markets where basic needs cannot be satisfied (bottom right quadrant) might still exhibit some use of the overdraft facility, mainly because their alignment with system's values and goals encourage them to participate and keep on trying to make the best out of the market they are faced with. In this case, the prosumers understand the need to create, in a continuous and extended way, a market to work with the proposed social currency. This might seem obvious at first, but in our conversations with many of the entrepreneurs who want to operate a social currency, we have come across the belief that the very creation of the currency creates the market, or that the market is waiting for a new medium of exchange. This is not the case when we work with solidarity markets, which operate under horizontal social control and have distinctive characteristics contrary to the dominant logic (Orzi, 2019), configuring one of the problems faced by social currencies in general, and those that work on mutual credit in particular.

c. Operationalizing the typology

The proposed typology can be operationalized by placing each respondent in a quadrant according to its own understanding of money and debt within the mutual credit system, and the depth of the market where it participates. To assess each user's understanding of money and debt, their answers to some of the related questions were used, requiring them to respond to at least 70% of the questions in line with the principles of Moneda PAR to consider their attitude towards debt is aligned with the system. The depth of the market where each participant operates was assessed by asking the coordinators of each Moneda PAR node what percentage of the basic needs can be satisfied by means of the social currency. The results are shown in Table Y, where the ratio of participants using the credit system as a share of the total of the respective category is presented.

Table Y: The situation of Moneda PAR

		Material dimension: size of the market where the social currency works	
		Basic needs satisfying	Not basic needs satisfying
Symbolic dimension: understanding of debt and money	Aligned with the conventional system	Intermediate use of the credit system **10/13 (77%)**	Scarce use of the credit system **6/14 (43%)**
	Aligned with mutual credit systems	Generalized and sustained use of the credit system **5/7 (71%)**	Intermediate use of the credit system **21/34 (62%)**

The first result that arises from the application of the typology to Moneda PAR is that the best-case scenario is highly unusual, as only seven users fall in this category. Surprisingly, two of them do not use the credit system, but this obeys the fact that the community did not grant her credit in one case and to a technical problem with the mobile wallet in the other

one. If it was not for this, it is expected that the rate of usage of the mutual credit system would have been 100% (instead of 71%).

A second noteworthy issue is that, according to the coordinators' perception, in most markets it is impossible to satisfy the participants' basic needs, thereby undermining the potential of the mutual credit system, as we explained above. Still, the credit system usage rate is not low, especially in the case where users' understanding of money and debt is aligned with Moneda PAR (62% of these participants use the overdraft facility). Here, in addition to an active participation in the market, there is an overcoming of the dominant thought about money, debt, credit and the market, showing -in general- an ideology in accordance with the experience.

The rate of usage of the credit system is reasonably lower in the worst-case scenario (43%), but still decent considering the adverse conditions found for the development of the social currency. The (lower number of) cases where the overdraft is used there where the market is not deep enough and there is not an accurate understanding of the mutual credit system can be explained by cases where, as users claimed, people "prefer not to have debts" but end up using the credit to purchase a good that they might be needing, even if they belong to a market where it is not possible to satisfy a relevant share of the basic needs, which continues in line with what was developed on Table X.

The third result that is derived from the analysis of the survey read through the lenses of the typology is that when the depth of the market is sufficient to cover an important part of the basic needs, an incomplete understanding of the underlying concepts of debt and money is not an obstacle to the usage of the credit system, as the 77% rate in the top left quadrant shows. In this case, usage of the overdraft facility could be given by a lack of reluctance to take debt (even in the traditional meaning of it) and/or due to a situation of urgency, where individuals prioritize their material needs over their beliefs concerning debt and money. The analysis of the ten users that without understanding debt and money as they are understood in Moneda PAR but still use the overdraft in markets where basic needs can be satisfied to a large extent shows that all of them exhibit a negative attitude towards debt in general (as they claim to avoid taking debts in the traditional system as long as they can do it). However, 7 out of 10 of these users had an income in pesos that left them below the poverty line, thereby giving room to the hypothesis stating that in contexts of unsatisfied needs, the material dimension might overdetermine people's behaviour, leaving the symbolic (or ideological) aspects on a second place. Once again, the importance of the continuous construction of the market arises in order, through constant material benefit, to pierce the "habitus" of our total market society.

The opposite way of approaching this hypothesis is to check the socioeconomic status of the users that, understanding debt and money that is aligned with Moneda PAR and operating in incomplete markets (bottom right quadrant), use the overdraft facility. What we are interested in testing is whether people whose needs can be satisfied in pesos (most likely through a formal employment relationship) can prioritize the ethical dimension, meaning that even in a context where it might not be easy to find attractive goods and services in the market of Moneda PAR, they still manage to participate in the fairs and use the credit system. The results show that 13 out of the 21 users (62%) that fall in this category were above the poverty line, suggesting again that the typology describing the fertility to develop a mutual credit system can be enriched by considering the socioeconomic status of the users.[2]

[2] An important caveat that needs to be made when reading the results is that the dichotomic nature of the ideal types, where we distinguish between markets where basic needs can be satisfied or not, necessarily loses the nuances that are found in the markets - for instance, users participating in markets where basic needs cannot be even partially satisfied might still use the credit system if there are just a few essential goods that can be acquired by means of the social currency.

6- Some preliminary conclusions

From the analysis of the results of the survey and the typology presented in the above section, we can conclude that in order to be sustainably adopted (and grow) over time, a mutual credit system needs to tackle two dimensions successfully: one of them symbolic, referred to the participants' understanding of money and debt and their alignment with the principles that the system aims to promote; the other one purely material, related to the capacity of the markets where the system works to fulfil the participants' needs. Failure to develop strategies that favour the creation of deep, diversified markets and a series of training and communication devices that help promote the underlying principles regarding debt and money and considering the period of time needed for the experience to do it, will jeopardize the whole project.

These two dimensions cannot be taken in isolation, as the socioeconomic status of the users has also proved to be relevant in explaining their behaviour - our evidence seems to suggest that while the behaviour of users living in tighter economic conditions, and -in general- the "popular sectors", are more driven by their material needs than their ideology, using mutual credit even they have not changed their "habitus", those living in better conditions are more likely to shape their behaviour according to ethical considerations.

It is worth noting that, taking the case of Moneda PAR, while the likelihood of the best-case scenario occurring is only 10%, the probability of the worst-case scenario is 21%. This implies that the most likely scenario, for a young experience, is one where usage of the system is intermediate and mostly conditioned by material conditions related to both the markets where the social currency works and participants' living conditions.

The experience of the Moneda PAR reaffirms the need to work on both the "habitus" and the construction and recreation of the market where the currency works: after 4 years of operation, the system still requires a greater appropriation by the community and -in some nodes- the market might be promoted more dynamically.

Practitioners that are willing to create mutual credit system aiming at establishing an alternative to the conventional monetary and financial system need to keep an eye on the dimensions analysed, to prevent the system from becoming obsolete before even having been launched.

Finally, these awareness about the symbolic and material spheres, which must run together in the development of social currencies that use mutual credit, would pave the way for the popular sectors to escape from the "exclusion and financial exploitation" to which they are exposed, by joining a credit system under the values of the Popular and Solidarity Economy.

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Social currencies as public policy instruments: The case of municipal social currencies in Brazil

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ABSTRACT

In Brazil, some local governments are creating their own social currencies for paying social benefits to poor families. These governments were inspired by the experiences of community development banks (BCDs) that use social currencies, which comprise a network of 148 initiatives in the country (Pupo, 2021). In addition, the digitalization of social currencies, which began in 2015 with the experience of the Mumbuca social currency, in the city of Maricá (Rio de Janeiro), and later consolidated through the acquisition of the E-Dinheiro platform by the Brazilian Network of Community Banks (RBBC), has contributed to municipalities' process of reapplication the BCD methodology. This reapplication process has taken place with the support and guidance of RBBC. Today, there are eleven cases of the so-called Municipal Social Currency (MSC) in Brazil. The purpose of this article was to understand how these social currencies have been assimilated by some local governments. However, the recent dynamics of the process made it difficult to get primary and secondary data. Therefore, this research was exploratory, and we present only two cases: the Livre (Free) currency, adopted in the city of Limoeiro de Anadia, Alagoas, and the Araribóia currency, used in the city of Niterói, Rio de Janeiro. We sought to understand the cases by associating them with the concept of public policy instruments (Lascoumes & Le Galès, 2004; 2007; 2012), and the Mirada ao Revés notion (viewing in reverse) in public policy studies (Amorim & Boullosa, 2013; Boullosa, 2013). In addition, we contextualize the relationship between the use of social currencies and public policy through some studies published in the International Journal of Community Currencies Research (IJCCR). We believe that the discussion we start here can provide the theoretical and practical foundations to guide the use of social currencies in municipal public policies. Our intention is to support RBBC in finding the appropriate institutional design for a democratic governance, without losing the potential of partnerships with public authorities, much desired throughout the network's development process.

1. Introduction

In Brazil, some local governments are creating their own currencies for paying social benefits to impoverished families. These governments were inspired by the experiences of community development banks (BCDs) with social currencies, whose use has become popular from the notorious experience of Palmas Bank, in Fortaleza, and due to the social changes they promote in the territories where they circulate.

Most BCDs are located in impoverished communities, mainly in small cities of the Northeast region of Brazil, and in poor neighborhoods of large cities. Each BCD, as part of its methodology of action, creates and manages its own currency that circulates only within that territory, building a local economic circuit between traders, producers, and consumers. Therefore, as social currencies and BCDs are seen as mechanisms for territorial development, they can also be understood as public policy instruments. This potential called the attention of governments since 2003, through the action of Senaes (National Secretariat for Solidarity Economy), linked to the Ministry of Labor and Employment at the time, and the federal public policies it created.

In September 2004, Senaes's support resulted in the first reapplication of the BCD methodology, and the PAR Bank was established in the western coast of the State of Ceará, in the city of Paracuru. In 2005, the idea of reapplicating the CDB methodology was consolidated, and several partnerships were built for setting up BCDs throughout Brazil. A relevant step was the creation, in 2006, of the Brazilian Network of Community Banks (RBBC), aiming to contribute for exchanging experiences and knowledge, gather resources, and strengthen partnerships between the network and support and promotion entities, in addition to partnerships with the public power itself. Another turning point was the National Solidarity Finance Program, also created by Senaes in 2010 (Neiva *et al*., 2013). According to the last survey, in December 2021, there were 148 BCDs affiliated to RBBC, of which about 50% were created between 2010 and 2015, strongly influenced by Senaes' programs and policies (Pupo, 2022).

As of 2015, with the near disappearance of Senaes from the national scene, the implementation of new BCDs became more directly linked to state and municipal government actions, especially those oriented to social protection, income transfer, territorial development, and access to microcredit. It was in this scenario that one experience stood out among the new BCDs. In the city of Maricá, state of Rio de Janeiro, the Mumbuca social currency was implemented by the local administration, ending a process that had begun in 2013. Mumbuca was the first digital social currency in Brazil (Cernev & Proença, 2016).

Following Municipal Act 2,448, of June 2013, BCD Mumbuca became the financial operator of municipal socioeconomic allocation and aid programs. The most important, Maricá's Basic Citizenship Income program, established BCD's debit-credit card and the digital social currency, the Mumbuca, as tools for transferring income to the poorest population of the city. Between 2013 and 2017, the network established between card users and local merchants benefited 14,000 families with BRL 100 per month (Faria *et al*., 2020). Actually, the municipality allocates annually an average of BRL 86.7 million (approximately USD 17.3 million) to 42,500 citizens of Maricá (26% of the local population). The Mumbuca is seen as an enhancement of payment logistics for low-income people, as digital social currencies, by incorporating information technology, expand their circulation in the territory (Alves *et al*., 2014; Gonzalez *et al*., 2020).

In the same period, in 2015, RBBC launched the E-Dinheiro digital platform, a prepaid payment arrangement that allows purchases and transfers through a digital social currency. The use of such currency by BCDs was only possible by Act 12,865, of 2013, that regulated digital payment arrangements in Brazil. The E-Dinheiro Brazil Institute was created to manage this platform, and operates together with the Palmas Bank Institute, which led the creation of RBBC. According to RBBC representatives, the E- Dinheiro platform, developed to operate on mobile phones, allows expanding financial inclusion to low-income people (although not excluding people from other classes). Hence, with the successful experience of Mumbuca and with the E-Dinheiro platform, the reapplication of the BCD methodology in other territories, with the leadership of local governments, has become a reality in the country.

This is the context of our study, whose goal was to better understand how social currencies are assimilated by local governments in some Brazilian cities. What we present here is part of a larger research project that began this year, under the coordination of one of the authors. It is entitled "Social currency and community banks in Brazil: Potentials and limits as public policy instruments for the development of territories", and foresees, among other stages, a new mapping of the entire RBBC, including BCDs and municipal social currencies, the focus of this study. At this stage of the research, still exploratory, we have identified the experiences of banks and municipal currencies created so far, and present two cases: the Livre currency, at Limoeiro de Anadia, Alagoas, and the Araribóia currency, in the city of Niterói, Rio de Janeiro.

We sought to understand the cases by associating them with the concept of public policy instruments (Lascoumes & Le Galès, 2004; 2007; 2012), and the Mirada ao Revés notion in public policy studies (Amorim & Boullosa, 2013; Boullosa, 2013). In addition, we reflected on the use of social currencies as public policies, through studies published in the International Journal of Community Currencies Research (IJCCR). Regarding the method, in addition to a bibliographic survey related to the topics of this study, we carried out interviews with four key actors: two representatives of the Municipal Secretariat of Social Assistance and Solidarity Economy of Niterói, responsible for implementing the Araribóia social currency; the district attorney for the city of Limoeiro de Anadia at the time of the Livre currency implementation; and Joaquim de Melo Neto, president of the Palmas Bank Institute and the E-Dinheiro Brazil Institute, the main protagonist of RBBC since its inception.

Although exploratory, the discussion we engage in this article is relevant for several reasons, of which we highlight two. First, there is no precise information on the cases of municipal banks and currencies in Brazil, since this is a recent movement. Second, our discussion can bring insights to guide the use of social currencies in local public policies, especially because we do not know the directions these initiatives will follow, and what will be their relationship with RBBC community banks that already operate in several territories.

2. Public policy instruments and the “View in Reverse”

Lascoumes and Le Galès (2004; 2007; 2012) provide a notion of public policy instruments that seems appropriate for understanding social technologies, such as social currencies (Rigo & Ventura, 2019). For the Lascoumes and Le Galès (2007), public policy is often analyzed as a result of the interaction of interests or of institutional structure, but they should also be considered a sociopolitical space built either through techniques and instruments or by goals or content.

> A Public Policy instrument is a device that is both technical and social, which organizes specific social relations between the state and society (those to whom the

> instrument is addressed), according to the representations and meanings that it (the instrument) carries. It is a particular type of Institution, a technical device with a generic purpose of establishing a concrete concept of political/society relations, supported by a concept of regulation (Lascoumes & Le Galès, 2007, p.4).

For these authors, the instrumentation of public policies means the set of problems posed by the choice and use of instruments (techniques, methods of operation, devices) that allow state public policies to take place. Therefore, instrumentation is a way of guiding the relationships between political society (through the administrative executive) and civil society (through managed matters), by means of intermediaries in the form of devices that blend technical components (measurement, calculation, the Rule of Law, procedure) and social components (representation, symbol) (Lascoumes & Le Galès, 2004). Hence, instruments enable forms of collective action to stabilize and make actors' behavior more predictable and probably more visible (Lascoumes & Le Galès, 2007).

Currently, multicentric approaches for public policies have gained relevance. They go beyond the state-centered approach, and consider public policies as "a complex, multifactor action to address a public problem, through instruments activated by different people in a policy arena" (Amorim & Boullosa, 2013, p. 59).

Boullosa's (2013) understanding reverses the logic of how public policy should be perceived and analyzed. The author suggests that the focus should be on the "problem of public relevance", rather than on the quality and attributes of actors, whether public or private. This leads the analyst to invert the expression "public problems" to "problems that are public", since, under this perspective, the attribution of "actions from one government" are understood as "government actions," that is, the ones that rule are those who are authorized, in the ongoing processes and flows of public policy. Hence, inverting the view, public policies are like

> [...] flows of instruments, practices, and arguments, activated by a multiplicity of actors and intended to solve a problem perceived as publicly relevant. Thus, if the problem of public relevance is the element that defines the public character of a policy, the quality of the actor that activates it is no longer determinant. Flows become multidirectional, non-linear, and the decision-making process becomes plural (Amorim & Boullosa, 2013, p. 20).

In this sense, public policies result from the contributions and interaction of various actors that establish rules and develop their own dynamics (Amorim & Boullosa, 2013). Thus, these actors govern the flows of actions, according to their powers of governance in certain circumstances. Moreover, the very definition of what is a public problem is left up to the actors who put not only their governance powers in motion, but also activate their intentions in the field and in making public policy. According to Boullosa (2013, p. 77-78), the government of certain actors takes place through "their powers of governability, of mobilizing resources, and influencing other actors that form that specific public arena".

That is, the policy is "public" because the problem that brings together the actors and their actions to define and address the problem are "public." Thus, "public" qualifies the problem (Boullosa, 2013). From this perspective, the actors grant themselves some degree of governance over the public policy process, and build their spaces within the arena around the problem. Boullosa (2013) understands public policies "viewing in reverse", which means going beyond laws, norms, procedures, objective phenomena, and ordered programs. Thus, it seems that, by "looking in reverse," a public policy is constantly under construction, starting from a problem (or several) that is socially recognized as public. Under this perspective, it is always possible to

~~interpret public policy as a complex, multifactor, and multicentric process, oriented to solving~~ a problem of public relevance.

3. The public authority and the interest in systems of social currencies

Blanc (2018) shows how, in recent years, public powers have acted and reacted in the face of the development of social currencies in the world. Some social currency systems by moving closer, others by deliberately moving away from potential state interference (even if to support them).

In a brief survey in IJCCR, searching for studies that directly address the discussion of the relationship between the use of social currencies (also called community or complementary) and public policies, we found those related to: (a) how social currencies can be influenced, to a greater or lesser degree, by the public sector (Honzawa, 2009); (b) how they can be legally accepted by the Central Bank and become public policy instruments within the national monetary system (Freire, 2009); (c) as a policy instrument for behavior change towards sustainability (Joachain & Klopfert, 2012); and (d) governments interested in research on the functioning and potential use of social currencies for supporting experiments or creating their own (Van Kuik, 2009; Freire, 2009).

In Honzawa's analysis (2009, p. 21), social currency systems undergo different degrees of public intervention, showing how public-private partnerships or, more commonly, public-community partnerships result in hybrid monetary systems. The author reminds us that "there are local social currencies that have developed exclusively in the public sector, as in 2014, when France began to regulate them (article 16 of the Act 2014-856, on the social and solidarity economy)". The specific legal framework facilitated the support of local governments for creating social currencies, as in Toulouse, Lyon, and Grenoble. In another example, in Bristol, UK, sometime between 2012 and 2020, the user could pay the municipal tax in Bristol Pounds, which were automatically exchanged for British Pounds (Honzawa, 2009).

Thus, local public authorities can promote the use of social currencies actively. In the case of Trueque systems in Argentina, between 2001 and 2003, the complementary currencies were widely accepted, including by the federal government. For exemple, the Patacón, the complementary currency in Buenos Aires region, was used to pay public debts (up to 80% of pension and salary payments) (Colliac, 2005).

According to Honzawa (2009, p. 27), "each project should design its own model based on its objectives, context, available resources, and the capabilities of the promoting organization". The fact is that, either to regulate (by supporting or prohibiting), governments have shown interest in exchange and payment systems through social currencies. Some require prior studies to understand the functionality and potential of local monetary systems to be adopted as instruments of public intervention (Van Kuik, 2009); others, to understand what it's all about, and if they harm the public authority for issuing currency (Freire, 2009).

Concerning the demand from the government of Landgraaf, Netherlands, in 2007, which requested an investigation to know if a community currency could support its anti-poverty policies, Van Kuik's (2009) literature review concluded that the general idea was that currencies still had to prove themselves regarding their effects. In this respect, although they advocate the use of social currencies, many scholars agree that their effects cannot be easily checked, and there is a real need for employing more appropriate evaluation methodologies (Lopes, Rigo, & Silva Júnior, 2018; Silva Júnior, 2016; Silva Júnior, Rigo, & Vasconcelos, 2015; Ruddick, 2011), mainly qualitatives evaluation methodologies (Rigo, 2020).

Freire (2009, p. 91), investigating the legality of social currencies in Brazil as instruments of public policy compatible with the monetary policy under the responsibility of the Central Bank, concluded that they were compatible and beneficial, because "the wealth produced in the local economy mainly benefits the people who participate in the social currency system, and each system builds what could be called an optimal monetary area". However, the author already warned that, from a legal point of view, it was important to investigate the cases of digital currencies, due to the volume of transactions they could reach and the absence of a specific legal framework in the country, at that time.

4. The E-Dinheiro platform and the potential for using social currencies as public policy instruments in Brazil

The debate about the legality of social currencies in Brazil has revealed two poles of understanding. On one side, less significant, is the argument that the Central Bank is being complicit and tolerant with the use of such currencies, assuming that they promote development. Thus, the Central Bank would not be fulfilling its function as "guardian of the national currency, preventing the emergence of others" (Caminha & Figueiredo, 2011, p. 118). In this sense, if not even financial institutions can create a currency, neither could the community banks, since they would be assuming the role of the Central Bank and interfering in the national monetary policy. On the other side, more expressive and supporting the development of the idea and practice of the use of social currencies in Brazil, is the argument that these currencies, beyond legality, do not pose any threat to the role of the Central Bank regarding national payment systems, much less to the stability of the financial system, since they do not represent a significant macroeconomic impact (Freire, 2009; 2011).

From this perspective, social currencies establish social monetary systems, based on available local resources, and directed to "meet needs not yet served by the official currency in such locations" (Freire, 2009, p. 91). Thus, in practice and legally, social currencies can indeed be public policy instruments.

In Brazil, some laws have contributed to sustaining and developing the field of solidarity finance, in general, and the use of social currencies, in particular. Act 12,865 of October 9, 2013, of Brazil Central Bank, which defines payment arrangements and payment institutions that are members of the Brazilian Payment System (SPB), was crucial for the digitalization of social currencies by BCDs through the E-Dinheiro platform. The legislation states that payment institutions, among other functions, can "convert physical or scriptural currency into electronic currency, or vice versa, accredit the acceptance, or manage the use of electronic currency".

According to this national legislation, electronic currencies are resources stored in an electronic device or system that allows end users to make a payment transaction. In addition to the principles provided for payment arrangements and institutions, such as soundness, efficiency, quality and transparency of services, and protection of data and of users' economic interests, this legislation stipulates financial inclusion, innovation and diversity of models of payment institutions and arrangements (Brazil, 2013, art. 7). That is, it foresees the process of financial inclusion through the use of mobile devices.

> Brazil Central Bank, the National Monetary Council, the Ministry of Communications, and the National Telecommunications Agency (Anatel) will stimulate, within the scope of their competencies, financial inclusion through the participation of the telecommunications sector in the provision of payment services, and may, based on periodic evaluations, adopt measures to encourage the development of payment

arrangements that use costumer-owned terminals for access to telecommunications services (Brazil, 2013, art.8).

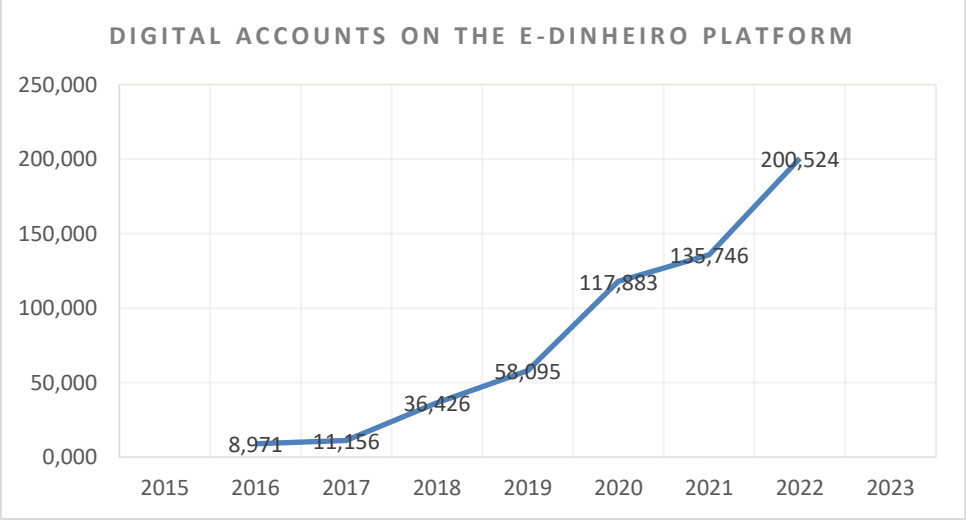
Other important and subsequent legislations were the Regulatory Framework for Civil Society Organizations, known as MROSC (Act 13,019 of July 2014), which provides the basis for "partnerships between the public administration and civil society organizations, for the achievement of purposes of public and reciprocal interest" (Brazil, 2014), and Act 13, 636 of 2018, in its article 3, which authorizes Civil Society Organizations of Public Interest (OSCIP) to operate or participate in the National Program of Productive and Oriented Microcredit (PNMPO). These regulatory marks strengthened the legitimacy of BCD methodology and the use of social currencies, and opened space for their digitalization.

Starting with the Palmas social currency, the E-Dinheiro platform has replaced paper currencies in several territories where BCDs operate. The purpose is to improve and increase the supply of financial services and, consequently, promote greater financial inclusion in the communities. With the platform, it is possible to pay bills, make transfers, buy credit for a cell phone, etc. It is also possible to have a more focused communication with users and gather information, to better manage the supply of credit and currency circulation.

In addition, according to Joaquim de Melo Neto, president of the E-Dinheiro Institute and Palmas Bank Institute, the 10 years of using the Palmas paper currency allowed building a sense of community among the neighborhood residents, and its replacement does not change this feeling in the territory. For Cernev and Diniz (2020, p. 490), "for many low-income people, this digital account through a smartphone application was probably their first and only experience of having and using a financial account".

These authors also mention (2020, p. 491) that "between 2015 and December 2016, when the expansion of E-Dinheiro platform to other locations began (including Maricá and the insertion of part of Mumbucas on the platform), 2,477 people were already using the platform in 166 accredited stores, with a transaction volume of BRL 10.5 million". However, the platform still has a large potential for growth, since only about half of the BCDs in the network have implemented it in their territories. Figure 1 shows the growth in the use of social currencies in RBBC through the E-Dinheiro platform.

Figure 1: Evolution of the number of open digital accounts on the E-Dinheiro platform (2016-2022)



Source: E-Dinheiro Institute (2022)

More agile and instantaneous, the digital social currency has the advantage of allowing immediate liquidity for the dealer, which increases the speed of exchanges and the circulation of local wealth. BCDs' digital social currencies strengthen the local market by stimulating demand, through the increase of local purchasing power, favoring the flow of production and distribution at the neighborhood, territory, or city levels. Although not immediately, traders and service providers have gradually accepted the digital social currency. A percentage of these transactions is set aside by BCDs for a credit fund to be offered to merchants at low interest rates. About the range of total BCDs operations, 57% carry out credit operations and 60% operate with the E-Dinheiro platform, using the digital social currency for consumption, bill payment, cell phone recharging, access to credit, and basic income transfers and social benefits. There were more than 135,000 E-Dinheiro users, mobilizing BRL 1.1 billion (about USD 220 million) in operations in 2021 (Pupo, 2022).

5. From support to government leading role: municipal social currencies as instruments of local public policy in Brazil

As we have seen, between 2005 and 2015, Senaes played a predominant role in the creation of new BCDs that formed RBBC, and in building the idea that they could be considered public policy instruments. At that time, although on a one-off basis, some BCDs received direct and constant support from city authorities, and the case of São João do Arraial, in the interior of Piauí, stands out. When realizing the potential of BCDs as a public policy instrument, the city government copied the experience of Palmas Bank and created the Community Bank of Cocais, in 2007, in articulation with the organized civil society. The goal was to mitigate the effects of the lack of a bank branch in the territory, and population's financial exclusion. To this end, the authorities enacted Municipal Act 112, in 2007, and made an agreement with the Community Bank of Cocais. Therefore, it was authorized to hire the bank to pay civil servants and collect municipal taxes with the Cocais social currency.

Unlike the process of constitution of Cocais Bank, as we saw in the introduction of this article, Mumbuca Bank, located in the city of Maricá, RJ, was created by the municipal government, through Act 2,448, of June 26, 2013, which established the Municipal Program of Solidarity Economy, Fighting Poverty, and Economic and Social Development of Maricá. This act allowed the use of a social currency, the Mumbuca, as an instrument of income transfer from the city to the poor families. Initially, this process took place through the use of a magnetic card, provided by a company. With the acquisition of the E-Dinheiro platform by RBBC, the Mumbuca could also be used in the platform, expanding the possibilities of social programs' payments. After that, the Bank and the Mumbuca currency became a recent example for municipal public managers to implement public policies of income transfer through their own social currencies, limiting their use within the cities.

We highlight that this process of reapplication of social currencies by local governments has taken place with RBBC's direct guidance, and each municipality establishes its own legislation for the operation of the social currency. Today there are 11 cases of the so-called municipal social currencies (MSC), and only a few cities, like Maricá, have set up a community bank to operate with microcredit.

Table 1: **Municipal Social Currencies (by legislation date)**

City/ State	Currency Name	BRL Value/month	No. of families	Municipal Legislation	Circulation period	Pop. *
Silva Jardim/RJ	Capivari	–	–	Act 1,502 /May 2010	Ongoing	21,775
Maricá/RJ	Mumbuca	100.00	42,000	Act 2,448/ June 2013	2015-today	167,668
Limoeiro de Anadia/AL	Livre (Free)	70.00	1,000-4,500	Act 173/ April 2019	Nov. 2019 to Dec. 2020	28,904
Porciúncula/RJ	Elefantina**	Digital accoun	E-dinheiro plataform	Act 2,378/June 2021	Ongoing, waiting for the cards and active on the platform	19,068
Itaboraí/RJ	Pedra Bonita	150.00	5,000	Act 2,867/April 2021	May 2022-today	244,416
Cabo Frio/RJ	Itajuru	200.00	1,000	Act 3,286/July 2021	March 2022	234,077
Niterói/RJ	Araribóia	Between 250.00 and 500.00	31,000	Act 3,621/July 2021	Dec. 2021-today	516,981
Saquarema/RJ	Saqua	–	–	Act 2,189/ January 2022	Ongoing	91,938
Indiaroba/SE	Aratu	450.00	100	Act 645/February 2022	August 2022-today	18,337
Iguaba Grande/RJ	Caboclinho	120.00	2,083	Act 1,403/ March 2022	March 2022-today	29,344
Itanhandu/MG	Tonites	-	-	Act 1,494/April 2022	Ongoing	15,511

Source: data from E-Dinheiro Institute, IBGE*, and Specific Legislations** (2022).

According to data from the E-Money Brazil Institute, the most common services paid in social currency are: a) basic income; b) food aid; c) social rent; d) bonus for civil servants; e) emergency programs for catastrophes; f) payment of servants; g) credit programs; and h) environmental projects (E-Money Brazil Institute, 2022).

5.1 Exploring two cases of municipal social currencies: Livre (Free) and Araribóia[1]

Between November 2019 and December 2020, in the city of Limoeiro de Anadia, interior of the state of Alagoas, Northeast Brazil, the Livre (Free) social currency circulated to pay social benefits to the poorest families. It was the first experience of using digital social currency after the Maricá experience in Rio de Janeiro. Its implementation process took place between 2017 and 2019, when the city mayor at the time started it, after learning about the social currency Terra, from the BCD at Igaci city, also in Alagoas. Next, the administration sought partners to implement the project, and two of them were crucial: a) the Technological Incubator of Solidarity Economy (ITES), of the Federal University of Alagoas (UFAL), which developed the methodology of implementing BCD and social currencies; and b) RBBC and E-Dinheiro

[1] **Araribóia** refers to an Indian chief that lived in the Guanabara Bay region and helped the Portuguese to conquer the territory against the French and the Tamoios, in 1567. The Portuguese rewarded him with a region at the bay entrance, which originated the city of Niterói, of which he is considered the founder. (Wikipedia, 2022). It is also the name of a snake species in the Tupi language.

~~Institute (which already provided the service of social currencies' digitalization through the~~ platform). Hence, the process of implementing the municipal social currency took place together with the BCD at Limoeiro de Anadia, which was born already connected to RBBC.

The city of Limoeiro de Anadia is peculiar. It is near Arapiraca, a city with an estimated population of 234 thousand inhabitants (IBGE, 2021), with high consumption power and a Gross Domestic Product (GDP) growth rate that exceeds that of the country and of the state of Alagoas[2]. Therefore, the population of Limoeiro de Anadia and of the towns near both cities prefer consuming in Arapiraca, either by the variety of stores or the ease of transportation,which results in the population's income flowing to Arapiraca; even the salaries are withdrawn in the bank branches of this neighboring city, and quickly spent there.

Based on this reality, the government of Limoeiro de Anadia and the partners in the process of implementing the currency raised awareness of the town's legislative chamber on the role of social currency in keeping part of the income in the city, since it could only be used there. Visiting Maricá, in Rio de Janeiro, contributed for convincing the City Council and the City Hall to enact Act 173, of April 3, 2019, which created the "Solidarity Economy Program, Fighting Poverty, and Economic and Social Development of the Municipality of Limoeiro de Anadia, as a way to fight social inequalities" [...]. According to the interviewee, the legislation of the city was designed to be wider, including social programs compatible with the whole field of solidarity economy. In practice, the legislation allowed the City Hall to sign an agreement with BCD to manage the Better Income Program, which pays social benefits to local vulnerable families.

Next, the Secretary of Assistance registered the beneficiaries and, between December 2019 and December 2020, the city transferred BRL 70 per month to each beneficiary. The funds were paid by BCD in the social currency Livre, through a magnetic card. Initially, the benefits were transferred to 1,004 persons, but with the outbreak of the Covid 19 pandemic, it increased the number of beneficiaries throughout 2020, reaching about 4,500 thousand people (Interview with former district attorney, August 2022).

Regarding the technology used, the card proved to be more suitable to the local reality than the E-Dinheiro platform. When queues became a problem, because of the crowds, in a region where much of the population lives in rural areas, with difficult access to the internet and using old cell phones, it was easier to educate them for using the card than the platform. Moreover, the interviewee highlighted that the payment of social benefits with physical currency, in this case paper social currencies, would face a legal obstacle, and digital means (card or digital platform) would be more consistent with the national legislation.

The benefits paid through the Livre social currency were interrupted by the new city administration in December 2020, two months after the municipal elections. Although the legislation defines the program as legal and legitimate, it does not guarantee its continuity, especially when there are government changes, since each public manager allocates resources to the actions he/she considers a priority. Because the income transfer program, the BCD, and the currency were directly linked to the previous government and its reelection campaign, we assume that they influenced the new government's decision not to continue allocating resources to them. The name of the social currency – Livre (Free) - was given by the previous mayor, relating to the notion of "freedom of speech", an issue that was part of his campaign.

[2] Between 2006 and 2009 (last data from IBGE), Arapiraca's GDP grew in nominal terms and on average 16.1%, reaching 1.7 billion, a growth higher than that of the state of Alagoas (10.5%), the Northeast (12.1%) and Brazil (11%). (https://www.fecomercio-al.com.br/2012/08/estudo-aponta-arapiraca-como-a-7a-cidade-com-maior-poder-de-consumo/)

More recently, and directly inspired by the Mumbuca, the administration of Niterói, also in the state of Rio de Janeiro, created the Araribóia currency, which, in the first five months of operation (December 2021 to April 2022), brought to the local economy BRL 134.4 million (equivalent to USD 26.88 million), through the payment of basic income to about 20% of its citizens. However, unlike Maricá, which started in one neighborhood and then expanded throughout the city, the Araribóia covered the whole city of Niterói. The authorities were in a hurry to use the social currency for replacing the Temporary Basic Income (RBT) program, implemented during the first year of the Covid 19 pandemic, which was about to end. Although the volume of income transfer and the number of people served by the Araribóia currency were smaller than in the previous program, the city kept a significant amount of resources in the territory, transferring BRL 500 per month to 50,000 families, from March 2020 to December 2021 (considering RBT program and Arariboia currency).

According to the interviewees, which represented the Municipal Secretariat of Social Assistance and Solidarity Economy, the process of implementing the Araribóia social currency occurred in two moments. The first comprised discussions and planning, and lasted from the first half of 2020 until the sanctioning of Act 3,621, in July 2021, which created the Solidarity Economy, Fighting Poverty, and Economic and Social Development Program of the Municipality of Niterói, as a way to combat social inequalities and foster the economic and social development of communities. Among other general provisions, the law established the Araribóia Social Currency Program, which provides a benefit value of 90.00 arariboias per person, limited to 6 (six) benefits per family.

The second moment was the implementation itself, starting with the bid of a Civil Society Organization (CSO) to manage the currency, which ended in October 2021. At this point, the CSO also started issuing cards and registering users, that is, traders and service providers in the municipality (formal and informal). Between September and December 2021, about 4,000 merchants and service providers were registered; there was a concern that when resources were available to the beneficiaries, they would find where to spend it. To give an idea of this task, the Cielo brand for food, Lelo, used by the RBT program that would end, covered 3,800 accredited merchants in the city.

According to interviewees, it took a specific task force and a great effort to explain and make people aware, before the currency was implemented. According to the Secretariat's estimate, more than 100 meetings took place in the city's poor communities to mobilize people. The team believes to have involved about 10,000 people, with crowded meetings, 200 to 300 participants, with the whole secretariat team working on this process.

They also mentioned that partnerships were fundamental, and highlighted the partnership with the Federation of Community Associations of Niterói (Fanit). They report that "Niterói has a very strong, very powerful community movement", including a direct and active relationship with the local public power. It seems that the role of associations in the city gains more legitimacy when they support community organization processes to make up public and social policies.

Regarding the initial criterion for registration of traders or service providers, they should be located in the city’s poor communities, in order to favor the low-income population in another way. However, after the first payment, the beneficiaries themselves started to pressure for the accreditation of some large supermarket chains. This was because, as an income transfer program, people typically used the resource to buy food. Therefore, the Secretariat decided to register some large supermarket chains, as long as they were located in popular areas of the

~~city. The supermarket chains welcomed the proposal, because they were already present in the~~ city of Maricá and knew how it worked.

6. Final remarks

This article is part of an ongoing research project, which began in May 2022 and is scheduled to end in March 2024. Therefore, the information and discussions we present here are still exploratory. The recent dynamics of the processes of creating municipal social currencies makes it difficult to obtain primary data, and based on some open interviews, documents, and websites we were able to present, although briefly, the cases of the Livre (Free) currency, in Limoeiro de Anadia, Alagoas, and Araribóia currency, in Niterói, Rio de Janeiro. Our goal was to understand how local governments assimilate these currencies. While both were created directly by the municipal authorities in each city with the same purpose - to transfer income to the poorest people - their implementation processes are much different, especially regarding the local context.

Both experiences have important similarities with the notions of public policy instruments and public policies "in reverse", proposed as a key reading in this article. Based on this understanding, an instrument such as the social currency (or even the entire BCD), is capable of structuring public policies from its own operating logics and through the relationship between actors, even producing governmental decisions. An instrument-focused approach is significant because it can complement the classical perspective that focuses on an organization or on the interaction between actors and representations, which has historically been central in public policy studies. It became clear that public policy instruments can be created by civil society actors, until they become government mechanisms for a more direct implementation, including building specific legal frameworks.

However, the greater participation of public authorities in systems that use social currencies raises important questions. One is about the autonomy of civil society in managing social currencies. Another question is on ensuring the continuity of the experience, with or without the participation of public authorities. In other words, what would be the appropriate institutional design to ensure civil society governance and the active participation of the public power in these systems?

The history of RBBC and municipal social currencies began with the complete absence of the public power, when the poorest families of Fortaleza, Ceará, were transferred to a distant neighborhood, Conjunto Palmeiras. In 1981, the residents created an association that, in turn, created the Palmas Bank in 1998. It was a period when the community organized itself and acted, while demanding unsuccessfully the attention and action of the local government. In 2003, as we have seen, Senaes was created and, as its head, Professor Paul Singer (1932-2018), a researcher and activist in the field of solidarity economy, undertook a series of policies for generating work and income, among them reapplicating the methodology used in the territory of Palmas Bank throughout Brazil. The partnerships between the Palmas Bank Institute, support and promotion entities (such as university incubators), and the federal public power ensured the constitution of RBBC and the consolidation of the practices of community development banks and the use of social currencies, especially between 2010 and 2015.

The continuous weakening of Senaes in the national scenario, since 2015, has led to reducing public policies for solidarity finance at the national level, but the visibility of BCDs and social currencies as potential public policy instruments was already consolidated. It seems that the legal framework, RBBC actions, the innovations of the Palmas Bank Institute, and research on BCD methodology have, to a large extent, ensured the legitimacy of these

~~community organizations. As a result, state and municipal governments began to support~~ directly some of these experiences, although not continuously.

However, cases like São João do Arraial (PI) and Maricá (RJ) show that the cities themselves can design projects to implement community banks and social currencies, without taking on the governance of the institutional arrangement built, that is, keeping the solidarity and democratic logic of BCDs' methodology, and not its technocratic and managerial logic. Currently, one of the most important challenges of RBBC is to support the use of social currencies through the direct leading role of city authorities, towards income transfer policies that aim to minimize local socio-economic difficulties, reduce social inequalities, and promote territorial development (goals compatible with the RBBC purposes). At the same time, it needs to ensure the permanence of one of its principles: participation and democracy in the bank's management and in the circulation of social currencies.

We believe that the discussion we have started here can provide the theoretical and practical bases to guide, at least academically, the use of social currencies in municipal public policies. It seems to us that by "viewing in reverse" at a public policy, we see it more clearly, in constant building. From now on, our intention is to support RBBC in finding the appropriate institutional design for democratic governance, without losing the potential of partnerships with public authorities, which have been so desired throughout the network's development process.

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Solving crises

Outline of a multi-currency system to meet contemporary challenges

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1. Introduction

Fundamentally, our monetary system based on a two-tier banking organisation (central banks and commercial banks) is focused on financing the production and marketing of financially profitable products and services. This profitability is essential to make it possible to reimburse the credit granted through money creation.

If, in the 19th century, this structure responded to the priority objective of increasing production and supporting industrialisation in order to meet unsatisfied needs, we can see today that this organisation is generating disastrous collateral effects with dramatic ecological and human consequences. The earth is suffering from a hypertrophy of economic activity.

The question today is not to produce more but better, to adjust production and consumption to the sustainability of living conditions in the long term and to respect social equity.
We consider that our monetary system, which organises, coordinates and informs our initiatives, our production and our exchanges, and which is constrained by financial profitability, does not meet contemporary needs. Of course, it must continue its mission of pre-financing the capitalistic economy, but it must open up to new missions that are essential to the survival of humanity, such as financing the realization of the ecological transition or the restoration of biodiversity that are not financially profitable.

At this time, these missions, which are essential to the future of the planet and humanity, can only be financed through taxation and redistribution policies that imply additional economic growth that is harmful to the environment. This leads to the paradox that in order to repair the earth, we must first damage it even more.

Our work leads us to consider that a multi-currency system would offer a relevant response to contemporary challenges. Such a system would differentiate the denominations, the modes of issuance, the primary allocations, the primary beneficiaries, the counterparties as well as the characteristics of the currencies in circulation by distinguishing between market bank money, public and private non-market currencies or currencies linked to the availability of natural resources. In such a system, the prices of products and services would be expressed in affected or vectorial form, each vector representing a monetary dimension of the multi-currency system.

The different vectors of the multi-currency system would be based on the characteristics of the real world, the availability of (non-)renewable, recyclable, (im-)material resources. Our approach aims to incorporate the environmental and human dimensions into the way we count in economics.

2. On money and its objectives

By adopting a panoramic view of the history of money, we can essentially discern two origins of the monetary phenomenon: the regal origin, on the one hand, which founded the monetary institution and sovereign or regal money, and, on the other hand, the merchant origin, which is at the source of the means of payment which, very often, have responded to the shortage of regal money or aimed precisely to do without it (bank account, bill of exchange, bank note, commercial or bank credit, cheque, credit/debit card).

Today, our monetary architecture, established since the 19th century, is based on a hierarchical system of two tiers of banking institutions; the central banks which are part of the state sector, at the first tier, and the commercial banks which are part of the market sector, at the second tier. Central banks create and lend central bank money to commercial banks and commercial banks create and lend means of payment to their customers. The fundamental criteria governing the operation of banks, both central and commercial, are the financial profitability of the operations financed and the creditworthiness of the borrower.

The aim of the monetary and financial system is therefore solely financial and based on the development of a credit economy which "*can be deployed as long as there are perspectives of growth of wealth allowing not to extinguish the debts but to remunerate them in the form of interest*"[1]. This aim seems to us to be totally out of step with the contemporary challenges of ecological transition, which aim to prevent and adapt to climate change and to regenerate biodiversity, without forgetting the imperative need to achieve social equity. These are existential goals of humanity that the monetary institution cannot incorporate in its current logic. For us, the monetary system must be put at the service of the ecological and social transition.

In this note, we first try to identify some defects of the monetary system and then try to propose adaptations in line with these objectives.

3. The issues of the monetary system

a. First issue: monetary commensurability, the basis for fungibility, full substitutability and weak sustainability

The value of all products and services is expressed through their price. The reduction to the single monetary dimension, the price, of all the components of products and services implies that they are commensurable by the single monetary unit. A single unit, the monetary unit, then expresses all the natural, human and financial resources incorporated in the products and services.

Since everything is expressed through price, everything can be converted into everything. Everything is commensurable and reducible to price. This is the indispensable condition for the affirmation of the liberatory power of money, the foundation of the general theory of equilibrium and the indispensable basis for the thesis of the substitutability of the factors of production (capital, nature and labour) among themselves[2].

Monetary commensurability is a prerequisite for the affirmation of the liberatory power of money. Money, which is perfectly fungible, has a liberating power over all debts regardless of the nature of the services or products exchanged. It is a universal purchasing power on all types of products and services without any limit. It allows one to buy petrol (a non-renewable resource), vegetables (a renewable biological resource) or to go to the theatre (a service) without any ecological, social or moral consideration.

Commensurability underpins the principle of substitutability of capitals. "*According to the neoclassicists, it is possible to envisage substitutions between the various forms of capital: an increased quantity of "man-made capital" (productive equipment, education, research, etc.) must be able to take the*

[1] GOMEZ, Pierre-Yves, (2022), "Le capitalisme", PUF, Coll. Que sais-je ?, 126p. (O.t.Own translation)
[2] VIVIEN, F. (2013). Chapitre 1. Les visions économiques du développement durable : quels enjeux en termes d'évaluation ?. Dans : Franck-Dominique Vivien éd., *L'évaluation de la durabilité* (pp. 23-44). Versailles: Éditions Quæ. https://doi.org/10.3917/quae.vivie.2013.01.0023 (O.t.)

place of smaller quantities of "natural capital" (environmental services and natural resources)"[3]. In the neoclassical conception, the transition from natural capital to productive capital and their supposed equivalence takes place over time through a succession of arbitrages based on price analysis based on a system of equations describing the economic equilibrium. However, prices do not incorporate all the information relating to the products and services exchanged; they only reflect market motivations and are not intended to reflect the environmental or social consequences of production processes. On the one hand, *"social relations to the environment and to natural capital are external to the market and are not mediated by the price system*"[4] and on the other hand, short-term financial interests are privileged[5] to the detriment of future capital.

b. Second issue: a monetary system with unlimited drawing rights on a limited earth

The mission of the monetary system, which is banking in nature, is to create so much money, so many drawing rights on nature and on people, that the investments financed on credit generate profits which are, in turn, invested in profitable projects which thus fuel a race to maximise economic growth. The purpose of the monetary system is profit through economic growth. The monetary and financial system is totally disconnected from the physical or biological environment which it perceives only through financial accounting indicators. Thus, the monetary system has an unlimited right of money creation giving unlimited drawing rights in a finite physical world. This is not a flaw, it is a chasm that separates the conception of money from the real world. "*It is an embarrassment to capitalism, ideologically speaking, that capital is no longer the limiting factor. Anyway, this difficulty was circumvented by asserting that capital could satisfactorily replace natural resources. The denial of any fundamental dependence on nature is the fundamental impulse of neoclassical economics*."[6]

c. Third issue: an intrinsic inability of the monetary system to finance the non-profit sectors and the ecological transition

The contemporary banking mode of money issuance, based on the quest for financial profitability, is intrinsically incapable of financing financially unprofitable investments in the non-profit sector or in the ecological and social transition. Under the current profit-driven rules, biodiversity regeneration, climate protection measures or investments in the non-market sector, which are not financially profitable, need to be financed by another mechanism than bank financing. These investments are currently financed through taxation, through public levies on income or wealth and through public debt. Consequently, in the current conception, the ecological transition can only be a derivative activity, secondary to market activity; it cannot be a priority objective of either society or the monetary system. In the present configuration, in order to finance the transition, it is first necessary to create profitable economic activity in order to create income, which can then, through taxation, be partially allocated to the non-market. Thus, financing the unprofitable parts of the ecological transition implies a prior growth of economic activity which, by definition, is harmful to the environment. This leads to the paradox that to repair the earth, we must first damage it further!

4. The proposal

To address the first issue of the monetary system, monetary commensurability, we propose the introduction of a multi-currency system whose objective is to reduce the liberatory power of money to control the consumption of resources deemed valuable. Therefore, the monetary vectors we propose are closely linked to these resources and are non-fungible.

To respond to the second and third issues, we propose to reform the aims of the monetary system by adding the mission of financing the financially non-profitable sectors, first and foremost the ecological

[3] VIVIEN,F. (2009), "Les modèles économiques de soutenabilité et le changement climatique" in "Regards croisés sur l'économie" N°6 2009/2, La découverte, pp. 75-83 (O.t.)
[4] VIVIEN, F. (2009). Les modèles économiques de soutenabilité et le changement climatique. Regards croisés sur l'économie, 6, 75-83. https://doi.org/10.3917/rce.006.0075 (O.t.)
[5] CARNEY Mark, (2015), « Breaking the tragedy of the horizon - climate change and financial stability », Bank of England, 29 september 2015
[6] DALY, Herman, E. (2004), "From Uneconomic Growth to a Steady-State Economy", Edward Elgar publishing, 272 p., p.326.

transition and the regeneration of biodiversity. In concrete terms, this means introducing new modes of money issuance in line with this purpose, the issuance of "voluntary money", money created through donations, possibly conditional and free-interest loans..

The solution we propose is based on a vector-based monetary system that would complement the current monetary system. This linkage would make it possible to finance the investments of the non-profit sectors by making it possible to control and limit the consumption of precious resources. In this way, the profit and non-profit spheres of society would be financed by appropriate solutions.

a. Reducing commensurability by introducing monetary vectors

If we agree that price is information to guide the economic decision-making, then the price formation mechanism should, in our view, incorporate all the information on the physical, biological, chemical transformations and human inputs that made the production possible. We are thus in line with N. Georgescu-Roegen[7], H.E. Daly[8], F. Roddier[9] or the CARE-TDL[10] accounting method for which prices must include the costs of consumption but also those of reconstituting human, natural and financial capital. Financial information can only be valid if it includes all dimensions of the production and consumption process

To achieve this objective of extended information, we propose to use four monetary units instead of one (or four monetary vectors). The price of each service or product would be expressed by four vectors, each representing a single type of natural or human resource. The one-dimensional price is then transformed into a four-dimensional price and the different dimensions are not reducible to each other. Consequently, commensurability and monetary fungibility decrease.

The four types of resources have been defined based on whether the resource is renewable or non-renewable and whether it is human or natural. We have also given a name to each vector.

The four types of resources and their monetary vector are:

1° Non-renewable physical resources: underground, ground, atmosphere, including mineral resources, air and water, which appear to us as common goods. The stock of these resources is limited, as is their availability. Consequently, the principle of their governance should be "sparing use" so that future generations can also benefit from these resources. In terms of governance, at present, the exploitation of the underground and the atmosphere is generally done through the granting of exploitation licences (mines, air traffic, GSM network, etc.) whereas the exploitation of the land is generally subject to private property rights, possibly limited by general rules (urban planning, land use planning, protected areas, etc.)

We propose to call the monetary vector associated with non-renewable physical resources: "**Terra**".

2° Non-renewable biological resources: these are the fossil fuels, coal, oil and natural gas, all three of which are the result of biological degradation processes. We distinguish these resources from the previous ones insofar as they are the basis of organic chemistry, a key industrial sector, and because the combustion of these fossil fuels is one of the causes of climate change. The governing principle of these energies should also be "sparing use" with the additional constraint that it is imperative to stop the accumulation of carbon dioxide (CO2) in the atmosphere.

We propose to call the monetary vector associated with non-renewable biological resources: "**Carbo**".

[7] GEORGESCU-ROEGEN, Nicholas, (1971), "The Entropy Law and the Economic Process", Harvard University Press, 472p.
[8] DALY, Herman, E. (2004), "From Uneconomic Growth to a Steady-State Economy", Edward Elgar publishing, 272 p.
[9] RODDIER François, (2015), "Thermodynamique de l'évolution – Un essai de thermo-bio-sociologie", Editions Parole, 215p. (English version : The thermodynamics of evolution, 2020)
[10] https://www.chaire-comptabilite-ecologique.fr/la-chaire?lang=en

3° Renewable biological resources: these are the products of agriculture, forestry, animal farming, fishing or hunting, the characteristic of which is that the resources can be reconstituted relatively quickly on a human scale so that they can be consumed sustainably. They are the combined product of nature and human activity and are highly dependent on climatic conditions. The governing principle should be the conservation of the natural reproductive capacity of the resource. Specific regulations for the sustainable exploitation of these resources seem appropriate (fishing or hunting quotas, standards for the exploitation of cultivated or farmed species).

We propose to call the monetary vector associated with renewable biological resources: "**Vivat**".

4° The resources of humanity: these are the means or capital that humans can use; productive and creative activities, knowledge, techniques, finance; to produce what they consider to be necessary, The fundamental principle of governance should be the search for continuity and permanence of human flourishing.

We propose to call the monetary vector associated with human resources: "**Euro**" to keep the current name but we would have preferred "**Huma**".

In concrete terms, in everyone's wallet there will be four currency units, terras, carbos, vivats and euros. The price of products and services will also be expressed in the four currency vectors.

For example :

a. The purchase of a new house made of bricks and cement (non-renewable resources):
100.000 terras ; 10.000 carbos ; 1000 vivats and 120.000 euros
b. The purchase of a new wooden house (renewable resources):
5.000 terras ; 10.000 carbos ; 80.000 vivats and 85.000 euros
c. The purchase of a pre-existing house will require:
0 terras ; 0 carbos ; 0vivats ; 150.000 euros
d. The purchase of natural gas by a bakery:
0 terras, 500 carbos, 0 vivats ; 20 euros
e. The purchase of flour by the bakery
0 terras, 10 carbos, 500 vivats, 10 euros
f. The purchase of bread by a consumer
0 terras, 2 carbos, 4 vivats, 1 euro

The examples lead to some initial observations

- Each price is composed of four vectors - if not applicable, one or more vectors is zero.
- Money vectors are used as regular money, money units are obtained and money units are spent. We will come back later on to the different ways of acquiring the different units as well as the rules of issuance, remission and exchange between the different money vectors.
- Business accounting systems need to be adapted to work with four money vectors.
- A price or service can only be acquired if the buyer has sufficient units of each of the vectors needed for the acquisition. The unavailability of one of the vectors makes it impossible to buy.
- The purchase of a pre-existing house does not require terras or carbos. These vectors are linked to environmental extraction. They are used in all stages of production up to the moment of release for consumption. The subsequent use of these resources through reuse, reutilisation or recycling no longer requires the use of these vectors as there is no longer any extraction of resources from the environment. This is a positive element for the establishment of a circular economy[11].

[11] With the normal losses due to entropy during successive recycling

b. Adding the non-profit sector as a monetary objective and transforming the modes of money issuance to finance its investments

We have seen that in its historical development, money has pursued two types of purpose: regalian and merchant. We propose to add the "non-profit" purpose. Under this heading, we include all financially unprofitable activities deemed indispensable by society, such as education, health care, the enhancement of the place of the old in society and their support at the end of life, for example, and, of course, the ecological transition. At present, investments in these sectors are financed via chronically deficit public budgets and therefore, indirectly, via public debt, the cost of which is equal to the interest paid to the holders of this public debt.

In the regalian context, the preferred method of money issuance is purchase through the putting of coins into circulation (bearing the effigy of the sovereign). In the mercantile context, the preferred mode of money issuance is lending or credit. In the non-profit context, the preferred method of money issuance should be through donations or zero interest loans. We can think of several forms of donation and therefore several forms of money issuance:

1° The voluntary mode of money issuance
2° The zero-interest loan
3° The Universal allowance of melting money

1° The voluntary mode of money issuance, a conditional gift on the restoration of the planet

Money donation can take the form of "voluntary money issuance"[12], which consists of issuing money without financial compensation and without repayment on condition that the amount issued is used exclusively for the restoration of nature. Through this conditional gift, financial capital is created to restore natural capital. In our proposal, the voluntary mode issues euros, however, if necessary, the voluntary currency can be issued in the form of a regional currency in order to couple the objectives of regional development, relocation of activities and use of local resources with the objective of environmental regeneration. This money issuance would be controlled by a multidisciplinary body combining political power, monetary power and representatives of various constituted bodies (employers, trade unions, nature conservationists, NGOs, etc.).

From time immemorial, the issuance of money without repayment, of permanent money, has been an essential feature of so-called sovereign or regal money. Money was not given by the sovereign, but once it was in circulation, it did not have to be paid back. This type of money has allowed humanity to produce and exchange for over two thousand years. From our point of view, this issuance without repayment is justified because the regeneration of nature has no profitability other than ecosystemic; it has no economic or financial profitability. Nature cannot therefore repay financial debts because it offers what it produces free of charge. It is in the name of this absence of financial profitability and in the name of ethics - leaving a viable planet for future generations - that we consider that this money should not be paid back.

The voluntary mode of money issuance is the only one in human history that reverses the relationship between nature and humanity. It allows humanity to put itself at the service of nature rather than nature at the service of humanity!

2° Bank money issuance at zero interest rate by the central bank to finance non-profit investments

In order to provide the necessary financing for non-profit investments, it is essential that public authorities have access to zero interest bank financing from the central bank. This type of zero-interest financing, a form of interest donation, is particularly suitable for public investments and amortising investment grants that are currently financed through public debt. It could be, for example, to accompany the development and generalisation of passive energy buildings, to rethink and reorganise

[12] COUPPEY-SOUBEYRAN, J. and DELANDRE, P., (2021), "The Case for Money serving the Common Good", Veblen Institute, https://www.veblen-institute.org/Monetary-Transition-The-Case-for-Money-serving-the-Common-Good

the occupation of the territory, to rebuild a health system centered on respect for the individual, etc. All these situations in which amortisable investments of a non-profit or public type must be made.

In this scenario, the interest burden of the public debt devoted to investments is reduced to zero. The public debt is then simply a monetary advance necessary for the realisation of useful projects, which is repaid in proportion to the duration of use of the investment. In such a scheme, public debt is valued, it becomes a symbol of civilisation and restoration and no longer has the negative character of an unbearable burden. At the same time, it ceases to be the raw material of finance and no longer offers any financial return to the holders of the debt. It is no longer a private tax on public investment.

3° The universal allowance of a melting currency to limit the consumption of non-renewable resources

In the name of inter-generational solidarity and sustainability, non-renewable resource stocks must be used sparingly by each generation. These resources are scarce and not substitutable. Therefore, an intergenerational system of distribution of resources until they are replaced, if possible, must be developed. An intergenerational distribution method, such as quotas per generation, could be applied. Within each generation, a technique for the fair distribution of these quotas must be found. We are thinking of a periodic universal allocation, a form of recurrent donation, whereby each citizen would receive a periodic quota - a drawing right - on non-renewable resources.

This proposal is particularly suited to the consumption of fossil fuels (non-renewable biological resources) through the allocation of carbon quotas to each citizen. A public institution would be in charge of issuing free of charge the carbos - individual carbon quotas[13,14] - and of allocating them according to a universal allocation logic in the form of "carbon units" on a personal account. From these accounts, citizens would have the right to buy a volume of fossil energy, goods and services that required the consumption of fossil energy. This mechanism of universal allowance of non-renewable resources could also be extended to non-renewable physical resources, in particular water. In this way, everyone would receive an annual drawing right on a volume of drinking water in the form of terras.

To avoid the accumulation of terras or carbos leading to forms of capitalisation of drawing rights or to forms of speculation, they would have a deadline for use. After this deadline, the unused units would be cancelled. Terra and carbo would be melting currencies. The total volume of allowances issued by the institution would be in line with the collective maximum cap. For example, for fossil fuels, the amount of allowances issued would be less than the maximum amount of carbon emissions allowed annually to preserve the climate. Each purchase of a product or service would be made by paying a price in euros and in allowance units. Through successive transmissions within the trade chains, the units would eventually be traced back to the original importer or operator of the resource, who would then have to hand them over to the authority responsible for the original emission of the units. The issuing authority could then check that the quantity of units delivered is in balance with the quantity of resource put on the market and destroy the units used. As the volume of allowances issued is controlled, the volume of resources consumed is also controlled. Considering their characteristics, currencies that melt if not used and are destroyed as soon as they are returned to their issuer, terras and carbos are genuinely ecological currencies that allow the consumption of certain resources to be limited. As their volume of emission is defined in relation to the quantity of real resources available, long-term resource management can be easily implemented and even if a secondary market is created, it will be certain that no more than the admissible volume is consumed.

c. Establish rules of exchange between currency vectors

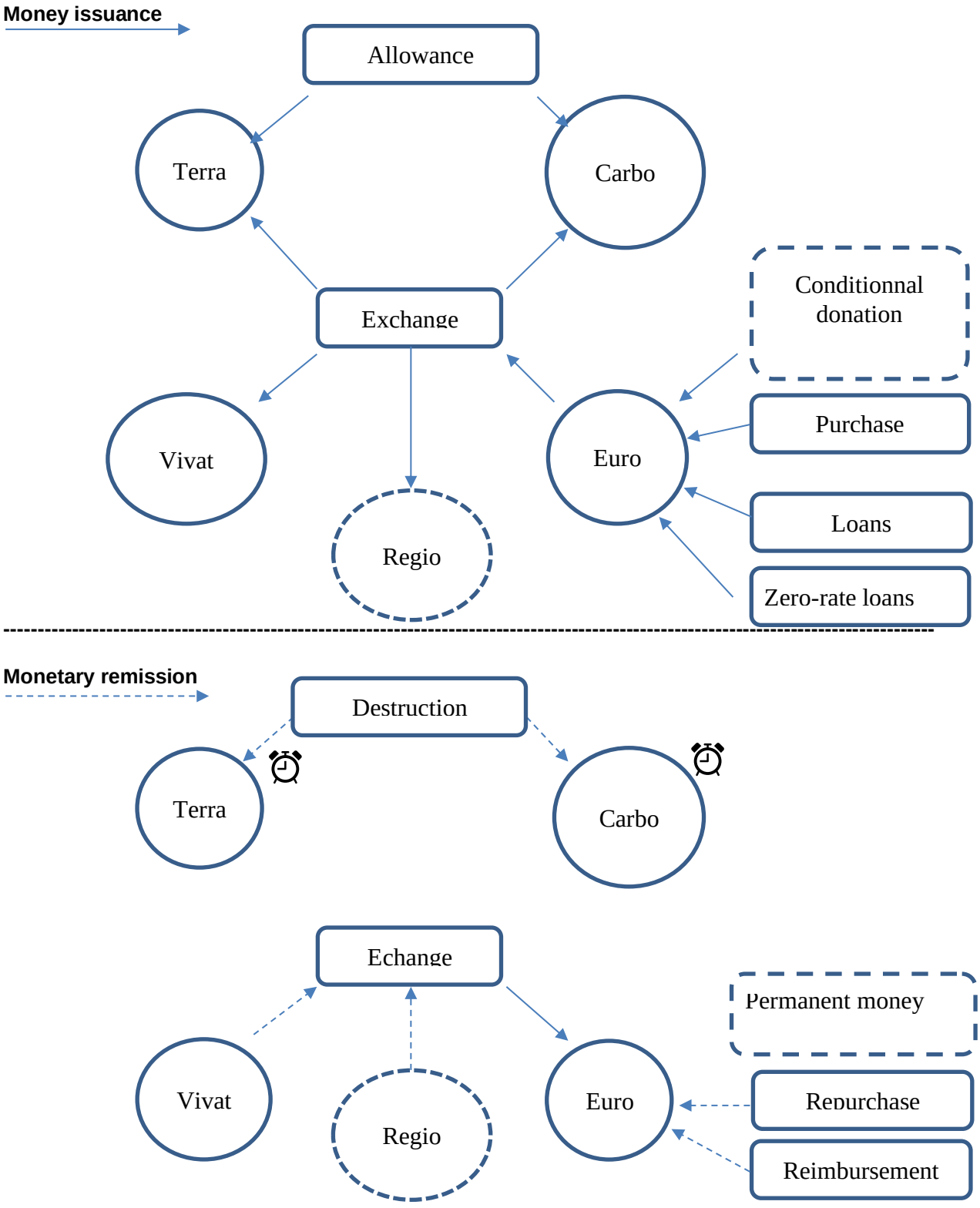
With this proposal, the vector monetary system remains essentially based on the euro with its current modes of issuance to which we add a "voluntary mode of issuance" and zero interest loans. All euros are perfectly fungible, nothing distinguishes them whether they are issued by the banking sector or by the voluntary mode. Where appropriate, with a view to promoting regional development, euros can be

[13] A. VAN DER CAM, (2021), "Designing an end-user carbon account scheme as a climate policy tool in the EU context", https://dial.uclouvain.be/memoire/ucl/en/object/thesis%3A30422
[14] https://comptecarbone.cc/mouvement/#ressources.

converted into complementary currency or into vivats for the exploitation of renewable biological resources. Vivats and regional currency units may, where appropriate, be converted back into euros at some form of exchange loss.

Terras and carbos can be issued and allocated to the population by universal allowance, but can also be acquired in exchange of euros (currency exchange) within the limits of annual availability. The terras and carbos issued cannot be converted back into euros since they are ecological currencies with a limited life span.

Schematically, this gives:



5. Synthesis

While the current context requires humanity to engage in a vigorous ecological transition and in the development of the non-profit sector, the profit-oriented nature of the monetary institution remains hegemonic. Its banking, profit-driven architecture not only leads to an intrinsic inability to finance the non-profit and the ecological transition but, worse, it gives humanity unlimited drawing rights on nature's limited resources. The use of a single unit of account (monetary commensurability) to express the price of various types of resources leads us to dead ends in terms of sustainability and substitutability of natural resources. All this leads to the dramatic conclusion that our way of life is unsustainable.

Therefore, in the monetary field with which we are concerned, it seems desirable and conceivable to complete the objectives of the monetary system by adding to it the financing of non-profit sectors, first and foremost the ecological transition and the regeneration of biodiversity.

In practice, our proposal is to introduce new modes of money issuance based on donation, such as voluntary mode of issuance, interest-free loans and universal allocation of drawing rights on the physical resources of the planet. At the same time, to reduce the liberatory power of money and to allow a control of the consumption of resources, we propose to introduce a quadri-monetary system (or vectorial money) in which each monetary vector addresses one and only one type of resource, the terra for physical resources, the carbo for fossil energies, the vivat for renewable biological resources and the euros, possibly converted into regional currency, for human productions. In order not to fall into the trap of commensurability, the different monetary vectors are only fungible with each other through precise rules.

In our view, this monetary configuration could meet the challenges of the time. It would reduce the pressure of finance on society and the environment, finance non-profit investment and land repair, and reduce public debt. It could also allow for economic restructuration without hindering or placing the burden of ecological reconstruction on the market world alone, while allowing for the recognition of necessary activities that are currently not valued, remunerated or quantified.

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TOKENOMICS BEYOND THE BLOCKCHAIN: BRISTOL PAY BUILDING FORWARD RESILIENCE IN THE LEGACY OF THE BRISTOL POUND

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Abstract: *In the world of community currencies Bristol Pound was a success. Yet in the realm of behavioural change it failed to bring about the great transition. In the face of the enviroclypse we need a new approach. By using countable tokens to encourage positive flows in social capital and environmental capital, rather than financial capital, Bristol Pay CIC is designing a new complementary system. This paper contains a historical review of the Bristol Pound with the lessons learned: the unintended barriers to entry for the majority of the population, the lack of value propositions to engage people; the technical shortcomings. It then outlines the hypotheses behind Bristol Pay, from behaviour change to gamification, and from multi-capital accounting to social economics.*

Keywords: *Community development, ecological economics, utility tokens, local development, energy transition, NFT*
JEL: *D16, Q56*

1. Introduction

The local currency movement has for many years been working to create economic interventions to correct the functioning of local economies to reduce environmental harms and build community capital (Kennedy et al., 2012; Rogers, 2013). Bristol Pound (hereafter £B) was one such currency (Marshall & O'Neill, 2018), operational from 2012 to 2021. In its early years, the £B became the largest UK local currency, both in terms of numbers of users: 1 600£B account holders and 600 business users reported in 2014 (Gilbert & Kenny, 2014); and quantity of money, with over a million £B issued and over 700 000£B in circulation (Hickey, 2015). It, along with the Brixton Pound, which used the same technology (Bindewald & Steed, 2015), was one of the first local currencies to offer digital and paper money. It was the first local currency to be accepted as payment for local taxes.

Here we look at the impacts of the £B currency, the reasons for its inability to become viable as a business in its own right, and the learnings that must be addressed in the design of Bristol Pay, the currency project planned for the future. We then explore the principles

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behind the design of Bristol Pay. We are influenced by The MetaCurrency Project (Brock, 2014; Wagter & Russell, 2016). There, the idea is that a value-flow can be seen as a current: a currency can be understood as a 'current-see' (Petz, 2020). Brock (Brock & Harris-Braun, 2011, m. 20:25) says "current-sees are the symbol systems to make flows at different levels visible". There is additionally, more than one current flowing in one direction at any time. Instead of seeing money as a marker of transactions, and focusing on money, currency can be seen as a way of making visible a reciprocal relationship between two parts of a system.

Money itself can be a wide variety of tokens; coins, notes, digital tokens (CoreLedger, 2019) or even commodity money, which contains both an actual usable function as a good, e.g. rice, squirrel skins, cigarettes or gold; and a token function, which has a store of value that can be transacted as a system of account as a service, thus fulfilling the properties of money (Petz, 2020). Tokens may be fungible (mutually substitutable with other tokens e.g., a 5-pound note can be swapped with any other 5-pound note) or non-fungible. An example is digital NFTs (or non-fungible tokens) (Popescu, 2021), they are non-fungible as they are related to a specific asset or service which cannot be substituted with another.

However, money is polymorphous and can have different uses and aspects (Gómez & Dini, 2016; Zelizer, 2000). Money may be special-purpose money, which is designed to be only spendable in certain situations or on defined products or services. The £B can be seen as a special-purpose money, which was locally restricted and limited to use with Bristol-based traders. Money is generally associated with market transactions, acting as payment for products and services. Yet, tokens can be created that act outside a market-based economy.

A token can be designed to mark an activity (such as pledging to avoid using herbicides and pesticides in your garden) that creates a specific value (in this example, an improvement in biodiversity) that does not involve two parties trading a product or service in a market. Marking that value creation with a token does not necessarily grant purchasing power; whether or not a token can be exchanged (for another token, a product or service) is part of the definition and protocol of each token type. This prompts the research question which led to this paper:

Can tokens be used to shape alternatives based on non-financial values?

To explore this wider role of tokens, we need to step back from how the economy is usually viewed. If we see the economy only as a system of investment, production and markets (the conventional macroeconomic approach), it is hard to understand the potential and use of tokens that do not confer purchasing power or financial value. However, if we take a broader view of the economy; as an emergent pattern of human behaviour through which resources and human effort create the goods and services to meet the needs of the population (behavioural economics), tokens can be seen as potentially transformational.

In a market economy model, in which money is seen as a store of financial value, the tools of choice for altering market mechanisms are financial; there have been many attempts to use

financial penalties and incentives to change individual and corporate behaviour; from carbon trading (Spash, 2010), to legislation to introduce charges for using plastic bags (Borg et al., 2021; Le Page, 2018), to volunteer reward schemes offering discounts for local services, e.g. Citizen Coin Bradford (T&A Reporters, 2021) in Bradford; and CounterCoin (Ntounis & Bailey, 2018) in Newcastle-Under-Lyme.

However, these sorts of financial incentives and penalties do not properly value the additional resources required to make the sought change, nor do they base the value of the reward or incentive on the true value of the intended outcome.

Moreover, there is a bigger problem with trying to change decision-making on the basis of financial value: Many human decisions are not made solely on the basis of financial gains or losses (Kim et al., 2009; Kurita et al., 2015).

A better understanding of the motivation for human behaviour is provided by the ISM model (Darnton & Horne, 2013). This postulates three main factors in determining behaviour:

- **Individual context:** what people themselves think about themselves, their beliefs and values, in turn dependent on their roles
- **Social context:** what people think others think about them, and the desire to be thought of well by those they aspire to emulate, social norms and institutions
- **Material context:** the infrastructure, both in terms of physical reality, technologics, legal and other regulations; and in softer terms, time and day-to-day schedules of life

From Bristol Pound to Bristol Pay

With this perspective, Facebook likes (Kosinski et al., 2013) can be seen as a powerful social token reputation currency that has been successful in changing the social and individual contexts in the ISM model for millions of people, and undoubtedly changed behaviours, albeit in an unhelpful direction from the perspective of BPCIC's aims (Bristol Pay Community Interest Company, formerly Bristol Pound CIC, hereafter BPCIC)'s aims. BPCIC has been exploring the application of behavioural economics to socio-ecojust ends (Finch, 2022).

Bristol Pay seeks to create token currencies that build on the ISM model, affecting both people's self-view and their view of how society sees them and their actions. Bristol Pay is hoped to be the first implementation of this City Pay proposition. The tokens are planned to be used to encourage pro-social and pro-environmental value-creation, and in turn to enable new positive social norms to develop. The Tipping Point (Gladwell, 2002) indicated there is a threshold to change behaviour and make this happen. While different subcultures and situations vary, around how many people need to be converted, BPCIC are using a heuristic of ~20% of the target population to adopt a behaviour under the idea this will cause a new norm that the rest of Bristolian society will adopt. We are building a new forward resilient society that has been nudged in a different direction (Revell & Dinnie, 2020).

To give a simplified example of how this might work in practice, consider the ideas the Bristol Pay team have explored with an environmental charity local to Bristol; Avon Wildlife Trust (AWT). AWT wants to create significant changes in how people design and maintain their gardens. AWT's Grow Wilder hub's "mission is to bring about urgent action for the restoration of wildlife by educating, upskilling and empowering people, communities and businesses to bring about positive change through wildlife-friendly gardening and sustainable food growing" (AWT, 2020). AWT aim to "deliver biodiversity gain", "restore and create … carbon sinks", and reduce run-off, thus reducing both drought and "local flooding"(Barrett & Relph, 2021). However, in the UK, social norms prescribe the antithesis, i.e. having a neat garden, with closely mown weed-free lawns, low maintenance patios, and neatly presented shrubberies and floral borders. Cf. Gaston et al., (2007); Goddard et al., (2013); Harwood, (2004) for details of how historical, social, and spatial factors affect garden design).

By "empowering people to take action for wildlife" through Team Wilder, based at Grow Wilder, AWT hope to get "25% of the population … [to] visibly take action, [and] create a social 'tipping point', where the majority will follow" (Barrett & Relph, 2021). Bristol Pay offers the opportunity of celebrating people's pledges to give up herbicides and pesticides in their gardening, or returning part of their patios and lawns to nature, via tokens. The tokens can be a measure of value with a unit of account for each of these varied behaviours, which is transparent to the people, Team Wilder and other stakeholders. Ultimately they can be used to evaluate whether a tipping point has been achieved (as evidenced by a rapid change in the rate of adoption of a certain behaviour) and what that tipping point was. Then to have a "messy", nature-enhancing garden will be acceptable, and people will feel less (real or imagined) pressure from neighbours to show off a pristine garden.

Similarly, Bristol Pay has explored potential use cases with local utility companies: such as Bristol Water, limiting showers to three minutes maximum per person per day in their households; or Bristol Waste, creating zero landfill waste in their household for a month. Here the aim is to encourage people to be more aware of their resource use through gamified tokens, and to set targets and suggest pledges.

At a wider scale, Bristol City Council, following consultation with people and organisations across the city, produced the One City Plan (Rees et al., 2021), which is aligned to the UN's Sustainable Development Goals (Brunnhuber, 2015; UNDESA, 2015). The plan offers a road-map of strategies and milestones to achieve net zero carbon for the city by 2030, as well as to make progress against various social targets.

To achieve this plan, which creates a new material context, significant behavioural changes are needed across society. Each of these could be gamified and tokenised, encouraging people to create and maintain new habits, simultaneously creating a data-set through which the council can measure the extent their engagement exercise is delivering the desired changes, and create communications that reinforce positive emerging social norms.

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2. Methods

We present our results as a case study (Yin, 2018) of the now closed £B currency and early research to support the design of Bristol Pay. As action research (Lagae, 2012; McNiff, 2013) this is an ongoing intervention in the city of Bristol. We are informed by an analysis of nudge economics (Sunstein & Thaler, 2021). We surveyed currently functioning reputational schemes. We carried-out market analysis and population surveying within the cultural milieu of Bristol targeted for behavioural change.

From £B, we have surveys of business and individual users. BPCIC, the organisation that designed, implemented and managed the £B currency, used semi-structured questionnaires and guided interviews to capture the data, as well as feedback and complaints received by BPCIC. Additionally we consider quantitative data from the operation of the currency. For Bristol Pay, BPCIC surveyed various local businesses (former members and non-members) on their attitudes towards the proposed payment methods. As yet, structured consultation has not included detailed discussions on the token operations, though this is planned as part of the development and implementation co-creation process.

BPCIC has been working with: Bristol Water, Bristol Waste, and the University of the West of England, Bristol, about the role of tokens to cut resource use and waste; the University of Bristol and the University of Edinburgh, about shaping student behaviour in line with the universities' aims for positive environmental and social performance; and the third sector, the most positive of which was Avon Wildlife Trust, and the need to set a new norm.

Additionally we have econometric data, from the operation of the £B, with a sufficient market capitalization and time-series that makes it realistic to consider technological transfer implications for other comparable sized cities.

Our data is generalizable. Our innovative field-based approach is linked with common business practices and not only a limited academic study. Thus we are not looking at only a pilot, but actual implementation in a social system. We are networked with academics and practitioners and would like to see what we have learnt shared more widely in a form others can apply in their situations. This means both academic audiences can be informed, for heterodox economic theory development, and those that might take action can hear about a real working case to learn wisdom from it.

3. History of the Bristol Pound

The £B was available in two formats: paper vouchers (£B notes) and digital money. Digital payments could be made online, via SMS messaging, and from early 2018, using a smartphone app. Usage of the £B notes did not require membership of the Bristol Pound scheme, whereas to open a digital account, users had to become members, not only of the currency scheme but also the then Bristol Credit Union (BCU), now named the Great

Western Credit Union. The reason for this joint membership was that digital currency fell within a UK regulated area of activity, and the Credit Union was already a regulated body.

It is worth noting that at the time the digital currency was first being designed, the Electronic Money Institution (EMI) regulatory framework (first enacted in 2011) did not exist (FCA, 2017). Had the currency been designed a few years later, other options that could have simplified the technical architecture would have been available, allowing real-time transactions and enabling BPCIC to use data to manage the network more effectively.

There were two classes of members: individual and business. The BCU rules ensured that only people who lived or worked in the BS postcode area could join as individuals, and that only businesses registered or operating mainly in the BS area could join as businesses.

Individual membership grew quickly in the first three years of operation, and continued at a slower pace throughout the period of operation. By contrast, business membership grew quickly initially, then dropped. Whilst some new businesses continued to join, others left, either by choice or because they ceased trading.

Analysis of the types of individuals joining showed that the vast majority (82%) were educated to degree level, had well-paying jobs (77% in professional or managerial roles), and were less diverse in terms of ethnicity than the population of the city in general, with 89% describing themselves as 'white British'.

Analysis of the business members showed that the majority were small and micro sized businesses, with 35% being self-employed unincorporated businesses. They covered a variety of sectors, but were predominantly retail and service businesses. Geographically, they tended to be situated in areas that were more deprived than average, and clustered in particular neighbourhoods.

There were two main transaction types: B2C (consumers paying businesses) and B2B (businesses paying other businesses). B2C transaction levels grew rapidly in the first three years of operation, plateauing in 2015-2016 and then reducing until the end of the scheme. B2B transactions by contrast started to drop in 2016, yet recovered and reached a peak in 2018, after which they declined sharply.

A key metric for the organisation was the velocity of the currency (de la Rosa & Stodder, 2015), calculated as the ratio of transaction values over a specific period compared to the value of balances held in the system. This was seen as an indicator of how effectively the currency was recirculating. Records show that the velocity of the currency dropped from 2016 to the end of the digital currency.

4. Analysis

The aim of localising supply-chains drew directly from the Transition Town movement, which seeks to empower local communities and reduce environmental harms (Aiken, 2012). The currency sought to encourage individuals to favour independent retailers and

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businesses, and in turn to encourage those businesses to favour other local businesses in their supply-chains. This was expected to:

- reduce CO_2 emissions, via reducing long distance transportation of goods
- increase turnover of local businesses, in turn creating profits locally that would be reinvested in growing local businesses
- create closer, mutually supportive relationships between local businesses, in turn creating more resilience in the sector
- encourage diversity and plurality in the local economy, helping to make the local economy as a whole less affected by changes in global markets

The data produced by the operation of the £B was not sufficient to enable any analysis of how well the currency performed in relation to any of the above aims. Given the scale of the currency operations (approximately £B1 million per annum at its height in 2015) in comparison to the entire Bristol economy (approximately £14 billion GVA in 2015 (see ONS, (2022) for various datasets, changing methodologies and spatial designations for relevant GVA estimations), any direct contribution to overall metrics in any city-wide data set of the £B currency would be impossible to detect.

However, there is evidence both from surveys of individual and business members, along with analysis of transaction data, that the currency did create changes in behaviour, and enable or at least make visible local trading loops through which money was recirculated.

For example, with regard to individual members, when asked what changes they had made to their wider economic behaviour to improve their impact after joining the Bristol Pound scheme, whilst as might be expected; over 70% said they changed where they shopped and what they bought; over 50% had begun to buy more second-hand goods, over 40% moved their main bank account, over 25% started to grow their own food, and 7% moved their pension, even though such behavioural changes were well beyond the explicit aims and functions of the currency.

As for business members, whilst as expected; over 70% had changed their policies around purchasing; 50% had changed various aspects of their HR policies, and over 15% moved their business bank accounts, despite these being activities not directly advocated.

In 2019, a retrospective analysis of B2B transaction data by Geofutures Ltd. (Thurstain-Goodwin, 2020) showed, over the first four years of operation, the network of businesses became significantly more connected, with key nodes emerging that enabled all transactions to be part of a connected network. After this point, as some key nodes left the network, there was a gradual disintegration of the network, with several businesses trading only with one other business, unconnected by trade with the rest of the business network.

5. Discussion

The pressure of climate change necessitates that more localised circles of production and consumption are developed. This was a primary aim for the £B in Bristol, with the local currency used as a tool to encourage localised economic behaviour for SME businesses and Bristolians.

Bristol's business community and customers have been open to fintech innovation in the past, with widespread issuance of coins (merchant tokens) by businesses in the 19th century (Mays, 1978). Product innovations (from paper to digital money) and process innovations (paying by mobile phone) in our time have seen this community alter its behaviour, yet more disruptive innovation is required due to institutional pressures, cultural change and increasing digitalization.

Regrettably, uptake of the £B currency was low as a percentage of the adult population (approximately 0.3%, based on ONS population figures), even though a large number compared to many local currencies. It seems part of the problem was that the motivation of the BPCIC team was not shared by most people.

For individuals, the currency had no clear value proposition. To commit to the call to action, individuals had to both understand the concept that a special sort of money could have beneficial impacts on CO_2 emissions and localisation of supply, believe that the currency would indeed deliver these benefits, and have the time and resources to change their shopping behaviour in ways that would require more of both. Commonly, BPCIC staff were asked questions like, 'What's in it for me?', or 'Do I get a loyalty discount card?'. With no obvious benefit for participating, it is not surprising that usage of the currency was restricted to a largely well-educated and wealthy minority.

Businesses joining were given a value proposition: Join the Bristol Pound currency scheme and you will benefit from additional marketing and increased footfall from people seeking places to spend their £B currency. This got many businesses to join, but given the low numbers of individuals using the currency, in reality they received very little additional footfall – if any. Indeed, most business members reported existing customers had changed their payment method, rather than any new customers had come seeking to spend their £B currency. Given this lack of delivery against the initial proposition, it is unsurprising that after a few years, some businesses started to leave the scheme. Based on customer complaints, many other businesses continued to be members officially, and yet refused to take payments in £B.

For the £B to make more impact in terms of localisation of the economy, and create a viable business model for its operations, its usage needed to have grown by at least a factor of ten, with adoption by at least 5% of Bristolians, as well as participation by most locally owned high-street businesses.

Additionally, given the aim of localisation, BPCIC wanted business members to change their supply chains, choosing local businesses wherever possible, and encouraging these businesses to join the Bristol Pound scheme if not already a member. In reality, businesses

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were reluctant to change suppliers if their business operations were going well: changing suppliers brings an element of risk along with significant administrative work. Encouraging one's suppliers to join a scheme that brings few benefits and several costs (such as training customer-facing staff, setting up tills, managing a more complex cash-flow situation) is also problematic in building or maintaining good relationships with suppliers.

Bristol Pound can be seen as having inherent inconsistencies. On the one hand, it was aiming to create community wealth, but on the other hand, it was inaccessible to most people without significant resources. It aimed to support local businesses, and yet failed to understand small business imperatives. It tried to reduce global transportation, and yet operated at a business rather than at a product level when judging whether something was 'local'. To some extent these inconsistencies can be seen as complementary and part of a wicked problem's nature, however they can also be seen as reasons why £B was a success in terms of a functioning community currency, yet a failure in the realm of creating measurable outcomes.

Already, by early 2019, BPCIC had become increasingly aware of the many problems with the model for the £B currency, and had started work on thinking about how the organisation could develop a different approach. It was clear that the organisation's mission of creating a more environmentally sustainable, equable and resilient local economy was still relevant, but the method of achieving this through a local currency in the Bristolian context had been shown to be non-viable as a business operation and had not achieved the scale of impact hoped for.

A key question at this point was:

Should the organisation remain focused on local independent businesses, or should it think in broader terms about influencing behaviours amongst both individuals and businesses using some kind of money as a tool?

Business focused ideas included developing the potential for businesses to create their own loyalty points, to reward returning customers with discounts. This could replicate aspects of the original Bristol Pound scheme, by encouraging people to buy from local independent businesses, but give people more reasons to get involved. As there are a range of organisations trying to assist SMEs in the region (including the chamber of commerce, the Federation of Small Businesses, and a range of networking and business support initiatives), it was felt by the team it would make more sense to take a wider focus around behavioural change.

A further concern was that enabling businesses to create incentives to purchase more from their shops could be seen as promoting and encouraging the growth of consumerism, which was at odds with the overall objective of creating an economy in which we live within the planet's boundaries. A modal change in the direction of degrowth rather than just product-

switching brings Bristol Pay to more of a behavioural modification than the product substitution of marketing that Bristol Pound appeared to have been manifesting.

Given these learnings and the difficulty in creating a proposition that would attract the required levels of usage, BPCIC stopped focusing on localising supply-chains and local independent businesses. It began focusing on other ways to encourage reduced consumption, pro-environmental choices, and the creation of social cohesion.

Various key ideas were discussed at this early stage. The first was the use of non-fungible tokens (Majer & Barbosa, 2022; Popescu, 2021), which offered the potential to create digital representations of unique activities or objects, and to track and count these on a distributed ledger thus avoiding the reliance on a single trusted authority to control data, and so allowing a more open monitoring and accounting system.

Another idea was to encourage behaviour change through a reward mechanism. Initial conceptions assumed extrinsic rewards would be the most effective approach, for example rewarding volunteering with discounts at participating businesses, who could in turn promote themselves as having a positive corporate social impact, much in the way Citizen Coin has done in Bradford (T&A Reporters, 2021). However, there were concerns that low-level financially framed incentives could undermine intrinsic motivation to change behaviours.

Research suggests that humans consider things very differently when a reward is stated in financial terms rather than as part of a social interaction (Dawnay & Shah, 2011). Indeed the mention of a financial value was shown to make people less likely to behave in a requested way (Ariely, 2009; Rustichini & Gneezy, 2000). This research furthered the team's conviction that any rewards should not be able to be equated in any way to money through market transactions.

It was felt by the team that one focus for behaviour change could be encouraging people and businesses to reduce their resource footprint, which would entail buying and using less of everything, and reusing things where possible. It was clear that social media was being used to drive demand for new goods and services, driving behaviour towards increased consumption. This view of what was really driving behaviour took the team towards looking at the ISM model of understanding behaviour. It seemed that minor changes to pricing, monetary rewards and penalties were less important in determining how people behaved on a daily basis than how they viewed themselves in relation to friends or people they aspired to be like on social media.

Reputation counters (likes, retweets, content repostings, and numbers of followers) were key currencies used in social media, determining how much social reputation and influence people had. These currencies had no extrinsic purchasing power; rather they were powerful in creating a feeling of social status, rewarding or punishing people by making them feel intrinsically good or bad about themselves and thus influencing individual beliefs and social attitudes.

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The team looked at a variety of apps and products that sought to create positive behaviours. Successful examples include: Fitbits, which encourages people to be more physically active (Kerner & Goodyear, 2017); and Duolingo, which engages people in learning languages (Munday, 2017). In cases such as these, there are points and achievements that encourage habit formation, but these rewards generally do not have utility outside the app.

In the autumn of 2019, the team became aware of the work of Arthur Brock (Brock, 2005; Brock & Harris-Braun, 2011) through a currency design course run by the MetaCurrency Project (Brock, 2018). This approach sees currency not as only a tool for market interaction accounting for flows of financial value, but as a wider tool for measuring and thus making visible any flows of value: 'current-see'. Brock identifies different types of wealth: Tradeable wealth that enables one to exchange and purchase is one type of wealth that is concerned with quantities; whereas rankable wealth enables a qualitative measure. Rankable wealth may be reflected in market pricing, but equally, it may not.

Alongside this, Brock identifies different sorts of capital: Financial capital, natural capital, social capital, knowledge capital, health capital and manufactured capital, amongst others. This approach led the BPCIC team to consider using tokens to make visible values and how they can change over time by offering specific tokens for specific pro-environmental and pro-social choices, such as switching to active transportation (Mueller et al., 2015) or volunteering with community organisations and outlined these ideas in the City Pay White Paper (Finch, 2022). Fundamentally the tokens show creation of value, which may increase, degrade, or remain constant over time.

These token ideas (see Table 1. Bristol Pound Tokenomics) would count different sorts of activities or behaviour changes, and would offer intrinsic rewards, such as improvements to self-esteem; rather than extrinsic rewards, such as discounts on goods and services. Tokens would act differently depending on what they were counting. For example, an Item Token could be created and assigned to an object by any user, and would increase in value each time it was passed on to a new user encouraging re-use, with possible provision of a new asset after a time to the system e.g. a drill after so many uses could be replaced or serviced. These ideas can be stated as protocols for particular types of NFT.

Table 1. Bristol Pound Tokenomics

Token Type	Protocol	Example
Action Token	These are non-transferable, but degrade over time, promoting continued activity. Like demurrage.	Active transportation, regenerative gardening, community volunteering.
Item Token	Tokens represent real world manufactured products. Their value increases with each transfer to a user or each re-use.	Tool sharing, clothes swaps, refillable water-bottles and take-out coffee containers.
Badge	Recognize skills in areas that can improve environmental performance or social cohesion. Like a certificate.	De-escalation training, cooking seasonally from local ingredients, repairing (clothes, appliances etc.).
Counter	Are awarded via a universal budget allocation, with tokens being burned as used. Like a prepaid meter.	Carbon budget. Water use.

Voting	Awarded by groups to educate and activate participation in decision-making by token usage by different cohorts, over time, for different decisions. A tool for monitoring and activation of democracy.	Community decision making. Voter and civic education.

In early 2021, the Dasgupta Review (Dasgupta, 2021) was published. The Review made it clear that the environmental capital of the world needs to be accounted for and valued. Whilst Dasgupta does not specify this valuation should be stated in anything other than financial terms, which is debatable (Costanza et al., 2015), he does recognise market mechanisms have not been sufficient to reverse the degradation of environmental capital – something going-on for over 200 years.

For example, carbon trading has now been in place in Europe since 2005 (Spash, 2010), and yet "Global GHG emissions have continued their steady rise" (Lamb et al., 2021). As finance is a way of valuing things specifically in relation to a market economy, the BPCIC team is interested in the power of NFTs to measure environmental capital itself, rather than a financial proxy of that value. If this approach is to gain traction, there is a need to experiment with non-financial accounting methods, and the team therefore sees the ideas it has been developing around the use of NFTs to measure and count activity without reference to financial equivalents as an important area for research.

In the longer term, the BPCIC team sees the potential of such tokens to create a 'triple bottom line' (Elkington, 2018) accounting method, in which financial accounts can be compared with token accounts that consider a company's impact on environmental, social, and manufactured capitals.

However, it was clear to the team as this thinking emerged that there was a danger of recreating some of the problems from the original £B currency. First, there was a danger of creating a non-viable operation that would remain grant-reliant in perpetuity, which is not an economically sustainable option. Second, the only people likely to join such a token scheme would be people who already saw a value in reducing their resource footprint. It was therefore agreed that a separate market-based operation was needed:

a) to create an income stream

b) to create an easy way to onboard people, by engaging with them in their current daily lives

This led the team to look again at the development of a payment platform.

In general when shopping using a debit or credit card or payment app, money leaves the customer's bank account, which may be at any bank in the network, and money arrives (less a transaction fee) in the merchant's account, generally at a completely different bank. This is an open system, in which any two accounts can transact.

However in such an open system, a variety of third-party services providers are required to create a bridge between the two accounts: the card issuer, the card network provider (e.g.

Visa and Mastercard), the merchant service provider (e.g. Worldpay, Stripe or Zettle), as well as clearing banks.

In a closed-loop system, the payer and recipient both have accounts in the same institution, meaning that there is no reliance on costly third-party services. Once accounts are set up and money loaded on, all transactions within the system are ledger entries between accounts, incurring no additional costs. Payji Ltd (who BPCIC is in talks with) were creating an EMI-regulated solution for closed loop payments. They are keen to create such a system operating within localities that would offer a slightly cheaper payments service for businesses, whilst also creating surpluses (thanks to lower operating costs) that could be used to fund voluntary and community sector organisations. Such a platform would only create significant surpluses by operating at scale.

As such, rather than limit people or businesses that can join in any way, the approach is to make the payment platform as easy to access as possible, and to encourage its use in chain and independent stores. Rather than trying to create a specific economic impact through the payment method as £B did, this payment method seeks only to help fund voluntary and community organisations through surpluses generated from payments, providing an easy value proposition for both individuals and businesses: By using this payment method, you can directly help to support voluntary organisations working in your community.

By creating a simple and widely accessible value proposition, the new platform not only generates funds to support the token-based approach already described, it can also introduce a far wider audience to the token schemes than would be the case without such a value proposition.

There is a further benefit to operating an EMI-based payment platform in terms of addressing digital financial exclusion. In the UK 3% of the adult population were unbanked in 2017 (Ripley & Watmough, 2018). Whilst many are working to safeguard the ability to use cash (Post Office, 2021; Statham et al., 2020; Wolman, 2013), this ignores some of the problems of being trapped in the cash economy.

Firstly, digital exclusion is one of the factors in creating the poverty premium paid by many disadvantaged people (Davies & Collings, 2021), for example paying more for utilities because they cannot pay by direct debit, or being unable to shop around for the cheapest deals online because they cannot pay digitally.

Secondly, with most jobs in the UK paying salaries direct to bank accounts rather than in cash (McLeay et al., 2014), not having control of a bank account means either people are reliant on a third-party processing their monies for them (putting them at risk of financial abuse and with a cost premium (Datta, 2007)), or people being trapped in cash wage jobs which are often either casual, or in the grey economy (resulting in precarious employment situations, unprotected by employment law, and potentially with national insurance contributions not being paid, further impacting on people's long-term access to benefits and pensions).

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Thanks to the very different regulatory environment offered by EMI regulations, it is possible to take a different, proportional approach to Know Your Customer (KYC) based on balance and usage levels, enabling many more people to open an account with access to digital money.

6. Conclusion

BPCIC has shown that, despite having the technical competence to run a community currency over time, the £B failed to bring about the desired ecological change, and this is perhaps generalizable to all the "town pounds" tried in the UK. An alternative is Altcoins and associated tokenization. However, it appears that Bitcoin and similar don't work either – so far. This can be ascribed to frothiness, with the hope that speculative bubbles will burst, current practice might change and a more sober usage follow.

Several projects have already started to experiment with blockchain as a tool for good. We can see this with the positive blockchain (PB) movement. Here there is a range of technologies, holochain, different consensus protocols (e.g. proof of work; proof of stake; proof of authority) and other adjustments and developments from the original cryptographic origins of the blockchain (Nakamoto, 2008). Positive blockchain projects aim to "solve social or environmental issues … and what all PB projects share in common is the aim to positively impact people's life" (PositiveBlockchain.io, 2020).

Such perspectives can help us to develop new sorts of money. In particular, NFTs potentially offer a good solution for currencies that work on principles other than trade and exchange. For example for carbon reduction, it can be truly said that, " Not All Blockchains are Created Equal" (Majer & Barbosa, 2022). NFTs and the associated techbro culture have been rightly criticised (Olson, 2022), yet the design of currencies, bit-tokens rather than bit-coins that operate outside the field of traditional financially driven market economies is an area that is worthy of further action research regardless of the technology used. Tokenomics is just at the beginning.

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Digitalization

Circulation of a digital community currency

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ABSTRACT

Circulation is the characteristic feature of successful currency systems, from community currencies to cryptocurrencies to national currencies. In this paper, we propose a network analysis methodology for studying circulation given a system's digital transaction records. This is applied to Sarafu, a digital community currency active in Kenya over a period that saw considerable economic disruption due to the COVID-19 pandemic. Representing Sarafu as a network of monetary flow among the 40,000 users reveals meaningful patterns at multiple scales. Circulation was highly modular, geographically localized, and occurring among users with diverse livelihoods. Network centrality highlights women's participation, early adopters, and the especially prominent role of community-based financial institutions. These findings have concrete implications for humanitarian and development policy, helping articulate when community currencies might best support interventions in marginalized areas. Overall, networks of monetary flow allow for studying circulation within digital currency systems at a striking level of detail.

Introduction

The circulation of money is generally studied in an abstract sense, for example as the extent to which monetary policy, productivity improvements, supply disruptions, or other shocks affect aggregate indicators of economic output[1–4]. Detailed observation has long been impractical for lack of empirical data. However, modern payment infrastructure is increasingly digital[5], and the circulation of money is leaving real-time records on the servers of financial institutions worldwide. These transaction records offer especially high granularity in time and in space, and open up the possibility of fined-grained data-driven studies of financial ecosystems[6–12]. In this paper we consider the question of how best to study the *circulation* of money as observed in transaction records. We argue that *networks of monetary flow* are a suitable representation for patterns of circulation over a period of time. Our findings show that techniques in network science — in particular walk-based community detection, measures of cyclic structure, network mixing patterns, and walk-based centrality metrics — together capture key aspects of circulation within a real-world currency system. We demonstrate that important practical and theoretical questions around the circulation of money can be studied using networks of monetary flow.

The main focus of this paper is on complementary currencies whose modern implementations produce comprehensive digital records—cases where transaction records are available for an entire currency system. Complementary currencies circulate in parallel to national currencies in that tokens are *not* legal tender, nor necessarily exchangeable for legal tender[13–15]; they are used under mutual agreements that come in many forms, from local community currencies[6,16,17] to global cryptocurrencies[18–20]. Sardex, for example, is a digital complementary currency used among businesses in Sardinia. Digital records of transactions in Sardex have been studied to show that cycle motifs are related to performance and stability of the currency system[21,22]. The full transaction histories of Bitcoin and other cryptocurrencies can be reconstructed from public ledgers[23–25]. Bitcoin transactions reveal a currency system that supports substantial trade outside centralized marketplaces, but where inequality has been increasing over time[19,26]. Sarafu, the currency considered in this work, is a "Community Inclusion Currency" (CIC) that incorporates elements of both community currencies and cryptocurrencies[27].

Digital administrative records of the Sarafu CIC from January 2020 to June 2021 have been published by Grassroots Economics (GE)[28]. GE is a non-profit foundation based in Kenya that operates Sarafu and leads related economic development projects in marginalized and food-insecure areas of the country. What began as several local, physical, community currencies was progressively digitized and then brought together onto a single platform, as Sarafu. The observation period began as this consolidation occurred, at which point Sarafu was available throughout Kenya. Mimicking the well-developed mobile payment infrastructure of the national currency[29–34], each Sarafu account was tied to a Kenyan mobile number and accessible over a mobile interface. An account could be created with an activation code sent to a particular mobile number, then used and managed via a series of simple menus. The resulting digital records became a dataset that includes anonymized account information for tens of thousands of users and records of hundreds of thousands of Sarafu transactions. Previously, the published

dataset has been described in raw form[27] and used in a case study introducing CICs as a modality for humanitarian aid[15].

In the context of community currencies, circulation is a crucial measure of economic impact—these currencies are typically created with the aim to support local economic activity[16,17,21,35]. We detail transaction volumes in Sarafu over time and then study the resulting circulation of Sarafu as a network of monetary flow among around 40,000 regular users. This weighted, directed, time-aggregated network captures the patterns of circulation in intricate detail, allowing us to study what shapes the Sarafu currency system as a whole. Anonymized information on account holders allows us to label each node with a geographic area, livelihood category, registration date, and reported gender. We apply network analysis techniques to the Sarafu flow network to answer three research questions with important implications:

Among whom is Sarafu circulating? The Sarafu user base grew rapidly over the observation period, especially as the COVID-19 pandemic disrupted regular economic activities. We summarize the resulting patterns of circulation using a so-called community detection method developed especially for flow networks. Specifically, the map equation framework and the associated Infomap algorithm[36,37] group nodes into modules that capture as much volume as possible. Since the link weights of the Sarafu flow network reflect observed flows of money, the discovered modules signal sub-populations within which Sarafu was *circulating*. We go on to investigate the composition of these sub-populations.

What network structures support the circulation of Sarafu? Degree disassortativity has been noted in a variety of economic networks[19,38–40] in that high-degree nodes generally transact with low-degree nodes. It has also been noted that network cycles may be key to the 'health' of currency systems and of individual accounts[21]. Indeed, detecting cycles and brokering 'missing' financial connections is seen by private actors as a promising credit clearing and risk management service[22,41]. In a similar vein, Ussher et al.[15] argue that community currencies compare favorably to cash assistance as an economic development intervention because they help establish economic connections that keep money local. We study the network structure underlying the observed circulation of Sarafu using several suitable network analysis techniques. Specifically, network assortativity measures and the density of cycles.

What characterizes the most prominent Sarafu users? We would like to understand patterns in who holds Sarafu accounts that are especially prominent, or perhaps even systematically important. Prominent users are identified by means of a network centrality measure that is directly related to the circulation of Sarafu, as captured by a network of monetary flow. Specifically, weighted PageRank[42] computes a metric that corresponds to the share of funds a given account would control, at any given time, if the observed dynamics were to continue indefinitely. We calibrate this measure against empirical account balances and use it to investigate the account features most associated with prominent users.

Our results indicate that circulation was modular and geographically localized, occurring within particular areas and among users with diverse livelihoods. Moreover, using network analysis, we confirm the intuitive notion that circulation requires cycles. This implies that community currencies can help support specific areas during periods of economic stress, so long as local economic activities are sufficiently diverse and adoption is sufficiently coordinated as to allow cycles to emerge. This has concrete implications for humanitarian policy in marginalized areas, in that rapid deployment may be necessary and impact can be expected to be higher in areas with a mix of economic activities already present. Community currencies also support localized economic development over longer periods of time[13,15,21]. We find that community-based financial institutions, and, in a few cases, faith leaders, are especially prominent among Sarafu users. Furthermore, these local "hubs" play a key structural role in that the network underlying Sarafu is consistently degree-disassortative.

The findings presented in this paper provide a fine-grained understanding of the circulation of Sarafu over a highly dynamic period that includes the arrival of the COVID-19 pandemic to Kenya. Our work demonstrates how networks of monetary flow capture key features of circulation. Moreover, walk-based and cycle-based network analysis are interpretable methods for understanding the underlying currency system. Noteworthy is that the methodology presented in this paper can be applied to study any currency system where digital transaction records are available. Indeed, there appear to be important regularities in the network structure underlying the circulation of money in such systems, and these would be well worth exploring further.

The remainder of this paper is organized as follows. The Data section briefly describes the Sarafu system over this especially tumultuous period. The Results section presents our findings on patterns of circulation, prominent users, and the network structure underlying circulation. We synthesize these contributions and discuss the implications of our findings in the Discussion section. Finally, the Methods section details the data preparation, network analysis measures, and statistical methods used in this study and provides references to facilitate data, code, and software availability.

Data

Sarafu expanded dramatically as the COVID-19 pandemic arrived in Kenya, growing from 8,354 registered accounts in January 2020 to almost 55,000 in June 2021. Figure 1 shows the transaction volumes for each of the complete months over the observation period. Beginning in April 2020 and continuing through the second wave of COVID-19 in Kenya, Sarafu saw transaction volumes almost ten times higher than in February 2020. This dramatic expansion occurred primarily in particular regions, described below, and we see a return towards the baseline in these areas by the end of the observation period. The

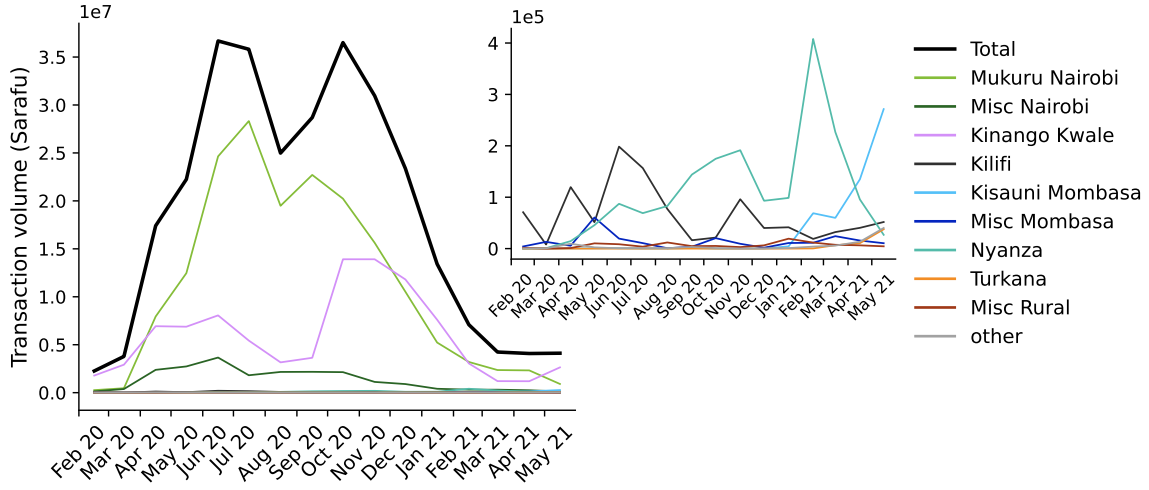

Figure 1. Monthly transaction volumes in total, and in each geographic area (shown at two different scales).

overall pattern is perhaps best explained by the counter-cyclical nature of complementary currencies, which are known to see spikes in usage levels during periods of economic disruption[13,43,44].

The figures in this work employ a consistent color scheme for geographic area. Purple corresponds to *Kinango Kwale*, a rural area where GE has had a substantial presence for many years; this area saw much growth during the COVID-19 pandemic due largely to word of mouth. Light green is *Mukuru Nairobi*, an urban area that was the site of a targeted introduction beginning in March 2020. For details we refer to the Data preparation section. Accounts located elsewhere in *Nairobi* are shown in dark green. In light blue are accounts in *Kisauni Mombasa*, the site of a second introduction beginning in early 2021. Accounts located elsewhere in *Mombasa* are shown in dark blue. *Kilifi*, in dark grey, is the county where GE is headquartered. Users with an unknown location (the largest category within *other*), are in light grey. In Figure 1, *other* closely tracks the remote rural county of *Turkana*, in orange. Teal and red correspond to locations in *Nyanza* county or elsewhere in rural Kenya, respectively.

Results

The Sarafu system supported over 400,000 transactions among more than 40,000 regular accounts between January 2020 and June 2021. This resulted in the circulation of 293.7 million Sarafu, visualized in Figure 2 as a network of monetary flow. The *nodes* are registered accounts, for which we know attributes such as the geographic area, livelihood category, and reported gender of the account holder. An *edge* from one account to another indicates that at least one transaction occurred across that link. The *edge weight* corresponds to the observed monetary flow along an edge, i.e., the total sum of transaction amounts across that link. The Sarafu flow network is a *weighted, directed, time-aggregated network representation* of the total circulation over the observation period, excluding system-run accounts. For details on the construction of the network, we refer to the Data preparation section of Methods. The network visualization employs the same colors for geographic area as does Figure 1, revealing patterns suggestive of modular and geographically localized circulation.

In the remainder of this section, we share findings resulting from network analysis of the Sarafu flow network. The Modular circulation section considers sub-populations within which Sarafu was circulating, and their composition along lines of geographic area and livelihood category. In the Underlying network structure section, we consider the network structure that supports this circulation, including analyses of cyclic density and network mixing patterns. The Prominent Sarafu users section compares relevant network centrality measures and describes the most prominent users of Sarafu.

Modular circulation

To more precisely understand the patterns of circulation present in the Sarafu flow network, we apply an especially suitable community detection method. The map equation[36] is defined in terms of flow networks and the associated Infomap algorithm[37] groups nodes into hierarchical *modules*. Specifically, Infomap assigns nodes to modules (and sub-modules) within which a "random walker" on the network would stay for relatively long periods of time. In our case, the weights on the edges of the Sarafu flow network reflect real, observed flows of Sarafu and so the Infomap algorithm will seek to discover modules that

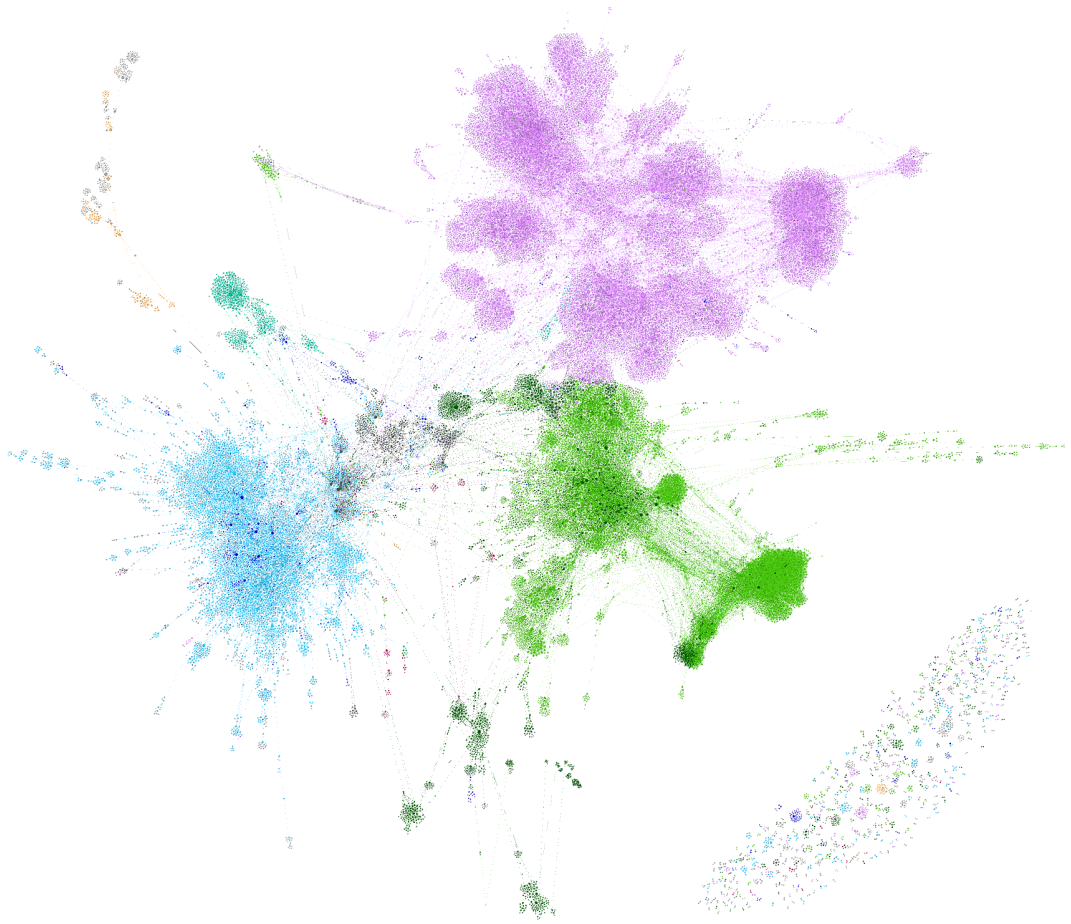

Figure 2. Visualization of the Sarafu flow network. Nodes are colored by the geographic area of the location reported for the account (see Figure 1 for legend), and node size is proportional to the value of unweighted PageRank as computed for that node.

contain especially much transaction volume. This identifies sub-populations within which Sarafu tended to *circulate*. For details about these methods, we refer to the Circulation section.

The Infomap algorithm recovers a hierarchical, nested, modular structure to the Sarafu flow network. The hierarchical structure consists of top-level modules, sub-modules and sub-sub-modules at respectively the first, second and third level of the community hierarchy. Circulation of the Sarafu community currency was highly modular in that activity occurred almost exclusively within distinct sub-populations. At the first hierarchical level, 99.7% of the total transaction volume was contained within the five largest so-called *top-level modules*. Moreover, there are 37 *sub-modules* composed of 100 or more accounts and these contained 96.5% of the total transaction volume. Only a small share of the overall circulation took place between the sub-populations defined at the second hierarchical level, and circulation within these sub-populations itself had a nested, modular structure. Indeed, the 455 *sub-sub-modules* composed of 10 or more accounts capture 80% of the total transaction volume. Altogether, these findings suggest that the circulation of Sarafu was extremely modular over the observed period.

Geographic localization

We investigate the extent to which the distinct sub-populations discovered above correspond to geographic location, as reported in the account dataset described in the Data section. Figure 3 shows the geographic composition of the top-level modules—four of the five map directly onto one of the main areas labeled in the data: *Kinango Kwale*, *Mukuru Nairobi*, *Kisauni Mombasa*, or *Turkana*. Only one of the modules has substantial membership from several regions; its sub-modules are, however, also geographically delineated. This top-level module combines several less prominent localities, including in *Kilifi*, in *Nyanza*, and in two localities elsewhere in *Nairobi*. We conclude that the circulation of Sarafu was geographically localized over the observed period.

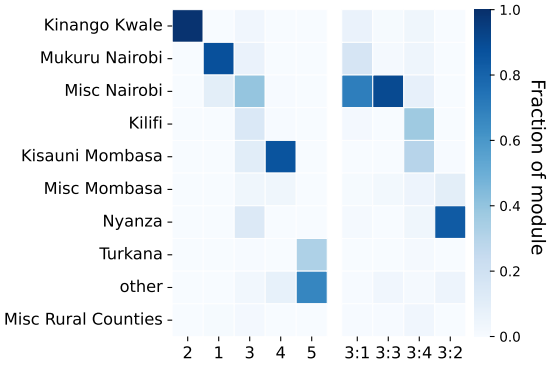

Figure 3. Geographic composition of the five largest top-level modules and relevant numbered sub-modules.

The top-level modules are amalgamations of circulation within sub-modules, which appear to correspond to geographic areas more granular than those labeled in the data. Indeed, raw reported locations were often quite precise and were converted to broader area labels in the anonymization that occurred prior to the publication of the data[27]. Several of the sub-modules highlighted in Figure 3 coincide with areas where early, physical community currencies were operating in the years before Sarafu became all-digital[45]. Within *Kinango Kwale*, moreover, the sub-modules likely correspond to individual rural villages or clusters of villages[15]. Thus, circulation was geographically local, predominantly. We will further consider the sub-populations delineated by the Infomap sub-modules in subsequent analyses.

Diversity of economic activities

Now that we understand the modular structure and geographic localization of circulation, we consider the composition of the localized sub-populations with respect to economic activity. This is of particular interest to practitioners as it helps illustrate *among whom* Sarafu was circulating. There are 14 categories of economic activities into which user-reported livelihoods were grouped, the most common of which are *labour* in urban areas and *farming* in rural areas. Many other users (in both urban and rural areas) report selling *food*, running a *shop*, or providing *transport*.

Most notably, we see a mix of the different economic activities within the largest second-level sub-populations. Figure 4 illustrates the livelihood category given for each account in the 15 largest sub-modules identified by the Infomap algorithm. To give a sense of how this diversity is experienced within sub-populations, we compute and report the view from the average user. The average user participates in a sub-module with around 2000 other users, and of these others, 66% report a category of work that is different from what they themselves report. Little diversity is lost as we consider even finer scales. The average user appears in a sub-sub-module with around 250 other users, 59% of whom do not share their same livelihood category. We conclude that the circulation of Sarafu involves a diversity of economic activities, even at the scale of a single village.

We also see that the composition of the sub-populations using Sarafu is substantively different in urban and rural areas. In Figure 4, the sub-modules where *farming* or *fuel/energy* are prominent are rural and composed of users reporting a location within *Kinango Kwale*, almost exclusively. Those where *labour* is prominent correspond to sub-populations localized primarily in urbal or peri-urban areas including *Mukuru Nairobi*, *Kisauni Mombasa*, and *Kilifi*. The geographic aspect of circulation is further refined by means of the type of geographical area.

Underlying network structure

In this section, we consider the network structure underlying the circulation of Sarafu. Each of the sub-modules considered above in the Modular circulation section is associated with not just a sub-population of 100 or more accounts, but also a sub-network of 100 or more nodes. An (unweighted) edge from one account to another indicates that at least one transaction occurred across that edge. Node degree corresponds to an accounts' number of unique transaction partners, incoming and outgoing, in their same sub-population. In the Cyclic density section we count the cycles present in the sub-networks, relating the presence of cycles to the notion of circulation and the sustainable operation of complementary currency systems. Next, the Structural correlations section quantifies network mixing patterns, relating degree disassortativity to the structural importance of local "hubs" in the sub-networks.

Cyclic density

Network cycles may be key to understanding the conditions under which an area is, or overtime becomes, able to sustain local circulation[15,21,22]. We explore the presence of cycles in the Sarafu sub-networks using k-cycle density[21]. This measure

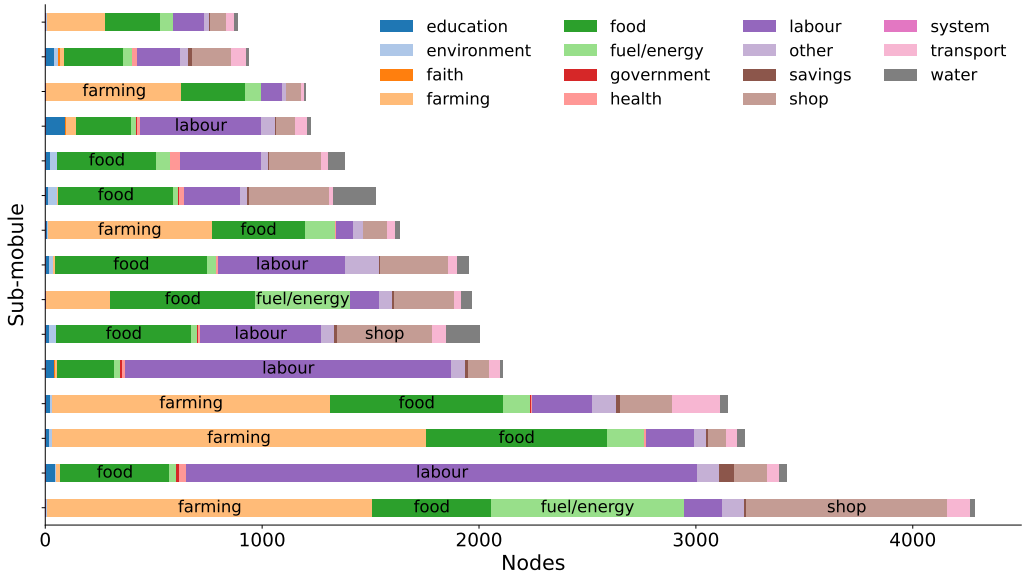

Figure 4. Composition of discovered sub-modules (bars) in terms of user livelihoods (colors, as shown in legend).

quantifies how much higher, on a log scale, is the number of cycles in the empirical network as compared to the expectation from a null model. We use two of the most common null models, as in prior work: Erdős-Rényi (ER) networks and randomized degree-preserving (RD) networks. ER networks have the same number of nodes and edges as the empirical network, but are wired randomly. RD networks preserve the indegree and outdegree sequences. For details we refer to the Network cycles section of Methods.

Figure 5 shows the cycle densities computed for each of the Sarafu sub-networks. The k-cycle density has values mostly in the range from 3 to 6 for cycles of length 2 and 3, indicating that the empirical networks have orders of magnitude more cycles than do the null models. Moreover, the k-cycle density appears to be even higher for longer cycles of length 4 and 5. These findings are closely in line with prior results computed for the Sardex currency in Sardinia[21]. Notably, this is the case even though the currency management practices followed by the two providers are quite distinct[21,27]. Based on these findings, we can conclude that cycles are a prominent network connectivity pattern in the circulation of (community) currencies.

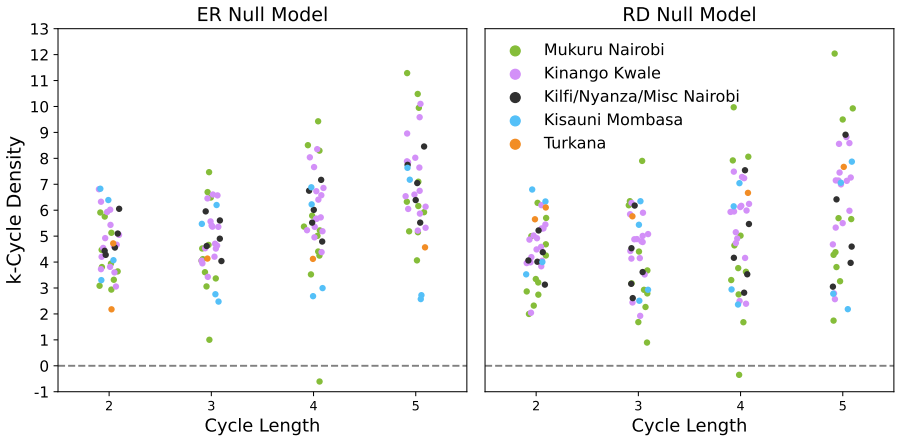

Figure 5. Values of k-cycle density for each sub-module, at different cycle lengths. Points correspond to sub-modules, and are colored based on the dominant geographic area of users placed in the top-level module to which it belongs.

Structural correlations

Degree disassortativity is an expected feature of specifically currency networks[19,40] and of economic networks, more broadly[38,39]. In networks with this property, high-degree nodes generally interact with low-degree nodes, not other high-degree nodes, and local "hubs" play a key structural role. Recall also that Sarafu sub-modules are diverse with respect to the livelihood reported by accounts (Diversity of economic activities section). Here we consider these and other structural correlations that help us better understand the circulation of Sarafu. Since the overall influence of account attributes on the Sarafu flow network is limited by the constraints of geography, and may be heterogeneous across sub-populations, we consider degree and attribute assortativities across the Sarafu sub-networks. For details we refer to the Network mixing patterns section of Methods.

Table 1 reports the average, the median, and the range for each property as computed on the undirected version of each sub-network. We find substantial disassortativity in degree across nearly all sub-networks. As expected, we also find that attribute assortativity is consistently low along the dimension of livelihood category. The consistency of these observations across sub-populations suggests that there may be important regularities in the structural correlations of networks that support the circulation of money.

Table 1. Network statistics and feature assortativity across sub-modules with 100 or more nodes.

	Network Statistics			Assortativity				
	Nodes	Edges	Volume	Business	Gender	Registration	Degree	W. Degree
mean	1021	2636	7.67m	0.032	0.146	0.154	-0.215	-0.066
std	1082	3789	10.83m	0.047	0.188	0.273	0.119	0.143
min	136	170	0.01m	-0.104	-0.081	-0.323	-0.448	-0.428
25%	222	544	0.59m	0.003	0.017	-0.072	-0.265	-0.168
50%	537	1151	2.99m	0.029	0.121	0.147	-0.221	-0.096
75%	1522	3513	11.05m	0.058	0.208	0.322	-0.152	0.012
max	4286	20458	43.64m	0.121	1.000	0.845	0.247	0.269

Correlations with respect to *gender* and *registration date* in the structure of the sub-networks can also be substantial, although these effects are not consistent across sub-populations. Again from Table 1, attribute assortativity on gender is present in about half of the 37 sub-populations and substantial in several. This may be related to the activity of community-based savings and investment groups, where women's participation is high[46,47]. Within Sarafu, such groups provide opportunities to transact assortatively on gender. Gender assortativity in payment networks may also reflect, for instance, gendered economic roles in ways that deserve further study. Strong correlations in registration date also appear in several sub-networks, indicating a cohort effect. For example, during targeted introductions as described in the Data preparation section, groups of users who share latent economic ties would together adopt Sarafu over a relatively short period of time. Correlations by cohort are likely to appear in any digital payment system where adoption and use are voluntary.

Prominent Sarafu users

Local hubs play a key structural role in the circulation of Sarafu, and it is important to understand who takes on such prominent positions. We ask what features are especially consistent among accounts with high network centrality, now across the entire Sarafu flow network. In the section Identifying prominent users we consider an account's number of unique transaction partners, transaction volumes, and additional measures for computing network centrality. Next, the Characterizing prominent users section asks what features of Sarafu accounts are strongly and consistently associated with high network centrality.

Identifying prominent users

As a first step towards understanding prominent Sarafu users, we consider distributions of relevant account statistics. Figure 6 (left) shows smoothed empirical distributions of node degree on a logarithmic scale. We note that values are highly heterogeneous across accounts; the tail of the right-skewed distribution indicates that a small share of accounts has orders of magnitude more unique transaction partners than do most accounts. Transaction volumes into and out of accounts are spread over an even wider range, also exhibiting a "heavy tail". Figure 6 (right) shows smoothed empirical distributions of weighted degree. A relatively small number of account holders spend orders of magnitude more (or less) Sarafu than do the bulk of the users. As expected, the Sarafu flow network has so-called "hubs" in that a small share of nodes are especially prominent.

Figure 7 shows the Pearson correlation between node degree, weighted degree, and the centrality metrics discussed in the Network centrality section in Methods. First we note that degree and weighted degree are not interchangeable, capturing different notions of prominence in the network. Weighted in- and out- degree themselves are exceptionally highly correlated, because accounts must receive large amounts of Sarafu in order to spend large amounts of Sarafu. This empirically confirms the underlying accounting consistency present in networks of monetary flow. The unweighted PageRank algorithm produces a

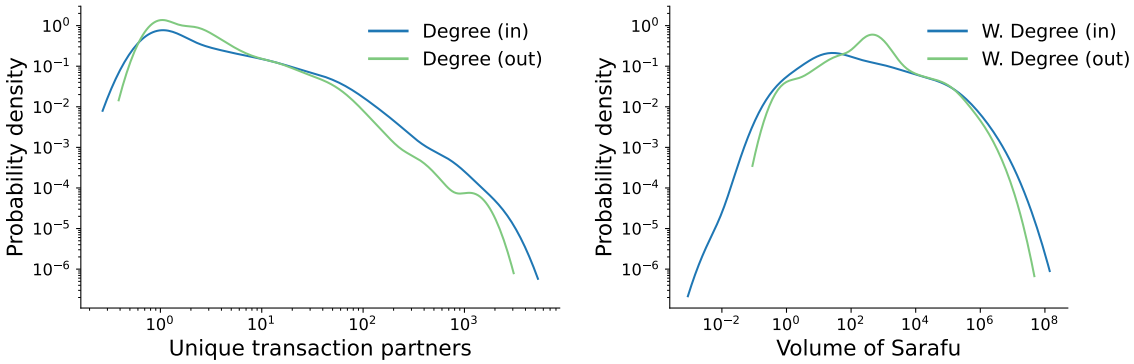

Figure 6. Distribution of degree (left) and weighted degree (right) for the Sarafu flow network. Probability densities are scaled such that nodes with a degree value of zero shrink the distribution total, as zero cannot be plotted on a logarithmic scale.

non-zero value for each node that is correlated with both the in- and out- degree; this makes it a practical centrality metric for downstream tasks involving the unweighted network. Most interesting, weighted PageRank captures something distinct from the in- or out- degree, the weighted in- or out- degree, and unweighted PageRank. Noteworthy is that values of weighted PageRank are interpretable as the share of system funds that the accounts would eventually control, if the observed dynamics were to continue. An empirical calibration to account balances is presented in the Network centrality section in Methods.

Characterizing prominent users

To characterize prominent users of the Sarafu system, we ask what features are especially consistent among accounts with high network centrality. Figure 8 illustrates the regression coefficients on account properties when PageRank and weighted, inflow-adjusted PageRank are used as outcome variables. Ordinary least squares (OLS) provides an estimated statistical contribution for each account feature, while Elastic Net (EN) incorporates regularization to highlight only those features most consistently associated with centrality. For details about this methodology, we refer to the Linear regression section.

PageRank and weighted inflow-adjusted PageRank capture distinct aspects of node importance, but are positively and negatively associated with many of the same account features. Most strongly and consistently associated with high network centrality are accounts held by *savings* groups. Indeed, community-based savings and investment groups are a key feature of local economies in Kenya and of the Sarafu system (as noted in the Data section). The size of this category is quite small, however, containing only 264 accounts. The number of *faith* leaders is even smaller, and some appear to play an especially prominent role in the local circulation supported by this community currency.

The other regression coefficients in Figure 8 reveal additional nuances among some of the largest categories of users. Accounts that were created *prior* to the consolidation of Sarafu, which occurred as the data collection period began, are consistently associated with high network centrality; early adopters show a higher tendency to be prominent users. We also find that account holders reporting their gender as *female* are associated with higher centrality in the Sarafu flow network—this

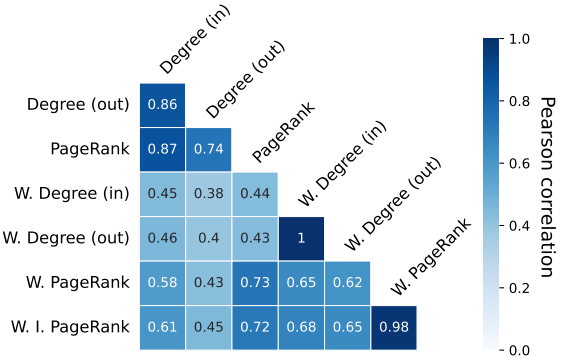

Figure 7. Pearson correlation between values for degree, weighted degree, and centrality metrics.

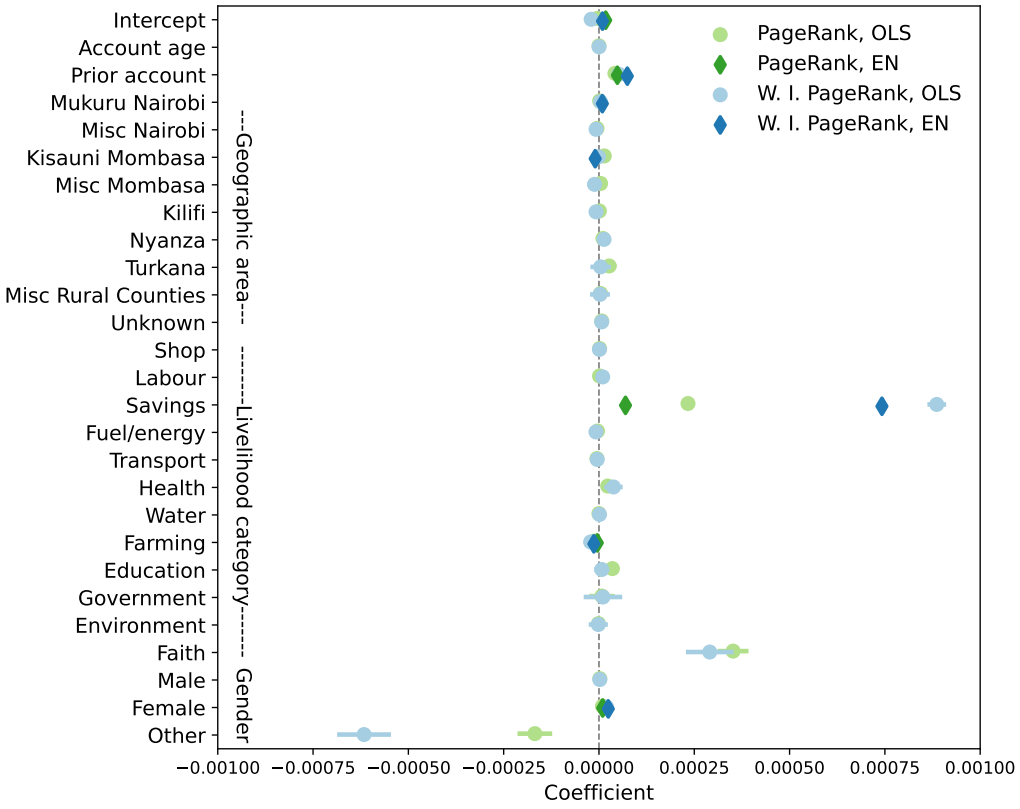

Figure 8. Regression coefficients for linear models fitting account features to centrality measures, using Ordinary least squares (OLS) and Elastic Net (EN). For the three categorical predictors, the reference categories are accounts that report a location in *Kinango Kwale*, report selling *food*, and do not report a gender.

prominence of women is remarkable. In fact, it conforms to qualitative accounts from field studies in Kinango, Kwale that report strong participation of women, and women's leadership, within community-based savings and investment groups that use Sarafu[46]. This has also been noted about savings groups in Kenya, more generally[47]. With respect to geography, recall that *Mukuru Nairobi* and *Kisauni Mombasa* refer to the site of targeted introductions in spring 2020 and early 2021, respectively. Timing appears to have made a substantial difference: the second intervention did not spur large transaction volumes, while those reporting a location within *Mukuru Nairobi* have higher network centrality (on average) than users in *Kinango Kwale* (the reference category). Perhaps most interestingly, *farming* is associated with lower centrality than other reported economic activities. Non-farming activities (e.g. selling *food*, running a *shop*, or providing *labour*) appear to be "central" to local economies even in areas of rural Kenya, such as *Kinango Kwale*, that rely heavily on subsistence agriculture.

Discussion

With respect to the circulation of money, this work has demonstrated how a network approach can unveil meaningful patterns and extract relevant insights from individual transaction records. Coinciding with the arrival of the COVID-19 pandemic to Kenya, the Sarafu community currency saw dramatic growth in its user base and accommodated large spikes in transaction volumes. We find that Sarafu remained a community currency wherein circulation was very modular, happening predominantly within distinct sub-populations constrained to a large extent by geography. Circulation within these localized sub-populations occurred among users with diverse livelihoods over networks with many short cycles. The underlying sub-networks are also consistently disassortative, indicating that local "hubs" play a key structural role in the circulation of Sarafu. Savings and investment groups, and perhaps other community-based institutions, appear to take on these prominent positions in the underlying network.

Our results shed new light on the conditions under which community currencies might form part of successful humanitarian or development interventions. In response to acute economic stress, rapid deployment appears to be possible in areas where local economic activities are already diverse. It may be that coordinated adoption helps to quickly establish the cycles needed

for circulation to take hold. Over longer periods of time, and in more peripheral areas, community currencies support economic development to the extent that they encourage diverse productive activities and strengthen short, local supply chains that keep money within a community[15]. Practically speaking, it may be possible to identify "missing links" in local economic or financial networks such that policymakers and organizers might intervene to close cycles by brokering among local businesses[22,41]. Our findings complement and corroborate a growing body of work informing policy on alternative interventions in marginalized areas[15,48–51].

Methodologically, our conclusions demonstrate the explanatory power of representing the circulation of money as a network of monetary flow. Walk-based methods applied to such networks, specifically PageRank and Infomap, produce readily interpretable results that can provide clear answers to context-rich research questions about currency systems. Notably, these methods rely on scalable algorithms meaning that our approach can be applied to study sizeable currency systems where transaction data is recorded in digital form. This includes other community currencies[6,16,17,21] as well as major global cryptocurrencies[19,20,26,40]. Recent methodological advances[10,52] promise to extend applicability also to payment systems that are not themselves full currency systems, such as mobile money systems[10,53,54], large value payment systems[55–61], major banks[12,62–64], and, in an exciting development, centralized national payment infrastructures[65–67] or central bank digital currencies[68]. Modern economic infrastructure makes detailed observation possible, and the circulation of money can be studied as (interconnected) networks of monetary flow.

Finally, the structural features we identify in the Sarafu network—degree disassortativity and an elevated cycle density—are likely to be general features of the economic networks underlying currency systems. Indeed, degree disassortativity has been found across many economic networks[19,38–40]. And our results regarding the presence of cycles are closely in line with prior analysis of the Sardex currency system[21]. This is despite considerable contextual differences. Kenya and Sardinia differ in their level of economic development, Sardex is aimed at businesses whereas Sarafu is aimed at individuals, and pandemic times are certainly different from regular times. Moreover, the two currency systems are operated differently[21,27]. There appear to be important network-structural regularities underlying the circulation of money, which deserve to be further explored across currency systems large and small.

Methods

The Data preparation section provides a detailed description of the portion of the raw Sarafu data used in constructing our timeseries and our network of monetary flow, plus three peculiarities of the Sarafu currency system that are of relevance to the implementation or interpretation of our analyses. Network analysis methods are used to quantitatively analyze the Sarafu flow network. The Circulation section articulates how the map equation framework captures and quantifies the circulation of money given a network of monetary flow. The Network centrality section describes walk-based measures of network centrality for characterizing prominent users. The Network cycles and Network mixing patterns sections introduce cyclic density and assortativity as tools to analyse the structure of the underlying, unweighted network.

Data preparation

The Sarafu CIC data[28] includes a transaction dataset and an account dataset collected from January 25th, 2020 to June 15th 2021. The raw form of this data has previously been described in detail[27]. The transaction records are labeled with a transaction type, and we consider the STANDARD transactions. Figure 1 shows the total volume of such transactions for each complete month. Note that the value of one Sarafu was understood by users to be about that of a Kenyan Shilling, though actual exchange was facilitated only in very limited instances. The Sarafu flow network is constructed from the STANDARD transactions that occurred within the Sarafu system over the observation period. Basic network statistics are shown in Table 2. As noted in the main text, the *nodes* are registered accounts, for which the account dataset includes relevant account features (detailed below). An *edge* from one account to another indicates that at least one STANDARD transaction occurred across that link. The *edge weight* corresponds to the total sum of all STANDARD transaction amounts across that link. Then, system-run accounts are filtered out from the Sarafu flow network. Regular accounts who neither sent nor received even a single STANDARD transaction from another regular account are isolates, which we also exclude from the network. Note that the giant connected component (GCC) encompasses nearly all the nodes, meaning that the majority of users are indirectly connected through their transactions.

Account features. The account dataset includes the registration date and reported gender of the account holder as well as categorical labels derived from reported information on home location and livelihood. Mattsson, Criscione, & Ruddick[27] provide a descriptive overview of each account feature. Notably, each geographic area is a combination of user-reported localities that could be quite precise. Ussher et al.[15] present an overview of the user-reported work activities that make up the livelihood categories. System-run accounts are those labeled with *system* in place of the node attribute indicating the user's livelihood, or assigned a formal role as an ADMIN or VENDOR account.

	Nodes	Edges	Transactions	Volume (Sarafu)
STANDARD transactions	40,767	146,615	422,721	297.0 million
Sarafu flow network	40,657	145,661	421,329	293.7 million
GCC	38,653	143,724	418,675	293.4 million

Table 2. Basic statistics for the network of aggregated STANDARD transactions, the Sarafu flow network, and its giant connected component (GCC).

Savings & investment groups. Community-based savings and investment groups are common in Kenya[69,70] and a key feature of many localities that use Sarafu, specifically[15,45]. Several hundreds of so-called "chamas" are present in the data, many with the label *savings* in place of the node attribute indicating the user's livelihood. For a time, Sarafu operator Grassroots Economics also had a program whereby field staff would verify the operation of community-based groups and provide additional support to verified chamas[27]. Notably, verified groups were conduits for development initiatives and humanitarian aid on several occasions. Some of these initiatives involved payments made to system-run accounts, in Sarafu, in exchange for donated food, items, or Kenyan Shillings.

Targeted introductions. There were two so-called targeted introductions during the observation period, conducted by the Kenyan Red Cross in collaboration with Grassroots Economics[27]. These consisted of outreach efforts and training programs in specific areas. The Mukuru kwa Njenga slum in Nairobi was the site of the first; educational and outreach programs began in April 2020. Soon thereafter, this intervention was scaled up in response to the COVID-19 pandemic and related economic disruptions. Again, community currencies tend to gain in popularity during times of economic and financial crisis[13,43,44]. A second Red Cross intervention began in in Kisauni, Mombasa in early 2021. This resulted in a wave of account creations[27] and rising activity by accounts with location *Kisauni Mombasa*[15]. However, as we can see in Figure 1, overall transaction volumes did not rise as dramatically during this targeted introduction, as they did during the first.

Currency creation. The digital payment system, as a whole, saw inflows when new units of Sarafu were created. For instance, newly-created accounts would receive an initial disbursement of 400 Sarafu, later reduced to 50 Sarafu. New users could receive an additional sum if and when they verified their account information with staff at the non-profit currency operator Grassroots Economics. Existing users could also receive newly created funds, such as in reward for transaction activity and as bonus for referring others. These and other non-STANDARD inflows are summarized as an aggregated value in the account dataset. We refer to prior work for a full account of currency management and system administration over the data collection period[27].

Circulation

To study circulation we turn to the map equation framework[36] and the associated Infomap algorithm[37]. This is an approach based on computations involving a walk process over a given network, which is relevant in that financial transactions describe a real-world walk process[10]. Infomap takes a weighted, directed network as input and outputs a hierarchical mapping of nodes grouped into discovered *modules*. This grouping is done via computational optimization. Specifically, the map equation defines a notion of entropy whose value is higher the more of the flow over the given network occurs between rather than within modules. The Infomap algorithm exploits meso-scale network structure to minimize that value, grouping nodes with much flow among themselves (and little outside). These are discovered sub-populations among whom a "random walker" would tend to stay for relatively long. We refer to top-level modules, sub-modules and sub-sub-modules at respectively the first, second and third level of the discovered hierarchy. The composition of these sub-populations can then be understood by means of an approach where we quantify their heterogeneity along dimensions of geography, livelihood, and gender, i.e., the node attributes. Implementation details for running Infomap and analyzing the resulting module mapping are included in Supplementary File 2.

Network cycles

To describe the network connectivity patterns underlying the circulation of Sarafu, we consider cycles. A *cycle* is a simple path starting and ending at the same node. In the context of complementary currencies, cycles ensure the flow of liquidity throughout the system. For cycles to occur, users must be willing to both spend and earn in complementary currency. Following this observation, we analyze cyclic structures in the Sarafu network using k-cycle density[21]. The measure of k-cycle density is defined as the logarithm of the ratio between the number of cycles of length k detected in an empirical network and the number expected from a relevant null model. Equation 1 reproduces the definition of the k-cycle density for an empirical network G and the chosen null model for G, G_{null}.

$$C_k(G) = \log\left(\frac{|P_k(G)|}{\mathbb{E}\left(|P_k(G_{null})|\right)}\right) \tag{1}$$

where $P_k(G)$ is the set of cycles of length k for the network G and $|P_k(G)|$ is its cardinality, that is, the number of unique cycles of length k in the network G. We use $\mathbb{E}$ to denote an expected value. Hence, $\mathbb{E}(|P_k(G_{null})|)$ is the expected number of cycles of length k for the chosen null model for G, G_{null}.

We consider two common null models: Erdős-Rényi (ER) networks and randomized degree-preserving (RD) networks. ER networks have the same number of nodes and edges as the empirical network, but are wired randomly. RD networks preserve the indegree and outdegree sequences of empirical network, but instead has edges assigned to link endpoints randomly.

The cycle density is computed separately for each sub-module identified by the Infomap algorithm described in the Circulation section. Directed cycles are detected and counted using an existing approach[71]. This is done for each empirical sub-network, and for ER graphs generated with the number of nodes and edges of the empirical sub-network. We use 30 realizations, and the expected number of cycles in the ER null model is the average over these realizations. As in prior work, the expected number of cycles in the RD null model (for each sub-network) is computed analytically[21,72]. The k-cycle density is computed using cycles of length 2, 3, 4, and 5. An implementation is provided in Supplementary Files 4 and 5.

Network mixing patterns

To characterize the mixing patterns underlying the network structure of the Sarafu community currency, we consider degree and attribute assortativity[73,74]. Values are computed separately for each sub-network delineated by the sub-modules identified by the Infomap algorithm described in the Circulation section. The categorical attribute assorativity is calculated along dimensions of livelihood category and reported gender, using the undirected version of the networks. These measures compare the number of links between accounts with the same livelihood or gender to that which would be expected at random, and can range from -1 to 1. A value of 0 corresponds to random expectation; a value of 1 corresponds to a network where transactions only occurred between accounts with the same attribute value. When there is no variation within a sub-population, the sub-network is given an assortativity value of 1. Similarly, we calculate the numerical attribute assorativity to quantify mixing patterns with respect to registration date, in-degree, and out-degree. Implementation details are reported in Supplementary File 2.

Network centrality

To characterize prominent users of Sarafu, we employ network centrality measures on the Sarafu flow network. Purely structural node-based metrics such as degree and weighted degree correspond to straightforward statistics about accounts. We also use walk-based methods for node centrality as these are especially interpretable with respect to monetary flow; the well-known PageRank algorithm is flexible and computationally tractable. These centrality measures are computed for our network, and then interpreted in the context of node attributes of the account-holders using linear regression. This lets us characterize prominent users without highlighting individual account holders, which is neither our goal nor desirable for privacy reasons (see the Data availability section). Below, we briefly discuss each employed measure.

Indegree and outdegree in the Sarafu flow network correspond to an account's number of unique incoming and outgoing transaction partners, respectively, over the observation period. It is possible for nodes to have zero indegree *or* outdegree, but accounts with neither incoming nor outgoing transaction partners would be isolates and hence do not appear in the network.

Weighted indegree and weighted outdegree in the Sarafu flow network correspond to total transaction volumes into and out of accounts over the observation period.

PageRank is an algorithm that produces a walk-based metric for node centrality given a directed network[6,42]. The obtained centrality values approximate the probability of finding a random walker at a given node at any given moment. More specifically, PageRank computes the stationary probability of a random walk process with restarts on a given network. A single parameter α is used to control the propensity for the simulated walkers to restart. An α value of 0.85 is the long-established default, meaning that 15% of times a random walker will restart rather than follow an out-link from the node where it currently resides. By default, restarts are uniformly random across the nodes. However, it is also possible to specify the probability of restarting at any particular node using a so-called personalization vector.

Weighted PageRank is an analogous centrality metric for weighted, directed networks. Over a weighted network, the random walkers choose among available out-links in proportion to their edge weights. These are flows of money, in our case, and so the stationary probability then corresponds to the share of the total balance held by each account at equilibrium. This is especially applicable in a currency system context, since it means that the values obtained by the Weighted PageRank algorithm are interpretable as the share of system funds that an account would eventually control if observed dynamics continued. Within this intuition, **Weighted Inflow-adjusted PageRank** employs a personalization vector to better capture idiosyncratic patterns of currency creation; real-world currency systems may be poorly represented by the default assumption of uniformly random restarts. Recall from the Data preparation section that Sarafu users could receive disbursements and rewards in addition to inflows from regular transactions. We use the aggregated values of non-STANDARD inflows, available in the account dataset, to set the PageRank personalization vector. The simulated random walk process is then constrained to reproduce the observed pattern of currency creation, on average.

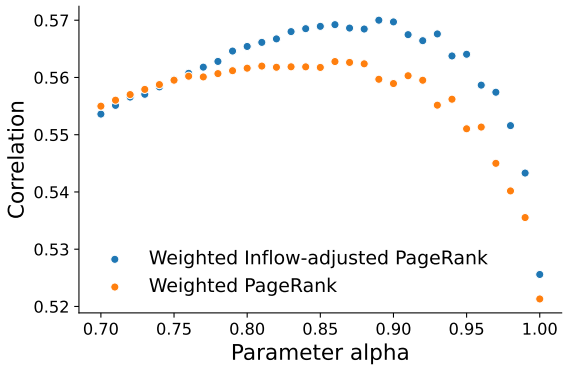

Figure 9. Pearson correlation of Weighted and Weighted Inflow-adjusted PageRank with final account balances.

Empirical calibration

Running the Weighted PageRank algorithm requires specifying the aforementioned parameter α. We would like to understand whether this parameter affects the suitability of these values as a centrality measure for networks of monetary flow. Recall that Weighted PageRank extrapolates the observed patterns of circulation towards a future where an equilibrium is reached. This means that the output values can be understood as a prediction for hypothetical future account balances (as a fraction of the total balance). While we cannot expect such strong modeling assumptions to produce especially accurate estimates, it is nonetheless instructive to compare to empirical account balances. In particular, we can determine whether this centrality metric is sensitive to α and whether modeling non-random currency creation, via the PageRank personalization vector, matters for this particular real-world system.

We consider the correlation of our centrality metrics computed on the Sarafu flow network with Sarafu balances observed at the time of data collection on June 15th, 2021. Figure 9 plots the correlation between these final balances and the values given by the Weighted PageRank algorithm, with and without adjusting the simulated walk process to account for currency creation. The resulting correlations are at most $R^2 = 0.57$ and $R^2 = 0.56$, respectively. Taking the perspective that Weighted PageRank estimates hypothetical future account balances, it is encouraging to note that these values correlate more closely with final balances than do the in- or out- degree ($R^2 = 0.28$, $R^2 = 0.21$), and the weighted in- or out- degree ($R^2 = 0.52$, $R^2 = 0.47$). Moreover, both versions of Weighted PageRank produce values that are consistently correlated with final balances over a wide range of parameter values that includes the long-established default ($\alpha = 0.85$); our centrality metrics are not overly sensitive to the propensity for restarts. We conclude that Weighted PageRank, especially Weighted Inflow-adjusted PageRank, is a highly suitable centrality metric for downstream analyses of networks of monetary flow.

Linear regression

To assess what recorded features of the account holders associate with higher prominence, as measured by network centrality, we use linear regression. Ordinary least squares (OLS) is used to fit a linear model to an outcome, in our case a network centrality measure, providing an estimated contribution for each input feature[75]. Regularization is a fitting technique that introduces a penalty term to the optimization limiting the number of regressors and/or their magnitude[76]. So-called Elastic Net (EN) regularization, as we use it, penalizes the number of regressors and their magnitude equally. The penalty weight is selected using five-fold cross validation, just before the point where additional features begin entering the model without qualitatively improving the statistical fit. Further implementation details are noted in Supplementary File 3, alongside the code that replicates the analysis.

Data availability

The dataset analyzed in this study is available via the UK Data Service[28] under the UK Data Service End User License, which stipulates suitable data-privacy protections. An extensive description of the raw data is available[27].

Software availability

All software used in this study are available under an open-source licence:

- `infomap v1.6.0`[77]
- `networkx v2.6.3`[78]

- `netdiffuseR v1.22.3`[79]
- `sna v2.6`[80]
- `statsmodels v0.13.2`[81]
- `seaborn v0.11.2`[82]
- `matplotlib v3.5.2`[83]
- `pandas v1.4.2`[84]

Code availability

The code required to reproduce each analysis is included the Supplementary Information:

- **Supplementary File 1** is a Jupyter Notebook containing the code to construct the network from the raw data.
- **Supplementary File 2** is a Jupyter Notebook containing the code to reproduce the analysis in the Modular circulation and Structural correlations sections.
- **Supplementary File 3** is a Jupyter Notebook containing the code to reproduce the analysis in the Prominent Sarafu users section.
- **Supplementary File 4** is an R Notebook containing the code to reproduce the analysis in the Cyclic density section.
- **Supplementary File 5** is a Jupyter Notebook containing the code to reproduce the figures in the Cyclic density section.
- **Supplementary File 6** is a high-resolution version of Figure 2.

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Author contributions statement

C.M. and F.W.T. developed the methods. C.M. conducted the research and drafted the initial manuscript. T.C. performed the cycle analysis and drafted the corresponding sections. All authors contributed to the final manuscript.

Additional information

The authors declare no competing interests.

Centralizing or sharing the digital community currencies governances? Proposing ways of thinking DCCs from the Mumbuca case

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ABSTRACT: This work deals with the implications of different ways of digitalizing social or community currencies (CCs) in Brazil. It starts from the following tension, verbalized by representatives of Brazilian Community Development Banks (CDBs): on the one hand, the digitalization of CCs would maintain "the same idea, [only] in different ways"; on the other hand, its governance would be nowadays "the most complex issue". The investigation examines this tension in Mumbuca Digital CC (DCC) case (Maricá, state of Rio de Janeiro), one of the greatest world's DCC experiences (considering the number of financial resources involved) and part of the Brazilian CDBs Network - which has brought together around 150 experiences since 1998. We collected data from 2015 to 2021, from semi-structured interviews, fieldnotes from an ethnographic research approach, and the Mumbuca DCC system administrative interface as well. The article advances in understanding DCCs: besides demonstrating that their materialities are inseparable from the "social arrangements" around them, it adds new elements to previous researches, proposing an analysis framework for different sociotechnical governance dimensions of DCC (GDs). Precisely, using tools and concepts from Actor Network Theory (such as translation, symmetry, networks, sociogram and technogram), we begin describing moments of Mumbuca DCC, each one corresponding to different versions of CDBs principles and to different sociotechnical governance configurations. Finally, we present a framework that brings together new DCC governance dimensions (like "management" dimension and "economic appropriations" involved) dialoguing with previous investigations GDs ("requirements", "data" and "source code" of a DCC), and classifying each one as "Centralized" (meaning strong state / private company presence) or "Shared" (strong self-management / community approach).

Introduction

This work deals with the implications problem of different ways of digitalizing the so-called social or community currencies (CCs) in Brazil, considering as reference the practices and the principles of the Community Banks of Development (CDBs). In this work, we dialogue with a vision of currencies as constitutive of society and as a common (Dissaux, Fare 2017), and additionally we seek to associate the reflection, already well consolidated by different studies in the Science and Technology Studies (STS) field, which technological issues are not separated entities from the political-social world. The problem presented is considered decisive by the Brazilian CDBs themselves, as well as it matters for different knowledge communities, related to digital currencies, complementary currencies (Siqueira, Diniz, Pozzebon 2020; Faria, Severo, Cukierman, Diniz 2020; Dissaux, Fare 2017; Blanc 2011; Théret, Zanabria 2007), democracy (Yates, Bakker 2014) and development (Walsham 2017). To analyze the digitalization of Brazilian CCs implications, the starting point taken is the following tension, concerning two statements assumed by CDBs representatives: community banks would have remained with “the same idea, [only] in different ways”, but the digital community currency (DCC) platform governance used by banks is “today the most complex issue” – both assumed by CDBs representatives. The work examines this tension in Mumbuca DCC case (city of Maricá, state of Rio de Janeiro), one of the greatest world’s DCC experiences (considering the amount of financial resources involved) and part of the Brazilian CDBs Network - which brings together more than 100 experiences. The authors collected data from 2015 to 2021 through semi-structured interviews, materials provided by Mumbuca CDB, data access at the digital platforms involved, and adopting an ethnographic research approach and organizing discussions with CDBs representatives as well.

The article advances on DCCs understanding, and particularly demonstrates the materiality of the digital community currency is inseparable from the “social arrangement” around it. A point “some way surprising in relation to theory or to common sense” (Burrel, Toyama 2009, 87), not only for the “popular knowledge community” around the CDBs, but also for some academic approaches in CCs knowledge community. We do so by discussing how some elements of the discourse of the community development banks (practices of autonomy,

proximity, and financial sustainability (Faria 2018)) were reconfigured, to a certain extent, during the CCs digitalization process. As a result, also considering the CDB principle of economic democracy, we propose what we nominated the five “sociotechnical governance of DCCs” dimensions: their requirements, data, codes, the platforms management, and their economic appropriation.

The article is organized as follows: initially, methodological options adopted in approaching the case in study are presented. In the second section, we address CDBs principles and practices discussed here (and captured from our field work), as well as some of the partnership first effects with Maricá local government on them. Then, we emphasize the scale effects required to implement the DCC Mumbuca, and the decision to use the magnetic cards materiality as well. The following section narrates the E-dinheiro platform entrance (which stands for “electronic money”, also “it is money”) on the network, and some of its consequences. Next, we discuss the inseparability between "technical aspects" and "social aspects" (precisely among the practices of the CDBs) in each DCC Mumbuca configuration, and finally present the “sociotechnical governance of DCCs” five dimensions. The discussion is supported by the sociogram/technogram approach (Latour 1998), in dialogue with the notions of discourse (Edwards 1996) and DCCs governance (Diniz, Siqueira and Heck 2019).

Methodological approach

This work dialogues with the notion of local / emergent approaches (Avgerou 2008), in an effort to seek developing concepts and knowledge regarding the organizations under study. Thus, it aims to address of one of the problems in the ICT4D (Information and Communication Technologies for Development) field, according to Qureshi (2015, 1), namely the “ICT4D researchers do not engage closely with the users of their research findings thus disconnecting findings from real-world issues”. In this way, research accuracy is achieved through “closeness of the researcher to the phenomenon under study - with the strength of claims of what is directly observed trumping second-hand reports” (Burrel, Toyama 2009, 84).

This engaged approach considers an openness regarding the categories that emerge from the field, as we can see throughout the text. In the case studied here, we use data collected from 2015 to 2021. It includes semi-structured interviews, specifically in 2015 and 2016i. Data collection also considered materials provided by the Mumbuca CDB (2016), as well as Mumbuca E-dinheiro DCC data, accessed through the administrative interface system (2018-2019)ii. Additionally, to achieve a "closeness of the researcher to the phenomenon under study" (Burrel, Toyama 2009, 84), an ethnographic research approach (which generated field notes) was also used, thusly producing a more detailed description of the referred Mumbuca CDB culture. It relied on immersive observations about Banco Mumbuca (in Maricá, from 2015 to 2016), for six monthsiii. Finally, a Banco Palmas Coordinator took part in a debate at the Esocite.BRiv meeting in 2021, presenting the E-dinheiro platform[v] experience.

To analyze our study object, we looked for approaches which would allow us to carefully discuss this supposed separation between "social aspects" and "technical aspects". Here we emphasize contributions related to ICT4Ds and STS (Science and Technology) fields, such as the Actor Network Theory (ANT), considering "the constructions of sciences and technologies [are analyzed] as phenomena in which the 'social' and the 'technical' are inseparably intertwined in a seamless network" (Marques 2003, 678). Precisely regarding to ANT, we use translation, symmetry, networks, sociogram and technogram concepts. As highlighted by Callon (1986, 18-19), "the notion of translation emphasizes the continuity of the displacements and transformations which occur in this story: displacements of goals and interests, and also, displacements of devices, human beings (…). To translate is to displace (…). Translation is the mechanism by which the social and natural worlds progressively take form". We use translation to narrate the facts (such as CDBs methodology) and artifacts (such as digital community currency) displacement, from which we can understand as its origin (Banco Palmas) to the different stabilizations of Mumbuca network.

In this approach, the symmetry concept is also fundamental: seeking to include non-humans and their agency, for ANT not only people do act, but also software, protocols, computers, the Internet, and other technologies do act (in the sense of making difference), e.g., when performing a currency functions. In Bruno Latour's terminology (1998), if we want (albeit

provisionally) to separate a network into technical characteristics (technogram) and social characteristics (sociogram), the analysis of an artifact technogram would provide clues to the sociogram that makes up its network (Faria 2010), and vice versa, as shown by figure 1.

Despite some critics regarding this approach - such as “paying little attention to broader social structures that influence the local”, or offering “no view, in itself, of the meaning of the term development” (Walsham 2017, 4) –, we consider that ANT seems adequate in this case. Further the reasons already explained, ANT is a research approach that promotes a cross disciplinary perspective on the DCCs topic, something relevant to ICT4D field, according to Walsham (2017)[vi].

Construction of autonomy of the Mumbuca CDB

Structured from local associative dynamics, CDBs rely on a series of tools to generate and expand income in the territory. With this purpose, four central action axes are articulated in its intervention process: (1) solidarity credit fund; (2) local current social currency; (3) fairs of local producers; and (4) training in solidarity economy. CDBs invention has gained relative scale since its first experience, the Banco Palmas (2000), and has been spread over more than one hundred of them in Brazil. It has achieved the status of a “social technology”, which may be replicated in different contexts (Brasil 2012), or which some call “frugal innovation” (Radojevic, Peerally 2016). More recently, especially since 2013, Brazilian CDBs have been promoting their community currencies digitalization, in a context particularly fostered by Brazilian legislation for electronic payments (eg. law 12865/2013 (Faria 2018)).

Mumbuca DCC was based on the Banco Palmas model (where one CC is worth one Real, Brazilian national currency) and was initially proposed by the local City Hall[vii]. It circulated around two million Reais per month (backed by Reais, the national currency) from 2015 until 2019 (Faria et al. 2020), which makes Mumbuca the Brazilian community currency with the greatest circulation volume. Mumbuca DCC has been implemented by different materiality forms: technological artifacts, at the first moment, which were like those usual electronic card networks, rather than paper money, and lately a digital application for mobile devices “E-dinheiro” - the platform currently under implementation by the CDBs Network community

banks. Through the “Mumbuca card”, from 2013 on, 14,000 low-income families in Maricá (RJ) started receiving monthly M$ 84.00 (eighty-four Mumbucas, eighty-four Reais, or around US$15, fifteen dollars) to be used at the local commerce, configuring the start of a minimum income program financed by the town government.

We propose the notion of discourse to deal with CCs materiality changes. In the historian Paul Edwards’ (1996, 31) perspective, a discourse is “a self-elaborating 'heterogeneous ensemble' that combines techniques and technologies, metaphors, language, practices, and fragments of other discourses around a support or supports”. This concept is useful to exam the extent to which changes in the support of a speech (in this case, the community currency on “paper-money”, on a magnetic card or on a mobile application) is also related to other characteristics of this speech. Faria (2018) highlights fundamental elements that constitute the community development banks discourse: autonomy, proximity, financial sustainability, economic democracies, community mobilizations and mediations. In this article we will focus on the first four practices, and in their reconfigurations observed on the transformation of the paper-money (as a CC) into other supports.

Consolidation traces of the proximity and autonomy notions are found in the 1st Brazilian Thematic Conference of Solidarity Finance, which formalized the “solidarity finance practices are distinguished from other economic organization forms by their initiatives self-managed character. It because the community is autonomously responsible for such practices management; […] Solidarity finance practices are distinguished from other economic organization forms, as they work according to a proximity finance logic. In it, human relations, personal contact, and social mediation (based on values such as trust, loyalty, and solidarity) are exchange relations structuring” (Brasil 2012, 180).

The initial umbilical relationship between the bank and the municipality of Maricá (which instituted its own legislation for BCD operation) constituted an important difference compared to the original proposal by Banco Palmas, especially concerning the population autonomy idea involved regarding governments. We are dealing with an experience that, on one hand, injects millions of Reais per month into the local economy using a local currency; but on the

other hand, it embodies the dependence of a partnership governed by a specific agreement between the Maricá government and Banco Palmas.

Over this period (from 2013 to 2017)[viii], Banco Mumbuca was not able to use some of the fundamental tools of CDBs due to a limit imposed by the local government: its DCC only circulated among grant beneficiaries. In that digital version, Mumbuca was limited to just “one spin”: after the beneficiary made his purchase at a local store, the bank deposited the corresponding amount, in Reais, into the merchant’s account. Hence, despite having a relatively high resources volume, the currency circulation was interrupted when the beneficiary shop.

This evident prominence of the City Hall (during that period) could also be noticed in the tasks division between the community bank and the government. Usually, the benefit candidates listened from the CDBs attendants: “do you know where the City Hall is?”, which indicates that the bank had no autonomy to solve that issue. However, the limited local autonomy was not only related to the link between the community bank and the local government. Paradoxically, it was possible to notice the constitution of a new center-periphery relationship: in Maricá, CDB members were then Banco Palmas employees. Despite the wish expressed by Banco Palmas coordinator for an autonomous local entity, what we experienced in Maricá's CDB first years daily life was a Banco Palmas centrality. This relative centrality could be noticed both in procedures terms - as research authorizations - and when someone mentioned the bank name: “you may go over there, at Banco Palmas”, or “good morning, Banco Palmas” were phases commonly heard in the period experienced in Maricá, either at the City Hall or at the community bank itself.

Thus, Brazilian CDBs practices, important references in the literature related to community management of a local currency and understood as common resources (commons) (Dissaux, Fare 2017; Hudon, Meyer 2016) faced challenges concerning autonomy and local management in Maricá. The complexity (and the delay) in consolidating a local entity was a key element for this CDB (lack of) autonomy. Mumbuca CDB team was not capable of managing completely the community bank, such as which projects conducting, which technologies adopting or when starting other CDBs practices, like microcredit. These seem

~~important effects, at least partially related to the scale involved, one of the main actors in the~~ next section.

Scale and magnetic cards: challenges for autonomy and proximity

Maricá government secretary has decided to recommend a translation: according to him, after witnessing a Palmas paper-money theft during his visit to the pioneer CDB experience, he decided to recommend that CC should take a magnetic card form in Maricá, as a way to meet Mayor Quaquá's demand to implant a social currency in town (a much bigger territory when compared to Conjunto Palmeiras). Banco Palmas practices hired for the task were then faced with an artifact hitherto unknown: the magnetic card and the POS[ix]. They formed the main materiality of Mumbuca DCC from 2013 to 2017 and were provided by the ValeShop enterprise.

As can be seen, the scale required at the Mumbuca case for DCC implementation was inseparable from its materiality, a card inspired by the Federal Government Bolsa Família Program (PBF) – which provides financial aid to poor Brazilian families. A solution hybridized with community banks methodology: if local government drawn its attention to the fact that with PBF "unfortunately" the population could use the money for alcohol and drugs, Bolsa Mumbuca provided a control of the registered establishments. Furthermore, while the federal program beneficiaries had to use their cards to withdraw Reais into paper-money, with Maricá's DCC the paper-money materiality would never pass through the beneficiaries' hands: the currency was used exclusively in a debit card form.

In a larger scale reality (when comparing to other Brazilian CDBs), in addition to the local wealth maintenance, Mumbuca DCC promised more security and more control, important characteristics to consolidate the results obtained with Maricá public policy. During one of our interviews in 2015, the local government mentioned the “control” over currency data: seventy percent of Mumbuca's expenses would have been spent in grocery stores and twenty percent in pharmacies. In the light of a new scale and the presence of a state actor, a

proximity new idea was emerging among the community bank, residents, and traders, now mediated by artifacts such as beneficiary cards and merchants' machines.

As a strategy to follow the effects of this “controlled proximity”, we propose a (temporary) division among use, management, and production / maintenance of technologies. Starting with the use of technological devices dimension, rather than a possible expected variety of ways to appropriate the use of technological devices, we observed an absence of relevant difficulties evidence in Mumbuca cards usage. This absence dialogues more with an entity that emerged in the work field itself: a certain “card culture” that circulates in the population, pointed out by Banco Palmas. A culture that is certainly related to the Brazilian banking services digitalization process, accompanied by cards and POSs. Beneficiaries often revealed a preference for this digitalization type, rather than paper-money: some interviewees’ statements, such use seems associated with the possibility of controlling the spending type on the grant. Hereupon, the card would be better than paper-money because whoever receives the resource could only use them in registered places, “otherwise people would spend on anything”, according to Maricá inhabitants. With the card culture associated with a new control praise, barriers to this digitalization version of Brazilian social currencies seemed small regarding these artifacts usage.

Proceeding with the observation of the beneficiaries' data management, it was not difficult to notice the Mumbuca Card network complexification, at least in two directions. Firstly, documents profusion has increased as a requirement to enter the database. Hereupon, delay to analyze new beneficiaries’ applications (government responsibility) was not seldom questioned to the bank employees. Secondly, the registration process started including promises associated with its computerization, which faced obstacles in the beginning – e.g., during a beneficiaries’ update registration event, the system went down and there were delays in all service stations. Therefore, it seems clear that, considering these examples, a new kind of proximity, more mediated and controlled, enters the scene. This proximity is connected to not only a beneficiary and his/her card equipped with Mumbucas, but also to rules (including options concerning who were the beneficiaries and how could the

beneficiaries spend the Mumbucas), documents, registers in the databases and software used for the registration process, which were essential to Maricá currency infrastructure.

Finally, if when examining the card and the beneficiary we were led to the database registration and construction processes, when we listened to the merchants, we quickly arrived at the machines and the systems that communicate them with ValeShop computers. We arrive here at the third dimension that we proposed, namely the machines production and maintenance and their communication system, which are the ValeShop company responsibility. It is worth saying that Banco Palmas coordinator was uncomfortable with the fact that poor communities where BCDs are do not have another control type, the technology of producing machines. We understand this annoyance as a clue that Banco Palmas' practices faced artifacts relatively unknown to that community. Autonomy sense that circulates in the social currencies proposal of community banks is manifested here regarding the information technologies used, both in terms of knowing how to use them understanding and even being able to produce them as well.

Practices of autonomy and proximity were thus challenged from different angles during the program implementation, whose process was characterized "much more [by] a bank serving a city" than by a city meeting the demands of a community bank, as Banco Palmas coordinator admitted. The initial nuisance, "why can't we produce these little machines?" (the POS's), which embodies an autonomous approach, faced the possibilities of a "card culture" reasonably established among the population (and connected to a relatively desired sense of control), which paradoxically conferred a certain stability and trust in Mumbuca DCC.

E-dinheiro App and a new techno-legal financial sustainability

A new translation acted to stabilize the DCC network at Maricá, entangled by juridical entities: in addition to the municipal legislation created in Maricá (which regulates Mumbuca), the 2013 Brazilian electronic payments legislation entered the scene as an opportunity for CDBs to become "digital banks" and achieve a desired so-called financial sustainability. This legislation formed a new market of alternative electronic payment means, a market into which CDBs entered due to a 2014 proposal by the MoneyClip enterprise: digitalizing BCDs

Network social currencies using the E-dinheiro platform, whose most visible element is an application for cell phones. E-dinheiro gained centrality among CDBs as "[…] the first Social Electronic currency in Brazil, from the Brazilian Community Banks Network, which proposes to serve as the payment means for products and services sold in the solidarity economy" (Carta… 2015).

In Maricá, the proposal to switch from the ValeShop card to the MoneyClip App only took place in 2018, when the MoneyClip's proposal materiality (translated into a smartphone app associated with a card) replaced those operated by ValeShop, not without financial, technological and governance changes connected to the process. Infrastructure change was associated with negotiations with Maricá government, ValeShop and Banco Palmas, according to local governments representatives: in Latour's (1998) terms, technogram and sociogram were connected.

Furthermore, the material change of the payment method would bring a new actor to the BCD network, the cell phones. It should be noted here that Mumbuca Card easy using - "the card culture" - was not verified with a hypothetical scenario of an application with smartphones. When asked about the possibility of Mumbuca grant being paid only through cell phones, we collected expressions from beneficiaries such as "Oh, no…", "It is very complicated.", "I don't even like cell phones. (…) Leave it as it is". Although considering a more positive reception of the proposal by young people, it was clear that the promises of a mobile payment system would need to be situated.

Despite these obstacles, digital payment method became a central matter to the CDB Network, which was beginning to bet on the new legal framework for electronic payments and on the E-dinheiro application as inseparable from its future: "I think community banks either migrate to electronic currency or they will have problems", said a Banco Palmas coordinator. If in Maricá municipal legislation already strengthened its local currency network, the national picture was different. CDB Network and its paper-moneys, on one hand, relied only in BACEN's (Brazilian Central Bank) technical notes, which guaranteed the operations legality, but did not allow community banks being paid for the paper community currencies administration (Faria 2018). On the other hand, electronic payments legislation (law

12865/2013) allowed non-financial institutions to administer electronic payment systems with remuneration for that. As we can observe, legislation was a fundamental actor for the Brazilian community currencies framework to gain digital features.

Thus, from 2013 onwards, electronic payment legislation has been understood as an ally of Brazilian community banks, now candidates to be “payment institutions” whose low financial volumes operated left them relatively free from BACEN inspection (Ibid. 2018)[x]. Along with the new legislation, MoneyClip proposal came to the BCD Network: the small company from Brasília proposed sharing the fees (collected by the platform) with the Network, due to the currency circulation (2% of each trade sale, and 1% of each local currency exchange for Reais) – a more advantageous agreement to the BCD Network, if compared with ValeShop deal[xi].

An analysis of Banco Mumbuca data (Faria, Pupo, Braga, Silva, Severo 2019) revealed significant revenues for the bank, of approximately 2% of the amount allocated by the town to Maricá residents (between forty and fifty thousand Reais monthly, in 2018 second semester and in 2019 first one). This amount allowed the bank to launch an interest-free microcredit program, with its own resources, for the local population. Additionally, in parallel with E-dinheiro platform adoption (fully implemented in 2018 first semester), there was an “explosion” in the trades’ adhesion: associated local producers/commerce number went from the magnitude of one hundred to one thousand trades in one year (Faria et al. 2019). Such a phenomenon met the demands of the own beneficiaries and traders, and it covered not only small businesses, but large businesses chains as well. As a result, while Mumbuca BCD's financial sustainability was increasing, a reorientation of beneficiaries’ purchases towards large chains of enterprises was identified, causing a relative loss for small local businesses (Ibid. 2019).

Finally, in what someone could call “technical” new platform characteristics, it is worth mentioning two elements highlighted by Faria et al. (2019). From the DCC platform users’ viewpoint, the field interviews pointed E-dinheiro application was hardly used by beneficiaries, among whom the use of the E-dinheiro card predominated, according to the interviewed merchants, reinforcing the “card culture” presence, already discussed here in this

text. Concerning the platform transparency and reliability: “[we] recommended ‘transparency panels’ for Mumbuca circulation in different levels [...]: to support the CDB Brazilian Network discussion with local governments and institutions; to increase community confidence where CDBs are situated, so that the [CDBs] Network itself could have a better data view and plan joint actions; every CDB could ascertain circulation in its own community” (Ibid. 2019). The research also recommended turning E-Dinheiro into an open-source software to facilitate security testing and possibly new software contributions. According to the authors, it would also enhance the dialogue among CDBs Network and other Brazilian collectives closer to solidarity-based economy and free software field.

Discussion: sociotechnical reconfigurations in discourse and governance

To illustrate the CDBs methodology translation into its Maricá’s version, we understand that Latour's approach (1998) is interesting. The author proposes that every change in the sociogram of an artifact, in our case Mumbuca DCC, may foster technogram tensions (and vice-versa). Figure 2 portrays these changes, which we propose (schematically) happen at least in four different moments in Maricá, based on descriptions in the previous sections. For each moment, there is a temporary stabilization of CDBs principles first examined here, namely, autonomy, proximity, and financial sustainability.

Taking Banco Palmas methodology as a starting point (T0), Mumbuca first moment (T1) represents this methodology translation for Maricá, with local government partnership, its social assistance program and local legislation. Here, a specific autonomy configuration of Banco Mumbuca was verified (symbolized in figure 2 with the word autonomy in bold and underlined), with challenges regarding the government (e.g., DCC initially only circulated among beneficiaries), also in relation to Banco Palmas. Due to a larger scale of this new network, magnetic card and ValeShop company entered the scene (second moment, T2 in figure 2). Proximity finance notion is then (T2) translated into what we called a controlled proximity scenario, where new mediations emerge (with artifacts like POSs, cards, and databases), as described.

Finally, in a third network stabilization investigated here (T3), migration aspects of the currency infrastructure were verified: smartphones, application and E-dinheiro card, as well as the MoneyClip company and its closed model of software development. Here, a greater financial sustainability perspective at Banco Mumbuca (and the CDBs Network) is central. The new stabilization also reconfigures the BCD autonomy, which started to implement a "zero interest" microcredit program in 2018. Indeed, it is worth mentioning the beginning of a T4 stabilization moment, as presented by Joaquim Melo during the Esocite.BR discussion: in this new configuration, which begun in 2021 first semester, CDB Network is no longer connected to Moneyclip, and software developers dialogue directly to the CDBs[xii].

This process allows us to affirm that different stabilizations of the discourse (Edwards 1996) of Banco Mumbuca are inseparable from its practices (from which were highlighted different practices of autonomy, proximity, financial sustainability arrangements) and its artifacts (paper-money, cards, applications). Hereupon, the case demonstrates that these elements are intertwined, a conclusion that remains far from the idea that changing the DCC materiality would not affect its principles and practices (or "the same idea, [only] in different ways", as verbalized by one of the Banco Palmas founders).

Alongside with these findings, Mumbuca DCC case allows us to discuss some aspects of what we call here DCC democratic governance. We propose connecting it to two works concerning DCCs and governance views. On one hand, Diniz, Siqueira and Heck (2019) framework proposes a DCCs taxonomy, including architecture, transactionality, virtuality, and finally governance. For the authors, governance dimension may be classified in "shared" or "centralized". On the other hand, Faria, Severo, Cukierman, Diniz (2020) discuss three sociotechnical dimensions, namely "requirements", "data" and "source code".

Faria et al. (2020) point the importance of what CDBs call "economic democracy": "[the] history of Brazilian Community Banks shows that democratic practices include not only disputing institutionalized politics power, but also community mobilization in the sense of currency management as common goods." The authors dialogue with Théret and Zanabria's (2007) classification, concerning the "states of a currency", namely, the "incorporated currency" (connected to the users' habits), the "objectified currency" (which serves as a

payment mean) and the “institutionalized currency” (which captures rules that unify a monetary space). Based on this classification, Dissaux and Fare (2017) understand that institutionalized currency dimension would be a preponderant state, insofar as a currency is abstract and immaterial: “it is first and foremost about the institution management at issue, much more than its objective expression in the payment means. [...]Social practices are built around it (self-organization, rules transparency, collective regulation, actors’ participation, individual non-appropriation of surplus, members cooperation, participatory and collective decision-making process, etc.) which should be analyzed and that allow considering the resource (the currency) to be instituted as a common good” (Dissaux, Fare 2017, 13, our translation).

Here, we share with Dissaux and Fare (2017) the attention to a democratic governance of community currencies, which is coherent to community banks and solidarity economy networks. However, when agreeing with Faria et al. (2020), we propose that materiality is connected to social practices, and therefore they should be placed in equal importance status. Thinking about democratic governances does involve considering social and technical (intertwined) dimensions, that is sociotechnical dimensions. We believe that dimensions proposed by Faria et al. (2020) (“requirements”, “data” and “source code” of a DCC) are connected to the CDBs practices examined here, as follows: the discussions around the CDB practices of autonomy are strongly connected both to the possibility of defining DCC requirements (with which rules and functions will be incorporated?) as well as with its source code (would who be able to access the “cake recipe”, the instructions executed by the software?). The proximity (and the discussions regarding the information control) is strongly connected to the data dimension (who does have access to it?).

When dialoguing with the authors, we propose to add two dimensions to their discussion, in addition to requirements, data and source code: DCC management dimension (would who take care of its functioning/availability?) and that of the economic appropriations involved (would who financially benefit from the activity?). Such dimensions may easily be coupled to the previous diagram, highlighting diverse sociotechnical governance configurations at different moments (figure 3).

The present research allows us to propose that Mumbuca DCC management (with ValeShop (T2), at the first moment, and after with Money Clip (T3)) is more centralized than “Palmas model” (T0). It is because, once the paper money was available to the community, it did not depend on an institution to manage the digital platform functionalities and its availability. Concerning the economic appropriation dimension, we may advocate that transition from ValeShop to MoneyClip allowed a more shared distribution of the financial benefits provided by DCC circulation (due to the interest-free microcredit program achievement).

Coming back to the categorization proposed by Diniz, Siqueira and Heck (2019) (governance dimension classified in “shared” or “centralized”), we consider this paper contributes with the authors’ discussion by emphasizing its inevitable “sociotechnical” aspect and by detailing this sociotechnical governance with the dimensions proposed (requirements, source code, data, management, and economic appropriation). We argue that each one of these dimensions may be categorized as “centralized” or “shared”. As a result, we propose a centralized/shared classification for the three moments of stabilization of different sociotechnical governances (T0, T2, T3), considering dimensions discussed here (table 1). “Centralized” means, for us, that there is a strong participation either by the state or by a private enterprise at this dimension; “shared” governance indicates a stronger self-management / community approach.

Then, we considered the platforms requirements are shared, from when it is decided with the CDBs Network - despite improving participation among CDBs might be interesting (Faria et al. 2020); CCs “source code” is centralized with capitalists enterprises (at any configuration, there are not “solidarity collectives” involved). T4 configuration points to a more shared stabilization, whether developers are directly connected to CDBs Network. Even so, both data and platform management dimension are more centralized with T2 and T3 CCs digitalized versions. We might say it considering that both all the network data and operating software are stored in centralized servers (computer), which are primarily administered by a capitalist enterprise – a different situation from T4, which could be even partially changed in the future, considering new technologies, such as blockchain (Diniz, Siqueira and Heck

2019). Finally, this framework makes more visible that transition from Mumbuca Card into Mumbuca E-dinheiro was an achievement in terms of a CDBs better financial appropriation.

The whole framework points to a centralization bias as a risk when information technologies come to the scene. However, it is possible to point out some paths to reverse this possible bias. In the code dimension, a more shared approach (which has already begun with the T4 configuration) could involve development models closer to the so-called free software. As for the data, for example, one can think in levels of aggregated data sharing (with communities involved and other CDBs) and in less centralized storage forms, as used in blockchain technology. Such technology could be promising even from the viewpoint of a more shared platform management, as well as used software improvements, towards more possibilities of local customization.

These assumptions dialogue with Diniz, Siqueira and Heck (2019) discussion, and makes sense to our case, as far as this categorization is a central issue to the idea of democratic governance in the solidarity economy proposition. It is aligned with the perception that state ("big government") and corporations ("big business") do not solve all the community problems (Craig 1993). One of the main Brazilian personalities concerning solidarity economy, Paul Singer (2002) calls attention to the fact that capitalism is a mode of production whose principles are the individual property rights applied to capital and the right to individual freedom. On the other hand, solidarity economy, as another mode of production, has as its basic principles the collective or associated property of capital and the right to individual freedom. Briefly speaking, in a capitalist company, a small and select group of owners is responsible by the main decisions on management processes, on the productive model adopted, on the profit allocation, and usually on tools used for the products / services provided[xiii]. Considering CDBs as participants of the solidarity economy movement, França Filho and Silva Júnior (2009) summarize the CDBs specificity as an experience of solidarity finance lying precisely in the fact that bank coordination and the resource management are carried out by a community organization. The authors also point out that, for a CDB to consolidate, among other aspects, it should establish a technological infrastructure that makes the community bank operations more efficient and effective.

What we argue here is the discussion of DCCs governance dimensions, as technological infrastructures of CDBs, is crucial for (and inseparable from) the “economic democracy” debate among community banks. This inseparability is anchored, for example, on STS field, and may be demonstrated by tools like Latour’s (1998) technogram and sociogram. Thus, our critical exercise here lies on the thought that, starting from the analysis of technology used in a determined way to manage work and production, there is a whole ideological and substantial model connected to it: schematically, more centralized systems, in the molds of traditional capitalist and state organizations (hetero management), or, furthermore, more shared systems, focused on principles of solidarity economy (self-managed).

Conclusions

This paper is situated in the context of monitoring and analyzing the Brazilian community currencies digitalization process, at the CDBs Network. In this community, the idea that this digitalization process would have occurred with “the same idea, [only] in different ways” was strong. At the same time, DCC governance used by the banks is considered a complex challenge to the Network. Drawing our attention to the study of one of the most relevant Brazilian DCCs, the Mumbuca, the paper demonstrates the digital community currency materiality is inseparable from the “social arrangement” around it.

Dialoguing to the ICT4Ds and STS fields, and especially with ANT, we used the concepts of translation, symmetry, networks, sociogram and technogram to describe different moments of Mumbuca. We showed interconnections between the sociogram and the technogram of Mumbuca DCC, emphasizing two approaches: first, discussing how some elements of the discourse of the community development banks (the practices of autonomy, proximity, and financial sustainability) were reconfigured to a certain extent (figure 2). Briefly, autonomy was challenged by dependencies of Mumbuca CDB regarding the local government, Banco Palmas and technology companies and its artifacts; the proximity notion faced the difficulties of the scale and the control possibilities, embedded in a more traceable network (a digital one); Banco Mumbuca financial sustainability was reinforced with the transition into E-dinheiro platform, increasing the bank financial autonomy.

Finally, we discussed a DCC democratic governance, linked to the economic democracy notion – another element of CDBs discourse. We propose that materiality is connected to social practices, and they should therefore be placed *a priori* in equal importance status, as intertwined dimensions: sociotechnical ones. The discussion was useful for us to evaluate each of DCC governance sociotechnical dimensions, namely, requirements, code, data, platform management, and economic appropriation. Dialoguing with Diniz, Siqueira and Heck (2019), we characterized these five dimensions as “centralized” or “shared”, according to each moment of Mumbuca DCC (table 1). Considering a desirable shared approach, in agreement with solidarity economy field, the framework proposed helps to highlight some of the greatest current governance challenges for Brazilian (CDBs) Network.

As future researches, we propose to advance on further discussions towards more shared approaches of code, data, and management dimensions; on the use and improvement of the framework with other DCCs analysis; on the connection of the framework with the discussion of the so-called platform capitalism; and on deepening the framework by analyzing complex governance cases, especially of new and promising technologies, such as blockchain.

Figure 1. Sociogram and technogram

(Latour 1998)

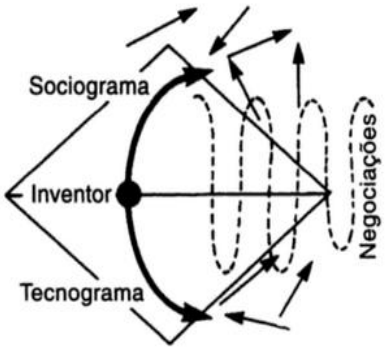


Figure 2. Sociogram and technogram (Latour 1998) adapted to the Mumbuca case. Successive translations lead to the network provisional stabilizations at different moments: different "social" and "technical" actors; in green, CDBs discourse, with relatively reconfigured CDBs practices.

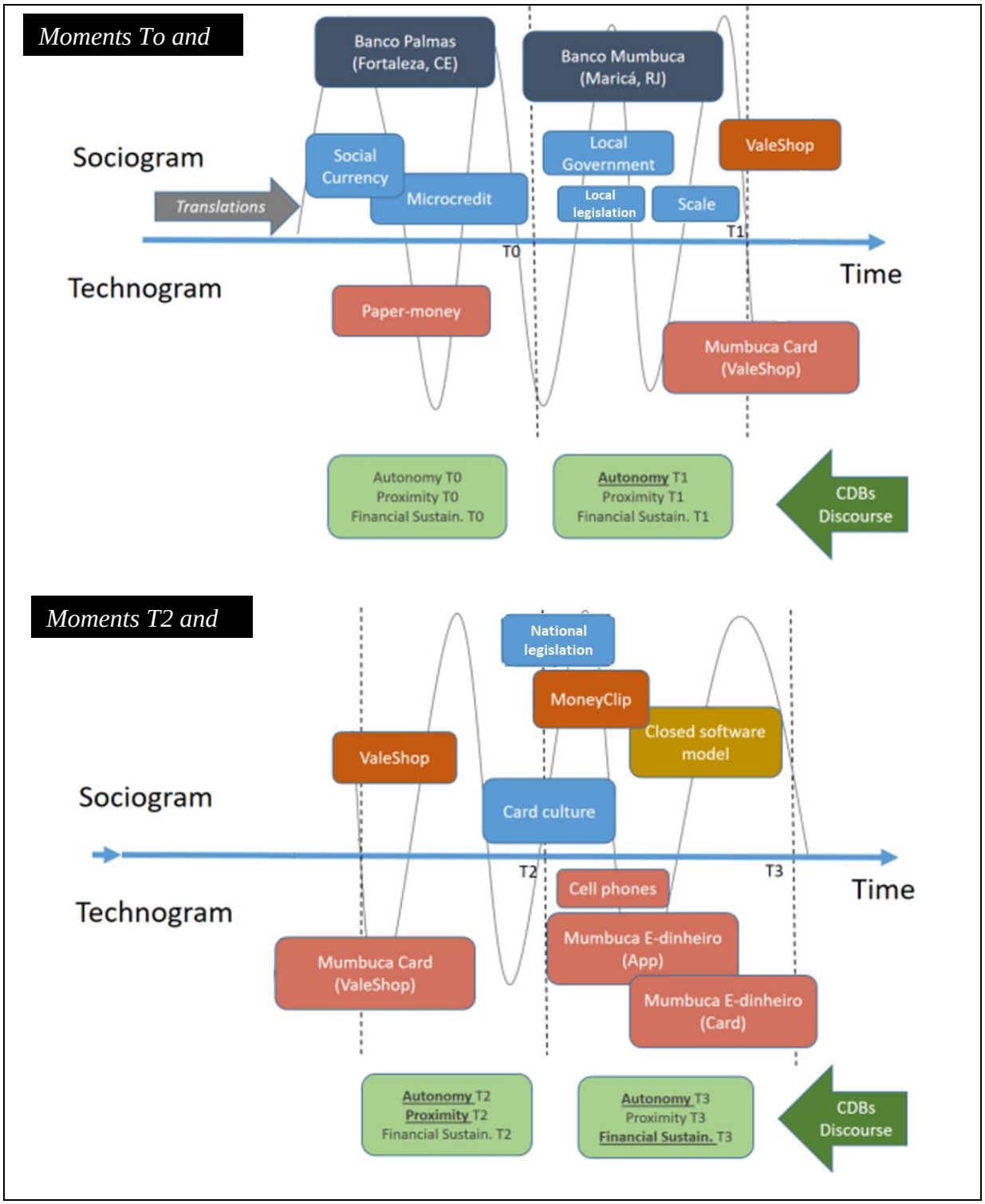
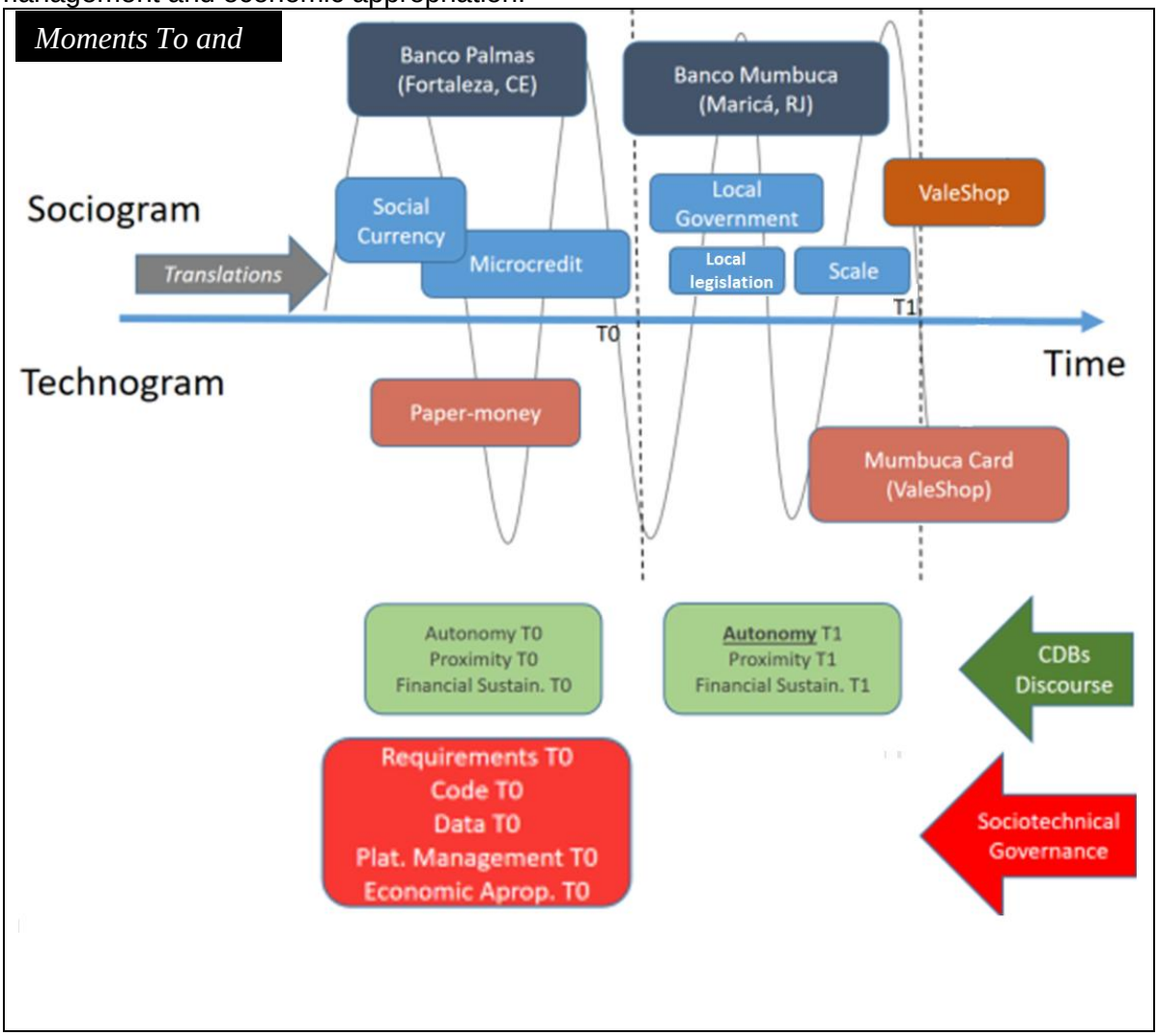


Figure 3. Sociogram and technogram (Latour 1998) adapted to the present case, including new governance sociotechnical configurations. Regarding the figure 2, we add (in red)

sociotechnical governance dimensions: requirements, source code, data, platform management and economic appropriation.



Moments T2 and

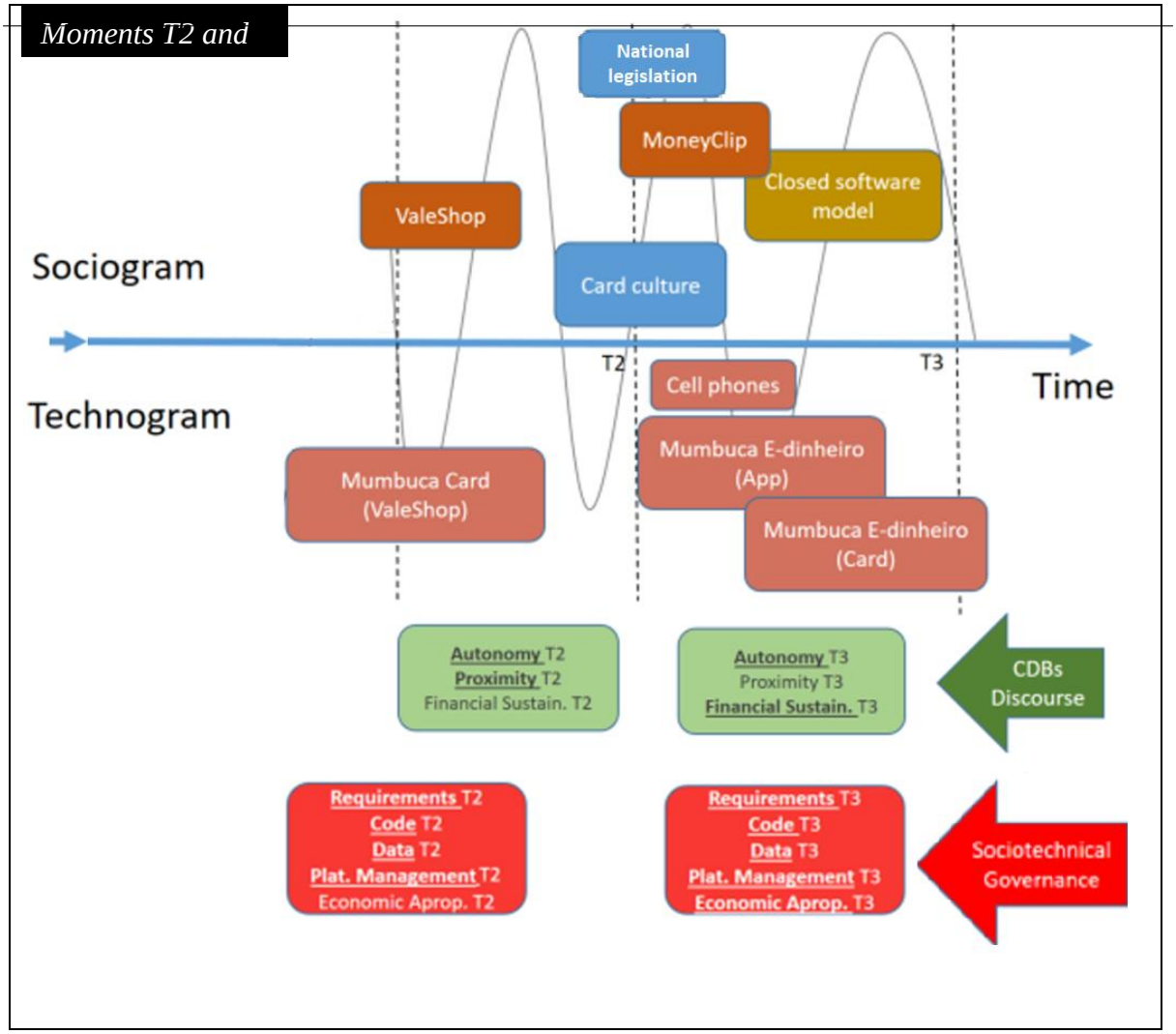


Table 1. Classification for each dimension of DCC sociotechnical governance: Centralized = strong state / private company presence; Shared = strong self-management / community approach

DCC Sociotechnical Governance *DCC Cases*	Requirements	Code	Data	Management	Economic Appropriation
Palma *(Paper-money, T0)*	**Shared** CDB	**Centralized** Printing enterprise	**Shared** CDB	**Shared** CDB	**Shared** CDB
Mumbuca Card *(ValeShop, T2)*	**Shared** CDB Network	**Centralized** ValeShop	**Centralized** ValeShop	**Centralized** ValeShop	**Centralized** ValeShop
Mumbuca E-dinheiro *(App + Card, T3)*	**Shared** CDB Network	**Centralized** MoneyClip	**Centralized** MoneyClip	**Centralized** MoneyClip	**Shared** Banco Mumbuca / CDB Network
E-dinheiro *(CDB Network developers, App + Card, T4)*	**Shared** CDB Network	**Shared** CDB Network	**Hybrid** CDB Network / Provider	**Hybrid** CDB Network / Provider	**Shared** Banco Mumbuca / CDB Network

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[i] Banco Mumbuca workers (3), Banco Palmas Coordinators (2), local commerce (1), Maricá inhabitants (2), local government (2) and MoneyClip enterprise (1) - the company was originally called MadeApp, which developed an application called MoneyClip (a software used to implement the electronic currency E-dinheiro). Subsequently, the partners opened a company called MoneyClip, a name adopted throughout the text, for simplification. The local commerce and inhabitants' interviews addressed aspects such as difficulties with technologies usage, mistrust in relation to the local currency, and changes in expectations regarding the project (at its beginning and by the interview time). The interviews with MoneyClip, Banco Mumbuca, Banco Palmas and local government addressed broader issues, related to mistrusts concerning Brazilian formal institutions (and their responses to local currencies), differences between paper and electronic currency, how users and

traders' data were recorded, and relationship with other parties (Banco Palmas, Banco Mumbuca, local government and ICT companies).

[ii] The materials: folders used by the bank to communicate with population, and spreadsheets with Mumbuca ValeShop Card circulation data. The system access allowed the elaboration of two reports about the Mumbuca currency circulation. More at https://is.cos.ufrj.br/producoes/. Access: 20 Jan 2021.

[iii] This approach also involved, during 2018, the organization of three "hackathons" (events that brought together software programmers and users): MumbucHackas I and II, which brought together software programmers, Banco Mumbuca and public managers in the municipality of Maricá-RJ; Hackathon at Solidários 2018, as one of the activities of a global meeting of development solidarity banks, organized by Banco Palmas, in Fortaleza-CE. More at https://www.marica.rj.gov.br/2018/01/10/desenvolvedores-discutem-nova-plataforma-do-cartao-mumbuca/, http://www.ofluminense.com.br/en/cidades/banco-mumbuca-no-2%C2%BA-distrito, http://bancossolidarios.global/ and https://is.cos.ufrj.br/producoes/. Access: 20 Jan 2021.

[iv] More at https://www.youtube.com/watch?v=wogq8WDKMYE. Access: 20 Jan 2021.

[v] Esocite.BR is the Associação Brasileira de Estudos Sociais das Ciências e das Tecnologias (Brazilian Association of Social Studies of Science and Technology). More at http://www.esocite.org.br/. Access: 20 Nov 2021.

[vi] According to the author, "[for] example, computer scientists tend to build ICT applications and then evaluate them in particular field contexts. [...] In contrast to computer scientists, sociologists and anthropologists normally address contextual issues in some depth but do not construct artefacts" (Walsham 2017).

[vii] Mumbuca DCC started its operation under the administration of the mayor of Maricá, Washington Luiz Cardoso Siqueira (Washington Quaquá), after a visit by its Municipal Human Rights Secretary to Banco Palmas, located in Fortaleza outskirts, in the State of Ceará, Brazil.

[viii] Banco Mumbuca was formally instituted (as an independent institution) in 2017 second semester.

[ix] "Little machines" ("maquininhas", in Portuguese) is the way a Banco Palmas Coordinator refers to POS (point of sale) machines.

[x] In practice, Brazilian State ended up favoring electronic currencies when designing a legislation that built a more advantageous market for arrangements that include ICTs.

[xi] 3% of merchants sales belonged to ValeShop.

[xii] In fact, CDB Network had already bought the E-dinheiro platform from MoneyClip in 2018, but CDBs were still depending on services concerning the platform maintenance.

[xiii] As a general rule, a profit portion is paid in cash to shareholders as dividends and the remaining goes to the investment fund. According to Lima (2009), in work cooperatives, the self-managing organization forms of production, the labor activity control, the product made by the own workers and leftovers have their destination decided by the partners collective. One

part is placed in an education fund of their own, other part divided between the use to expand the cooperative assets, another part to the cooperative, and finally the remaining is distributed in cash to the partners by some established pre-criteria.

Municipal currencies in Brazil: potentialities and limits beyond the case of Banco Mumbuca (RJ)

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ABSTRACT:

Community banks in Brazil are solidarity practices which started with the Banco Palmas experience. This first bank establishes its own methodology for organization and local development based on the solidarity economy (SINGER, 2004). In this context, the bank must be managed by its own community and must support local enterprises with little or no technical organization and capital, called by Santos ([1975] 2008) as a lower circuit, to generate local development. They usually operate with credit for consumption (with interest-free local community currencies at parity with the national currency) and credit for local production.

Community bank experiences have reached the number of 147 initiatives in Brazil, based on this methodology presented, which have spread throughout the Brazilian territory supported by federal public policies, called solidarity finance (2006 and 2015). Without the support of the federal government, the Brazilian Community Banks Network (BCBN), the main articulator of these local solidarity experiences, has sought alternatives for financial self-sustainability. With the regulation of electronic money use in Brazil (federal law 12.865/2013), BCBN started considering the possibility of maintaining community banks with revenues coming from a digital platform (E-dinheiro).

In 2013, BCBN made its first public partnership with the municipality of Maricá (RJ), using a digital currency as a basic income program and creating a municipal community bank. We propose to discuss the recent movement that is underway in Brazil, which expands experiences of digital municipal currencies managed by BCBN, based on the case of Banco Mumbuca (RJ), the first and most consolidated experience in Brazil. The data presented was collected between 2018 and 2022, resulting from participant observations, semi-structured

~~interviews with actors involved in the implementation and management of community banks,~~ analysis of public documentation and literature review.

As theoretical assumptions, we start from the contributions that observe the solidarity economy as democratic and cooperative processes built from the decisions and needs of communities (SINGER, 2004; GAIGER, 2000; CORAGGIO, 2007). Public policies in this field can present broad local development results if they obtain co-production effects between communities and municipal governments. The concept of translation, based on Actor Network Theory (or Sociology of Translation), will be the basis for narrating the shifts in legislation and methodologies (of coins and community banks) between different territories.

In this process of expansion of municipal digital currencies by BCBN, tensions between governments and fundamental solidarity economy principles of community banks can be noticed. The Mumbuca case is paradigmatic because it brought about a coexistence between solidarity economy, local development and public policy. The 10 new Brazilian experiences analyzed - notably the Arariboia case, in the municipality of Niterói (RJ) - indicate that the municipal government may not be attentive to the needs of the communities or taking advantage of synergies that already exist in the municipalities, distancing itself from the guiding principle of the solidarity economy. Therefore, it is necessary to create an agenda so that the co-participation between community actors and public authorities is effective, contributing for the expansion of the methodology of existing community banks.

Keywords (*Community Development Banks; Public Policy; Solidarity Economy; Digital currencies* **)**

1. Introduction

Community Development Banks, in Brazil, are solidarity finance institutions, traditionally managed by communities through a self-management approach, with the objective of financial inclusion, enabling socioeconomic development in peripheral areas. Its performance generally unfolds on two fronts: i) provision of microcredit at low interest rates for small producers and local traders (production) and for families (consumption); ii) issuance of social currencies (backed in reais) whose circulation is restricted to the region where the bank operates, strengthening local consumption and enabling development.

Such organizations may be supported by NGOs, companies and local governments, being mostly community associative entities, located in impoverished peripheries of Brazilian cities (FRANÇA FILHO, SILVA JR, RIGO, 2012, p. 504). It is worth emphasizing, therefore, that community banks, in general, are institutions embedded in the economy and sociability of the places where they operate, with a democratic management and social activism characteristic that goes beyond finance - although these are an important pillar. These solidary finance institutions are spread across the national territory in all five Brazilian regions, where there are currently approximately 150 community bank initiatives, part of BCBN (PUPO, 2022).

In 2013, Brazilian Community Banks Network (BCBN) made its first municipal partnership with the municipality of Maricá (RJ), using a digital currency as a basic income program and creating a municipal community bank. We propose to discuss the recent movement that is underway in Brazil, which expands experiences of digital municipal currencies managed by BCBN, based on the case of Banco Mumbuca (Maricá, RJ) - the first and most consolidated experience in Brazil.

The community banks methodology is based on the premise that no territory is poor *a priori*, but becomes impoverished because it loses its local savings, as stated by one of its founders, Joaquim Melo (QUEM..., 2014). In the early 2000s, local paper currencies went through a legal process, being allowed to circulate in the neighborhoods where community banks are located, since they were “parallel currencies” and could incite a decrease in national sovereignty (CAMINHA E FIGUEIREDO, 2011). However, there was an understanding of these local currencies as a promotion bonus and not as a promise of payment, allowing their existence, even though there was no specific legal framework for their regulation.

With the political instability that Brazil experienced and that culminated in the impeachment of President Dilma Roussef, the Solidarity Economy Secretariat (SENAES) - responsible for operating and increasing the number of community banks in the country - began to stop

supporting CDBs initiatives, In this way, the CDBs members felt the effects of the lack of federal support: the BCBN, the main articulator of these local solidarity experiences, has then sought alternatives for financial self-sustainability. With the regulation of electronic money use in Brazil (federal law 12.865/2013), BCBN started considering the possibility of maintaining community banks with revenues coming from a digital payment platform (E-dinheiro). This system allows the survival of dozens of CDBs by transferring 1% of the taxes charged when a client makes a payment.

Figure 1 - E-dinheiro card. Source: Carolina G. de Paula Pupo, 11/7/2018. . For the customer to purchase it, it is necessary to pay the amount of R$8.00. Note the "Near Field Communication" system in the lower right corner.

The Institute integrates the coordination of BCBN and represents at the Central Bank of Brazil (BACEN) for the purposes of law 12.865/2013. Such digitization was seen as an opportunity for the sustainability of CDBs, as it was anchored in legislation that allowed institutions not participating in the Brazilian Payment System (SPB) to manage means of payment (as long as they were electronic and backed in Real), guaranteeing a previously non-existent legal stability (FARIA, 2018) (PUPO, 2022)[1].

The ways in which social currencies are put into circulation have taken different forms in the history of community banks CDBs. In addition to the productive and consumption microcredit,

[1] It is worth mentioning that BNCB is also supported by the microcredit legislation: Banco Palmas has a legal entity (Instituto Palmas) which allows it to operate microcredit, and is also registered with the PNMPO (National Program for Oriented Productive Microcredit), enabling the institution to operate public resources for microcredit (MELO, 2018) - the PNMPO "was established by Law No. 11,110, of April 25, 2005". More at <http://portalfat.mte.gov.br/programas-e-acoes-2/programa-nacional-do-microcredito-produtivo-orientado pnmpo/>. Accessed on 16 Aug. 2018. It should also be noted that in other countries there are laws that explicitly support "social" currencies, even if not electronic, as in the French case.

the social currency has allowed the payment for repairing Banco Palmas building (Fortaleza CE), the purchase of waste from collectors/carriers by Fortaleza municipality (CE) and the management of the payment of a social benefit from a city hall (Banco Mumbuca, Maricá, RJ), all of them being ways of bringing social currencies into circulation.

Banco Mumbuca - located in Maricá (RJ) - has so far had the most impact among BCBN, from the point of view of resources involved in the circulation of community banks' social currencies. It inaugurates the recent process of expansion of municipal digital currencies by BCBN, where tensions between governments and fundamental solidarity economy principles of community banks can be noticed. The Mumbuca case is paradigmatic because it brought about a coexistence between solidarity economy, local development and public policy - we will go through this case in section three of this paper.

Also, the Banco Araribóia case must be highlighted. Created by the municipality of Niterói (RJ), its social currency circulates on a territory where another CDB has already worked for more than ten years (Banco Preventório) – we will describe this case in section four. Subsequently, we will discuss initial lessons learned from the collected data, which briefly indicates that the municipal governments may not be attentive to the needs of the communities or taking advantage of synergies that already exist in the municipalities, distancing itself from the guiding principle of the solidarity economy. We will begin this journey by describing methodological aspects of this research, in the next section.

2. Community banks and social currencies: theoretical debates about their territorial and solidarity meanings

As theoretical assumptions, we start from the contributions that observe the **solidarity economy** as democratic and cooperative processes built from the decisions and needs of communities (SINGER, 2004; GAIGER, 2000; CORAGGIO, 2007). In other words, the solidarity economy must value socially excluded populations, emphasizing cooperation, the establishment of new production relations, environmental concerns and the social sharing of the means of production. In this way, opportunities for equal participation would be created for all those involved and the logic of cooperation would override the logic of competition (SINGER, 2004). In this sense, we consider the social currencies analyzed here to be part of the solidarity economy field.

According to Soares (2009), social currencies are a set of alternative monetary means that originate from the economic and social needs of certain communities and that, for this very reason, do not necessarily require the issuance and state regulation, being the mutual trust between its users its organizational substrate (SOARES, 2009). Additionally, they can be analyzed as local devices oriented towards the socio-environmental sustainability of the

territories involved. For this, such networks reinvent features of modern money, such as its issuing entities and interest associated with them, seeing it as a common resource (OSTROM, 2011). In addition, we consider that currency and markets are institutions that exist in an embedded way in society (POLANYI, 2012). In this way, the construction of local currency systems by the agents involved gives them a purposeful character, that is, to establish a market - and its corresponding monetary environment - aimed at achieving social, cultural, environmental and economic objectives of the locality in question.

There is a relative consensus among social currencies researchers that they partly represent responses to the advent of globalization (PACIONE, 1999; BÚRIGO, 2011, PUPO, 2022). In this sense, they constitute not only an appeal for communities to recover over their territories (FARE, FREITAS and MEYER, 2015) but also a symbolic way of contesting the power of the financial market and the control of money by banks (INGHAM, 2002). In other words, the globalization of markets removes the protection and interdependence that small producers had in relation to their small economic spaces. The geographic position no longer guarantees markets for local producers who now compete with global transport and information networks and which therefore allow the arrival of products from other corners. This is why, thinking about social currencies - and, perhaps, about solidarity economy in a comprehensive way - demands a new concept of local development, which must encompass the mobilization of different resources coming from the public, private and civil society sectors. In other words, the construction of local solidarity networks can be allied to public policies as long as they guarantee co-production between community agents, companies, local governments and public-private structures on a national or even global scale (EVANS, 2008; OSTROM et al. , 2001).

Hart (2006) follows a similar reasoning when defending that the social currency is a device that can precede a truly democratic society. As money is one of the most important economic institutions in society, its control by communities deepens democracy, by increasing the access of the poorest people and regions to this instrument.

Thus, democracy would be achieved not only through political formalities, but through access to the market and actual consumption. More than that, via a decentralization of monetary power and of the decision-making process for the production and circulation of goods and services. In this sense, social currencies are also under the concept of solidarity finance, a term that roots the granting and management of microcredit in values such as trust, solidarity and proximity. In this sense, Community Development Banks (CDBs) - so typical of Brazil - are hybrid institutions in which the issuance of social currencies coexists with the granting of credits in official money. Well then: the economic logic in creating a bank of this type, therefore, bows to the imperatives of such solidary values. This means that proximity and a

sense of community are issues that define the issuance of credit, since the purpose is financial inclusion and appreciation of the local economy and territory. In other words,

> (…) the bank must be created in response to an intrinsic desire of the community, even when external agents contribute to this by motivating and mobilizing this community. The process of implementing a CDB [Community Development Bank] must begin with a genuine community desire. In any event, some requirements must be met, such as financial capital for a credit fund; financial resources to cover the bank's operating expenses; a community organization (association, board, council, etc.) that can manage the bank; people trained for the roles of loan officer and credit manager; and support for the assimilation of the new technology by the community. These steps describe how many CDBs have been created: through a process of institutional partnerships involving supportive organizations (such as university incubators and Non-Governmental Organizations - NGOs - specialized in this field) and funding institutions (municipalities, state governments, government departments, foundations, etc.) (FRANÇA FILHO, SILVA JR, RIGO, 2012, p. 504).

Local currencies are a key CDBs characteristic. Concerning them, August Corrons (2017, p. 71) adopts the terminology "complementary currencies", whose main objective would be to "improve the social well-being of communities", and lists what the four types of complementary currencies would be: time banks, mutual credit systems, local currencies and barter markets (trueque). Time banks would be the most common form of complementary currency for Corrons (2017, p. 70), gathering 50.2% of the experiences. The second most numerous typology today would aggregate mutual credit systems, where members of a community disclose their offers and demands (with an accounting system that records transactions), with 41.3% of the total. For Jerome Blanc (2013), both systems would compose a generation of social and complementary currencies with significant growth in the 1980s.

Added to these is a "Latin American translation" (BLANC, 2013), especially in Argentina in the 1990s, the barter markets: "aimed at overcoming the scarcity of money and facilitating exchanges in a group of users, generally in a regular market", less frequent (1.4%) worldwide. The social currencies of Brazilian CDBs would be located in the field of local currencies, "monetary systems geographically delimited to a region" - the third most frequent typology, with 7% of the total. It is worth mentioning that, if we follow the classification "by generations", proposed by Jérôme Blanc, they would be part of a generation, born in the nineties, with an "economic ambition" different from those of the eighties (BLANC, 2013).

CDBs and their social currencies characteristics, described above, have undergone significant changes, both in their digitization process (FARIA, 2018) and in the experiences promoted by local governments, generally for the payment of social benefits, such as we will see in the next two sections with Banco Mumbuca and Banco Araribóia. Thus, as Brazilian social currencies become instruments of public policies, we perceive significant changes in

the networks of actors connected to them. We were inspired by findings from Actor Network Theory (ANT, or Sociology of Translation) as tools to map these differences. Briefly, its perspective is to make visible

> (...) a network of entities of different types, heterogeneous, like a seamless tissue constituted by actors that can themselves be seen as networks – hence, the term actor-network. The usefulness of this approach is shown, for example, when we verify that an a priori technological infrastructure can influence the so-called social relations between the people who manage or use them (directly, the technical influences the social); or when CTS Studies also show us that artifacts have politics (WINNER, 1986), in the sense of incorporating the worldviews of their builders (the social influences the technical); or even when we realize that the materialities of the artifacts make difference, insofar as they do not translate only and exactly into those values and worldviews incorporated therein (the materialities are surprising). (FARIA, 2018, p.131 our translation)

We adopt here Bruno Latour's (1998) terminology of sociogram (sociogram) and technogram (technical characteristics), to describe (provisionally) the digital social currency networks analyzed here, bearing in mind that the analysis of the technogram of an artifact would provide clues to the sociogram that makes up its network (FARIA, 2010), and vice versa (figure 2).

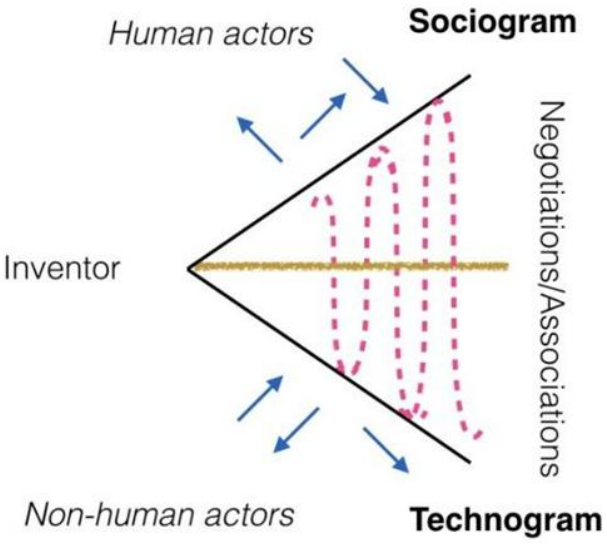

Figure 2 – Socialgram and Tecnogram (adaptation from Latour, 1987)

The concept of **symmetry** is important in this approach: for ANT not only people do act (in the sense of making difference), but also cards, smartphones, paper-money, computers and other artifacts. Also, we dialogue with the ideia of **translation**, when describing the shifts in legislation and methodologies (of currencies and community banks) from one territory to

another - for example, the displacement of facts (such as the CDBs methodology) and artifacts (such as the digital community currency), from what we can call its origin (Banco Palmas) to the different stabilizations of Mumbuca and Araribóia networks.

Finally, the data presented here was collected between 2018 and 2022, resulting from participant observations, semi-structured interviews with actors involved in the implementation and management of community banks, analysis of public documentation and literature review. Among the experiences and materials collected by the authors, the following stand out: organization of the 1st Seminar on Community Public Emergencies and their Citizen Technologies held on March 21[2] and 29[3] 2022, with the Secretariat of Social Assistance and Solidarity Economy of the City of Niterói (responsible for the Araribóia currency), which took part in the discussions "Strengthening community dreams: the microcredit" and "Circulating Local Riches: social currencies", as well as in the opening and closing sessions of the event; participation in the URBE Latin America (Urbe LatAm) project (described in section four), especially in the initiatives to discuss and implement the new microcredit methodology with Banco Preventório, as well as in the "Solidarity course on social currency and microcredit with Preventório", discussing the arrival the Araribóia municipal currency with the bank's members and different associated projects; visits to Banco Mumbuca and Banco Araribóia, participating in semi-structured interviews with six members of the banks; participation in debates during the implementation of Banco Araribóia, with emphasis on a public hearing and a meeting between the local solidarity economy forum and the municipal government.

3. The Mumbuca case: a public policy in dialog with a communitarian approach

In Brazil, the most paradigmatic case of public support for a social currency occurs in the city of Maricá (RJ). There, the municipal government - anchored in revenues from oil exploration - created a legislation that provided the basis for a social assistance program in local currency, known as Mumbuca. Initially, it was a benefit intended for low-income families, in the amount of 85 mumbucas (= R$ 85.00)[4]. According to Souza (2018), until May 2018, the program had a budget of around R$24,000,000.00 per year, which were turned into mumbucas as soon as the municipal government deposited this amount in the users' accounts.

As a result, the impacts on the economy and social life of the city of Maricá were considerable. Also according to Souza (ibid.), there was a significant reduction in poverty

[2] https://www.youtube.com/watch?v=ZW1vm6Du5Qc. Acess on 14 Set. 2022.
[3] https://www.youtube.com/watch?v=RqHAzKpCzEs. Acess on 14 Set. 2022.
[4] Law Nº 2.448, de 26 de junho de 2013. More at http://www.institutobancopalmas.org/wp-content/uploads/lei-moeda-social-mumbuca.pdf

accompanied by an increase in the revenue of local companies which, in turn, were able to hire workers, increasing the level of employment - something difficult to verify in smaller circuits of social currencies.

That is to say, the Mumbuca assistencial program was progressively gaining new modalities, supporting pregnant women and students, and being a minimum income experiment. According to Faria (2018), after initial reports of distrust from merchants, CDB managed to establish a local payment infrastructure. In 2018, the currency materiality was migrated from a magnetic card based platform to the digital platform E-dinheiro (accessible by card, smartphones and web), a change that allowed part of the administrative fees to remain with Banco Mumbuca[5] (figures 3 and 4). This migration was concomitant with the increase in the number of beneficiaries and traders, from just over 100 to over 1000 during 2018[6]. The scenario allowed the CDB to finally start its interest-free microcredit program in electronic social currency.

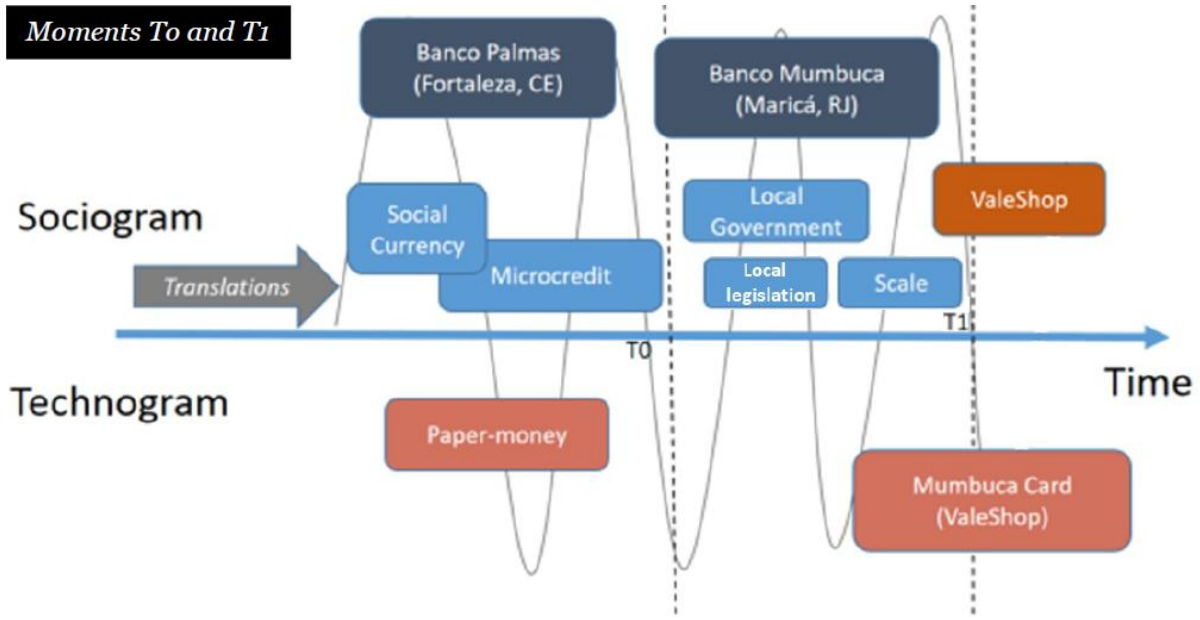

Figure 3 – Represents temporary stabilizations: of the socio-technical network of Banco Palmas (Fortaleza-CE) and of its translation for the first phase of Banco Mumbuca (Maricá-RJ)

[5] The BCBN model generally charges from the merchant 2% of the payment value, on each sale, and 1% on redemption (exchange of local currency for Reais): this revenue is divided between the local CDB and BCBN. In Maricá case, where the municipality pays for expenses such as the rent for the CDB, all revenue remains with CDB Mumbuca.

[6] It is important to point out that, given the extension of the territory, Banco Mumbuca currently has 4 bank branches in the city, in addition to the central one. More in the reports on the circulation of Mumbuca produced by LabIS/UFRJ, at https://is.cos.ufrj.br/producoes/. Accessed on Aug 21, 2020.

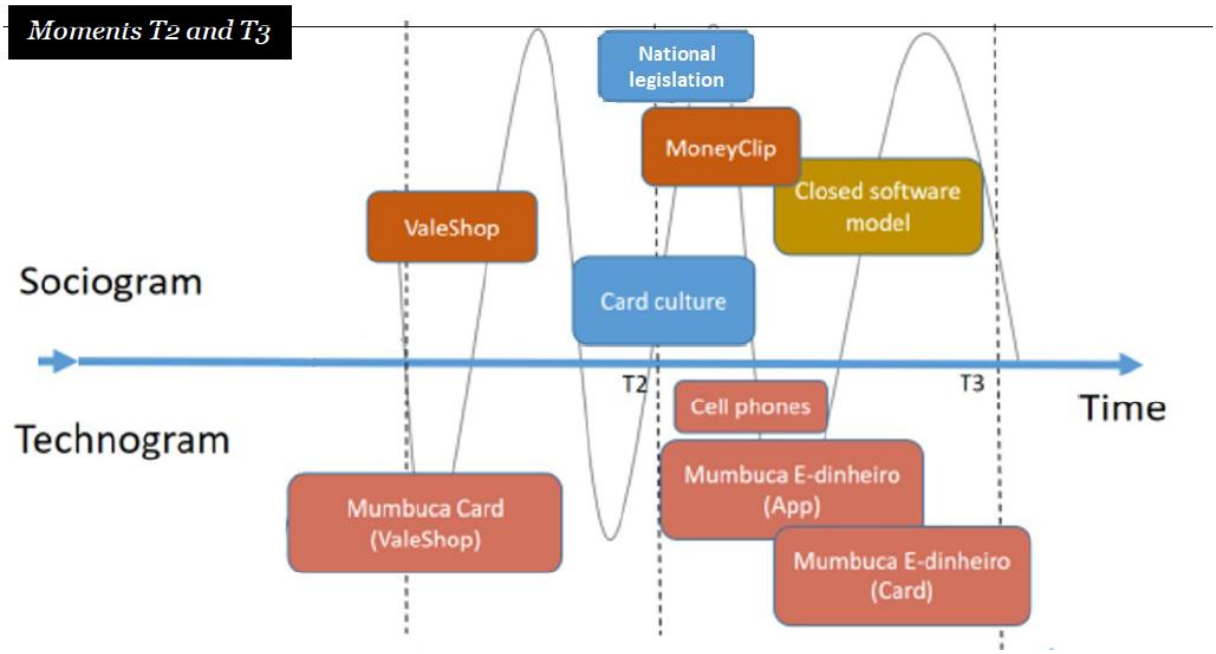

Figure 4 – Represents temporary stabilizations: the change of the technological provider of the digital platform (from ValeShop to MoneyClip). Anchored at the national legislation and at a partnership with MoneyClip, Banco Mumbuca benefited with more resources, enabling a local microcredit program.

Currently, the program has an annual budget of R$ 62 million and covers families that earn up to 3 minimum wages, constituting the main laboratory for the implementation of a basic income plan in the national territory. Its effects so far are remarkable: in addition to the expected reduction in poverty, there is also growth in economic activity, which is expressed in an increase in ICMS and ISS collection of around 15%, while in the rest of the state there was an average drop of 30%[7].

Additionally, there are effects that are manifested in the social and political life of the municipality. Souza (2018) points out that the beneficiaries began to have more confidence in the government and to participate more in the political life of the city. The creation of local institutions, with the strengthening of community ties and the creation of social capital are effects that are largely verified in experiences of social currencies and contribute, to a great extent, to the resilience of territories.

From an organizational point of view, the Mumbuca system proved to be innovative. The origin of social benefits paid in local currency results from public resources collected by the

[7] The spending multiplier effect can result in increased government revenue. If the income received by beneficiaries manages to boost local economic activity, there will be higher tax payments. More information at: BETIM, Felipe. Maricá, no Rio, preserva empregos e negócios na pandemia e coloca a renda básica no centro do debate. **El País.** Maricá, p. 1-2. July 19 2020. Available at: https://brasil.elpais.com/sociedade/2020-07-19/marica-no-rio-preserva-empregos-e-negocios-na-pandemi a-e-coloca-a-renda-basica-no-centro-do -debate.html. Accessed on: 21 Aug. 2020

municipality, mostly from oil royalties. Therefore, it is up to the local government to determine the budget and allocation of resources. At the same time, the Banco Mumbuca is an institution managed by community members and is part of the Brazilian Network of Community Banks. Its performance is based on the promotion of technical expertise and social relations that disseminate knowledge for the construction of new banks, guaranteeing technical and human support. It is therefore a social network that promotes the dissemination of knowledge and the emergence of social innovations (GRANOVETTER, 2007).

The role of the community bank at Maricá is to operationalize the payment of resources to beneficiaries selected by the city government. In other words, it is at the forefront of local currency management, dealing directly with the realities of the territory. In addition to receiving public funds, the bank finances itself through fees generated in the digital social currency payment system itself. That is, most beneficiaries use a mobile phone application to make payments at registered establishments. In short, the local government provides budget resources, while the community bank manages the social currency circuit.

Additionally, it is worth mentioning that the CDB was initially implemented by the Banco Palmas team, a period in which many of the bank customers and employees confused the very identity of Banco Mumbuca with that of Banco Palmas (FARIA, 2018). Currently, we could see that Banco Mumbuca is not only formally an association located in Maricá, but has gained autonomy to analyze strategies, its own lines of microcredit and support for social projects.

4. Arariboia case and new BCBN categories: a municipal bank with a social municipal currency

Perhaps the authors' first approach to Banco Araribóia was through the URBE Latin America project (Urbe LatAm) and Banco Preventório. The project (started in 2020) and community resilience as its main theme and the Preventório community bank (located in Niterói city), as long as its microcredit and social currency iniciatives, as community potentialities. The social currency Prevê was inaugurated with Banco Preventório in 2011, but from 2016 on has barely circulated in the community (FARIA et. al, forthcoming). At the end of 2021, after the most difficult phase of the COVID-19 pandemic, the Preventório community and the project understood that it was time to resume strengthening the circulation of its social currency.

Banco Preventório, unlike Banco Mumbuca and Araribóia, is an experience that did not have significant support from the municipal authorities. As shown in figure 5, its network points to a variety of partnerships (with universities, volunteers, and donors) and actions (such as recycling and cultural projects) that currently help keeping the Bank alive and the microcredit

operation active. This one, it is worth mentioning, was specially remodeled in partnership with the Urbe LatAm project, through online regular discussions during the COVID-19 pandemic.

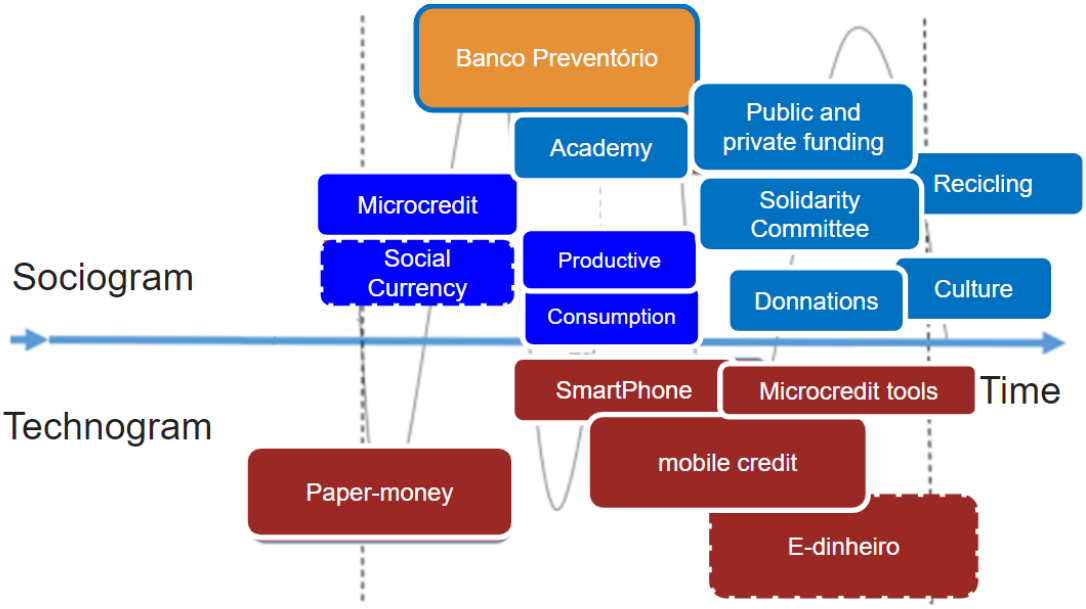

Figure 5 - Provisional stabilization of the socio-technical network of Banco Preventório

In the second half of 2021, the weekly planning online discussions for Preventório microcredit and social currencies continued. On that occasion, the emergence of other complementary currency experiences in the city was identified, notably the municipal social currency Araribóia and the NITE currency (CityCoin project). Regarding the resumption of circulation of Prevê, some steps were defined in the discussions, among them the establishment of a partnership with the Araribóia currency (which would start circulating in January 2022) and training sessions in order to re-discuss social currencies concepts and practices with new and old bank members (FARIA et. al, forthcoming).

The project organized the 1st Seminar on Community Public Emergencies and their Citizen Technologies, held on March 21[8] and 29[9], 2022, motivated by the necessity of dialoguing with the local government. The government Social Assistance and Solidarity Economy Secretariat (responsible for the Araribóia currency) took part in the discussions

[8] https://www.youtube.com/watch?v=ZW1vm6Du5Qc. Accessed on 14 set. 2022.

[9] The Seminar's discussions pointed to extremely interesting opportunities in the sense of articulating the experiences of the Prevê community social currency, the Araribóia municipal social currency and the NITE municipal digital reward currency. As an example, the possibility that citizens who consume products and services from small producers and traders of the solidarity economy, with Araribóias or Prevês, are awarded with NITEs. Another possibility was the partnership between the currency Araribóia and Prevê in the territory where Banco Preventório operates, ensuring that the community identity of Prevê is maintained and strengthened (FARIA et. al, forthcoming). https://www.youtube.com/watch?v=RqHAzKpCzEs. Accessed on 14 set. 2022.

“Strengthening community dreams: the microcredit” and “Circulating Local Riches: social currencies”, as well as in the opening and closing sessions of the event.

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During the event, it became clear that the Arariboia currency, on the one hand, was the result of the articulation of community banks (as stated by Joaquim Melo himself, one of the founders of the pioneer Banco Palmas) and their “community social currencies” around the BCBN. On the other hand, Arariboia was also the result of BCBN’s move to approach local governments in order to compete in the electronic payment market forged by Law 12865/2013 (FARIA, 2018), in the digitization process of their currencies through the E-dinheiro platform (which would also support Arariboia currency). In the State of Rio de Janeiro, in addition to Banco Mumbuca (initiated in 2013), from 2019 on five other municipalities articulated what came to be classified as Municipal Social Currencies by Instituto E-dinheiro Brasil (IEB): Niterói, Itaboraí, Quissamã, Saquarema and Porciúncula.

It is worth mentioning that the history of the Araribóia currency was controversial since its beginning, since no action was made aiming to dialogue or even strengthen Banco Preventório Bank and the solidarity economy in the municipality. It is important to point out that the city of Niterói already had articulated solidarity economy actions, such as small producers' fairs, a local solidarity economy forum, in addition to the Preventório Bank itself. A different scenario from the one found for example in Maricá at the beginning of Banco Mumbuca. The municipal law project in Niterói that gave rise to Banco Araribóia, for example, was the subject of many amendments, promoted especially by actors from the local solidarity economy forum, including Banco do Preventório. In a public hearing on the subject, the bank articulated with different actors, including researchers from the Observatory of Community Banks and Social Currencies (OBM, in which the authors participate), represented - at the time - by the geographer Carolina Pupo. At that moment, little or no articulation of the actors involved in the consolidation of the Moeda Araribóia with the actors of the solidarity economy of the municipality was perceived. A certain concern was then built in the creation of a digital social currency without local roots, which could even become an obstacle to the activities of existing community banks, in this case Banco Preventório.

Thus, from the point of view of Banco do Preventório, the paths towards the desired partnership with Arariboia around social currencies took longer to take shape than those discussed in the Preventório circle at the end of 2021. Even after the seminar, the mediations continued: in May 2021, Banco Preventório sends proposals to Instituto Edinheiro Brasil, requesting

> 1 - formalize a partnership with Banco Preventório, to carry out the microcredit actions corresponding to the revenues generated by the Araribóia currency and others from the municipal program;
>
> 2 - formalize a partnership for the management of Araribóia currency in the communities of Cavalão, Grota, Preventorio and Jurujuba, areas close to Banco Preventório; and
>
> 3 - stablish periodic meetings (between the IEB and Banco Preventório) to coordinate the Prevê community social currency and the Araribóia municipal social currency.

The agendas between Prevê and Araribóia were accepted by the Local Forum of Solidarity Economy of Niterói, and later taken to the local government. Within the scope of BCBN, Joaquim Melo signaled positively about the proposals, however pointing out a dependence on the local government to implement them. However, until the writing of this paper, there was no decision by the local government on the subject, and the Araribóia network did not include Banco do Preventório, Prevê Card, the social paper-money currency, and also did not provide microcredit to the local population (figure 6).

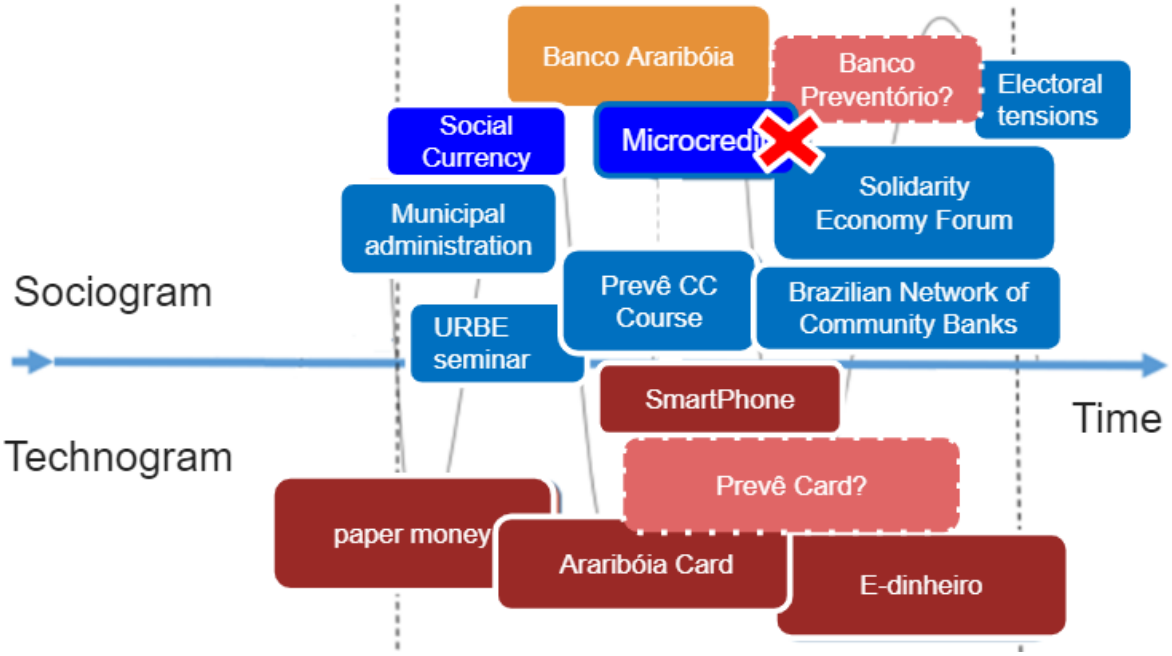

Figure 6 - Provisional stabilization of the socio-technical network of Banco Araribóia

If, from the point of view of Banco Preventório, the frustration with the process of implantation of Araribóia is notorious, it can be said that from the point of view of the city hall, BCBN and Instituto Edinheiro Brasil (IEB), the case is perceived with enthusiasm. In February 2022, the IEB released a public document (https://bancomunicipal.org/) in which they differentiate "Municipal Social Currencies" from "Community Social Currencies", assuming important differences between the methodologies, among which we can highlight:

"A social currency 'created' by a municipal law, there is no doubt that the municipality belongs to its governance. Just as a currency created by a community, under the aegis of a Civil Society Organization, to which its governance belongs. This is not about measuring which model is more popular, participatory, democratic; both can create a form of shared governance and democratic forms of decision-making."

The same document[10] points out the relevance of the numbers of the new experiences: community social currencies add up to approximately 23,000 accounts (2021), while municipal social currencies add up to 8 experiences, with 113,000 accounts (2021), with the following amounts (Dec 2021): Maricá (Mumbuca) BRL 26,000,000.00; Niterói (Araribóia) BRL 6,000,000.00; Cabo Frio (Itajuru) BRL 1,000,000; Itaboraí (Pedra Bonita) BRL606,750.00.

Another important epistemological landmark for the knowledge community of Brazilian CBDs, identified in the data of this research, was collected in social networks. The profile of @edinheirobrasil on the Instagram network (on 08/31/2022) starts to differentiate "community banks" from "municipal banks" (figure 7).

[10] Link direto: https://drive.google.com/file/d/1_tWY8qg39u2Xa2k0CxCSz_vYPG3Mhtpb/view. Accessed on 14 set. 2022.

Figura 7: IEB differentiates community banks and municipal banks

The post establishes the common goals of the two models,

> Both models use the E-Dinheiro platform; They promote the development of territories; They encourage social currency; They promote a network of contacts between customers and local merchants.

They also point out their differences:

> Community banks are banks built on the basis of popular organization, with projects and benefits organized by the people, in partnership with popular associations and cooperatives. Their projects are supported by the local community organization. Municipal banks are banks managed in partnership with municipalities based on municipal laws, generally they work by helping to deliver social and financial benefits to the population, contributing to the distribution of income through the public authoritie.

It is also worth noting that, as we pointed out above, each municipal law defines the (important) details of each experience. For example, Araribóia foresees seven branches spread across the city of Niterói (by the way, including a branch very close to Banco Preventório), and the constitution of a fund for local solidarity economy initiatives (partially formed by the fees charged on the E-dinheiro platform). However, it is not clear how (and if) the effective constitution of a bank (whether community or municipal) will be carried out independently of the City Hall (as is the case of Banco Mumbuca, in Maricá). Finally, as a last relevant data collected until the writing of this paper, an important difference in the methodology of the municipal bank of the city of Cabo Frio indicates the payment of social benefits with a “regionalized” currency, that is, the beneficiary can only use it in its region of

the municipality (a format that points to a greater similarity with the more traditional model of community banks).

5. Discussion

Initially, it is important to point out that the “Mumbuca model” (in short, started with the payment of a monthly income to a population through social currency), despite its relevance, does not summarize the history of partnerships involving CDBs and public policies. A noteworthy case is the purchase of waste with social currency, currently carried out by the Fortaleza cleaning company, in partnership with Banco Palmas (E-carroceiro)[11]. In this experience, the company's employees buy waste, according to a price list, from the “carroceiros” of Fortaleza, paying in Palmas E-dinheiro. The project is related to other experiences, such as “Pago em lixo”, developed by the local government of Campolide (Lisbon region, Portugal): in that initiative, the local public power organized monthly events in which citizens took their recyclable waste, exchanging it as “Lixo” (local currency with Euro parity) accepted by small businesses. In both cases, the central issues are the correct destination of the waste, urban cleaning, protection for small businesses and, in the Brazilian case, the social inclusion of carters.

Historically, other modalities of public power support to CDBs have proved to be important: resources that support funds intended for community microcredit (whether reimbursable or not) were fundamental, for example, in the BNDES' (Banco Nacional de Desenvolvimento Econômico e Social) support for the expansion of the Brazilian Network of CDBs (FARIA , 2018). There are also important resources to support the implementation of new CDBs, involving, for example, networks of incubators linked to the solidarity economy, as well as other advisory structures (in Universities and Institutes) – for Banco Preventório, for example, the Incubator of Solidarity Enterprises of the local University was a fundamental agent. Training support, either from microcredit agents (historically quite relevant) or from agents supporting the use of electronic social currency (a topic with increasing importance), enter the list of possibilities for promoting CDB s by the public authorities. Assistance in renting or granting physical space is also an important condition for the sustainability of CDBs: experiences where such support is obtained are not uncommon internationally - as in the cases of LaTuruta (Vilanova i la Geltrú, Spain) and lÉlef (Chambéry, France) -, and constitute an important advantage for the financial sustainability of CDBs, as pointed out by Faria (2018) in the experience of CDB Preventório.

[11] More at http://edinheirobrasil.org/prefeituras-fortaleza/ and https://diariodonordeste.verdesmares.com.br/metro/mais-100-trabalhadores-sao-recebidos-no-e-carroceir o-1.1984447 . Acess on 19 Aug. 2020.

Other forms of action by the public power can be mentioned, which, while promoting social currency systems, end up bringing tangible benefits to the territories. In Santa Catarina, the NecDindin project was developed by teachers from the public school network in the city of Itajaí city (SC)[12]. It is an action that aims to circulate a social currency within schools in order to encourage students to reflect on the currency and the economic system in general. Furthermore, the Palminha currency - a project by Banco Palmas de Fortaleza - fulfills similar functions and objectives.

The educational potential of such experiences highlights the centrality of public power as a policymaker in this direction. Extending the discussion to “non-monetized community banks” (or local monetary systems not backed by official currency), there are various types of local monetary experiences worldwide that exert positive externalities on society. There are projects that pay people who engage in community gardens, in solidarity activities, in urban revitalization projects, support for neighbors with low mobility - the elderly, the sick, etc. (SEYFANG and LONGHURST, 2013; BLANC, 2013).

Such incentives, although they could be in official currency, play a greater role when paid in currencies that circulate only in the localities in question (even when the currencies are not convertible into “official currency”). Even for systems with such characteristics, several of the aforementioned support from the public authorities are valid (such as technical support, physical space, etc.). With these social currencies, it is possible to fulfill a dual function: to stimulate the engagement and improvement of communities through the actions mentioned above, while creating a circulating medium that retains resources and values local economies.

There is, therefore, a variety of articulations that the public power can exercise in order to promote practices with social currencies. From financing to purely organizational support - providing consultancy, dissemination, technical support, mapping local offers and demands - the possibilities are fruitful and depend on the scale at which the social currency system(s) is intended to be built.

The examples examined more closely in this research point to the implementation of public policies for basic income by community banks, an agenda of this movement that is able to enhance the generation of local income, as it was possible to observe in the municipality of Maricá (RJ) with the Banco Mumbuca. Additionally, we saw that the current legislation for electronic payment arrangements started, as of 2013, allows community funds to be generated, constituting relevant legacies for the populations involved. Organized in a network, community banks have a unique digital platform, the E-Dinheiro platform. Some

[12] More at: https://www.facebook.com/moedasocialnecdindin/

operations on the platform, such as payment or withdrawal, generate small fees that feed the community funds of each of these solidarity organizations.

Such a “techno-legal” arrangement seems to have contributed to the recent strategy of the Brazilian Network of Community Banks, in which the E-dinheiro platform is seen by municipalities as a means of payment for grants and basic income programs, which brings new connections and challenges. Among the concerns perceived is the possible appropriation of financial inclusion policies by local governments and companies. If, on the one hand, basic income policies can provide virtuous effects in various spheres of economic and social life, on the other hand, municipal (community?) banks, conceived and managed by actors potentially not involved in the community, can build a dynamic that ignores the needs of the small local merchants and undermines pillars of solidarity finance, supported by local development.

In this sense, it is important to draw attention to issues such as the autonomy of the community banks involved, in relation to the municipalities that implemented such policies. Such autonomy allows, on the one hand, the continuity of these currencies and banks over time (less dependent on the governments in charge), and, on the other hand, it opens up more concrete possibilities for the participation of the local population in the decisions of the banks through, for example, advice for formulating and evaluating microcredit lines (as we could see at the Mumbuca case).

Another relevant point that the data collected in Niterói points out refers to the territories that bring together municipal and community Banks (using here the new nomenclature promoted by the Instituto E-dinheiro Brasil). We bring up the need for dialogue between existing local community banks with the new municipal “community” banks, which are being implemented, as is the case of the local community bank of Preventório and the municipal bank Araribóia, both in the municipality of Niterói (RJ).

In the Araribóia case, the data shows that the municipal bank has been built without dialogue with the existing CDB. There, evidence indicates that the reason for the difficulty in dialogue may be related to different political parties affiliations - when we compare, on the one hand, the municipal secretariat responsible for Araribóia and, on the other hand, some of the builders of Banco Preventório - despite the fact that definitive evidence in this regard were not found.

It is worth noting that efforts were made to build bridges between the CDBs at Niterói, specially those initiated by the Urbe LatAm project, such as the participation of the municipality in the 'I Seminar on Community Public Emergencies and their Citizen

~~Technologies', the invitation to the local government to participate in the 'Solidarity course on~~ social currency and microcredit with Preventório' and a letter from the Urbe LatAm Project addressed to the city hall, as a feedback on the seminar and an invitation to dialogue. This experience points to the need for reflections within the BCBN in the sense of mechanisms to strengthen community banks without partnership with local governments, reducing the asymmetry between these and the so-called municipal banks.

We start from the assumption that the resources from IEB's contracts with municipal governments and, especially, the fees collected through the E-dinheiro platform, are potential sources of extremely relevant financial resources for the BCBN as a whole, and not only for municipal banks. Joaquim Melo himself points in this direction when he states that both Banco Araribóia and the E-dinheiro platform are collective constructions resulting from the work of many community banks, such as Preventório. One option that seems viable and not subject to interference from municipal managers would be that a part of the resources collected by IEB (with the contracts and fees of municipal banks) were destined to a fund to support other community banks (figure 8).

Figura 8 – Possibility of funding for community banks

We represent in the figure some of the BCBN community banks, as well as the Instituto E-dinheiro Brasil (IEB, registered with BACEN and which provides the platform for CDBs). That is to say, Banco Mumbuca and Banco Araribóia appear within the BCBN, insofar as, on the one hand, we did not find any evidence that municipal banks will not participate in the network, and, on the other hand, we identified the new nomenclature 'municipal bank '. The Community Banking Fund (FCB - Fundo para Bancos Comunitários) would thus be fed by a portion of the fees and contracts between IEB and municipalities (such fee should be agreed between BCBN and IEB). The other community banks (non-municipal) could access the fund

~~according to rules defined by the BCBN. As possible rules for the FBC, we can imagine: that~~ a CDB that is located in the territory where there is a municipal bank (case of Banco Preventório) would have access to a greater portion of the resources coming from that municipal bank assigned to the FBC; that the fund could be accessed in a loan modality (where the CDB would use the resource for local microcredit) or in a non-refundable transfer modality (in which the CDB could use it for its infrastructure or local projects).

A socio-technical arrangement like that could reduce some of the risks examined here (such as the increase in asymmetry between municipal and community banks) and would enhance the historical experiences of CDBs, community participation and solidarity economy. Here, it is worth dialoguing very briefly with the article by Milton Santos, published in the Brazilian newspaper Folha de São Paulo (late 1990s), in which the Brazilian geographer pointed out to us that crises and tremors established by finance are capable of creating awareness of the problems local and national. Santos proposes that it is the place and its dynamics that builds other financial forms. It seems to us, therefore, that community banks, their social currencies and the E-dinheiro digital platform are expressions of this “chão contra o cifrão” (“ground against the money sign $”), as Santos proposes, giving strength to territories.

6. Conclusion

The paper shows the Banco Mumbuca case, a paradigmatic one because of the amount of resources involved as well as the coexistence between solidarity economy, local development and public policy. Another case discussed was the recent Banco Araribóia case, in the municipality of Niterói (RJ), on a territory where another CDB has already worked for more than ten years (Banco Preventório). We discussed different modalities of public support for local banks and currencies, and specially the issues brought by the examination of Mumbuca and Araribóia experiences. In addition to understanding that the characteristics of community banks can also permeate the new municipal banks (as the history of Banco Mumbuca has shown), the paper advances proposing a possibility framework in which the municipal banks model (already explicitly admitted by the IEB) encourages the existing community banks.

Here, the action of community development banks is advocated in synergy with local governments with regard to the implementation of basic income policies. Although it is widely known that such policies have beneficial effects in reducing poverty and other deprivations, improvements in their applicability can be suggested, providing them with the necessary democratic decentralization, something that community banks have to offer.

By operating in a way that is rooted in the places where they are located, community banks have the ability to map local needs, as they are in close contact with the surrounding citizens. This brings about a desired approximation between public policies and communities through community banks. This integration allows its credit agents, as well as the families and companies involved in the locality, to act in co-participation with public policies, improving their control, their implementation and their results. There is, in the literature on the subject, a series of evidence that points to the positive aspects of this interaction, since the appropriation of community resources empowers and feeds back governmental action in the territory, perpetuating its benefits.

In this sense, although the creation of community banks encouraged by the municipalities is a promising practice, we reinforce that there is in this process a great opportunity for valuing the existing practices and initiatives of the community banks experiences in Brazil, with their social currencies connected to the local populations. Here, therefore, we draw attention to the power of gathering the benefits of inclusive public policies, such as basic income, with the virtues of community resource management, in this case a social currency. The engagement of local populations in maintaining common resources (whether they are water, forests or currencies) strengthens and roots solidary and democratic management practices in the territories, something necessary and especially relevant in Brazil nowadays.

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Data Utilization of Digital Community Currency for regional economic policy: Case of TARCA in Otaru, Hokkaido

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Keywords

Digital Community Currency (DCC), Regional Economic Circulation, Network Analysis, Regional Economic Society Analyzing System (RESAS)

Abstract

There has been an increased interest in digital currencies (DC) worldwide, including in Japan, affecting the economic activities of various agents. This interest has spread to urban areas and rural areas, and digital community currency (DCC), that circulate within specific areas as a tool for revitalizing the local economy, were introduced in quick succession. Japanese pioneering DCC, "Sarubobo Coin (Hida Takayama Area in Gifu)," was launched by the Hida Credit Union in December 2017 and has reached a cumulative settlement amount of approximately 5.1 billion yen as of the end of January 2022. The number of users has reached approximately 24,600, and the number of member stores has reached approximately 1,700. Multiple agents, mainly credit unions and local governments, such as "Aqua Coin (Kisarazu City in Chiba)," and "Setagaya Pay (Setagaya Ward, Tokyo)," that use the same DCC platform "Money Easy" as Sarubobo Coin. These projects are focusing on stimulating consumption in the region while simultaneously achieving regional economic revitalization and community formation (Yoshida et al., 2021). In addition, as DCC use blockchain, "Byacco" operated at the University of Aizu and "Kintetsu Harukasu Coin / Shimakaze Coin" experimentally operated in the Kansai Area have appeared.

The purpose of this study is to consider how regional economic policy can contribute to Fin Tech and regional revitalization, by examining the methods of analysis and utilization of macro data, such as regional economic circulation rate and interregional balance, and micro data, such as user trends obtained through social experiments of DCC. With macro data, it is possible to grasp the structural characteristics of the regional economy, mainly focusing on the "Regional Economic Circulation Map," which can be obtained

from the Regional Economic Analysis System provided free of charge online by Japanese government. In addition, regarding micro data, we analyze transaction data between users obtained in the social experiment of DCC "TARCA," which was introduced in Otaru, Hokkaido, to promote volunteer activities and regional economic circulation.

TARCA employs an online account-type system that enables electronic payments through smartphones and tablets to be made within the community. It is easy to send and receive information about events and stores, and messages are sent on the completion of every transaction. Miyazaki has been involved in research and management as a secretariat since considering the first introduction of TARCA in Otaru and has supported its efforts. We started the DCC social experiment for approximately two years beginning 2012 and achieved some results (See Miyazaki 2019 for details). Subsequently, in collaboration with Kobayashi, we examined a circulation design utilizing transaction network analysis that visualizes the behavior of participants using transaction data from TARCA (Kobayashi and Miyazaki, 2021). Through these analyzes, we will clarify the vision of regional economic policies and the possibility of data utilization that contributes to the formation of local communities while stimulating consumption in the region.

Introduction

In this study, we propose a regional economic policy based on regional data by utilizing a circulation experiment of digital community currency (DCC) and its circulation data. Regional policy in Japan needs to shift from the traditional "opinion-based policy-making (OBPM)" to "evidence-based policy making (EBPM)" in recent years (Hayashi et al., 2021). Regional data analysis and its use are essential for promoting evidence-based regional economic (or community) policies.

Evaluating business promotion and regional revitalization based on evidence has been challenging. A typical case study is a stamp business, in which a store or shopping street aims at a customer retention strategy and sales promotion. In the traditional stump business, it is difficult for shopkeepers to take much trouble and accumulate business data for analysis to verify user information. Consequently, subjective satisfaction of customers and shopkeepers is often the key to business continuity. Furthermore, data analysis and its outcomes have not been returned to the regional community, and data utilization has not progressed well in the local loyalty program and some of the Community Currencies (CCs) provided by local governments in Japan.

This study focuses on DCC transaction data as complementary to existing regional data and examines its applicability to evidence-based regional economic or community policy based on the analysis of connections.

1. Regional economic or community policy based on regional data analysis

Since the 2000s, interest in "evidence-based policy-making (EBPM)" has surged worldwide. Although there is no clear definition of evidence in EBPM among experts, the US government report describes it as follows:

> "Evidence" can be defined broadly as information that aids the generation of a conclusion. Throughout this report, the Commission uses the term more specifically. This report uses the shorthand "evidence" to refer to information produced by "statistical activities" with a "statistical purpose" that is potentially useful when evaluating government programs and policies.
>
> Commission on Evidence-Based Policy-making (2017)

In other words, "evidence" can be considered as material (data) to clarify the degree to which a policy contributes to its objectives and effects based on causal relationships or inferences. Until now, policy-making and the evaluation of policy effects have been mainly based on subjective factors such as intuition,

experience, and assumptions of policymakers and residents (local actors). However, since an accurate understanding of policy effects makes verifying their effectiveness and determining appropriate budget allocation by national and local governments, more objective evidence and data-based verification of cause-and-effect relationships are becoming essential.

This trend began in the 2000s, mainly in Europe and the United States, and is now becoming a common goal worldwide. On the other hand, the areas in which practical EBPM efforts are progressing and the status of progress differ significantly from country to country (Baron 2018). For example, circulation experiments and program evaluations, such as randomized controlled trials (RCTs) preceded by EBPM, have been conducted since the 1960s in the United States. Subsequently, the formation of organizations leading EBPM in a wide range of fields, from poverty and education to health and welfare, and the development of laws, have been promoted. In the UK, the What Works Centre (WWC) has been established as an intermediary organization that links academic research and policy-making in each policy field, such as health care and education. It collects and organizes evidence for each field and supports its utilization. In addition, the What Works Centre for Local Economic Growth (WWCLEG) has been established to conduct impact evaluations of local economic growth, examining whether policy interventions lead to increases in employment, wages, and added value (WWCLEG website).

Japan tends to be a backward country regarding EBPM, and most discussions are based on subjective evaluations by national or local governments and residents. According to trends in other countries, the e-Stat (Portal Site of Official Statistics of Japan), which releases statistical data held by the central and local governments, began to be built and disclosed to the public in 2008. Furthermore, to make statistical data easily accessible to local government officials and the public, open data utilization platforms for understanding regional economies, such as the Regional Economic Analysis System (RESAS) and regional economic circulation, have been established. The Cabinet Office and other ministries and agencies are accelerating the promotion of EBPM. There is an emerging movement to understand local (community) economic data and apply them to economic (community) policies.

However, some aspects of data collection and their effective use by local governments and residents have not been found. One reason for this is the problem of personal information protection and security related to data collection and use. Recently, there have been discussions and initiatives such as decentralized Parsonal Data Store (PDS) and information banks in Japan, where companies or governments do not hold data but are managed by individuals and opened to companies and other entities as needed (Hashida 2017). In addition, it is pointed out that there is a shortage of professional human resources responsible for data analysis.

This study, considering these circumstances, examines evidence-based analysis and policy-making for local economic policies using the DCC. The question is, how far have empirical studies on CC progressed in previous studies? Representative examples include a questionnaire and interview-based surveys, input-output analysis, transaction network analysis, simulation analysis, and circulation experiments (e.g., Kichiji and Nishibe 2008, Nakazato and Hiramoto 2012, Kurita et al. 2012). They all show subjective values and satisfaction levels, such as user awareness and behavior changes, and visualize objective behaviors from transaction data to clarify their impact on the local economy and society. Prior studies have often shown the use of CC and its impact on subjective data, and few attempts have been made to move toward subsequent policy-making.

On a practical level, the Community Currencies in Action project, conducted from 2012 to 2015 by a cooperative organization in the UK, France, the Netherlands, and Belgium, can be positioned as an essential activity. This project provides various tools to verify complementary currencies' institutional design, effectiveness, and evaluation methods. For example, the handbook "People-powered Money- Designing, Developing and Delivering Community Currencies" for introducing complementary currencies provides the following information. (1) The potential benefits of CC projects and considerations for implementing them, and (2) specific issues, prospects, and case studies regarding the design, supply, and implementation of currencies. It states that the best way to collect data is through electronic payment instruments, and it is envisaged that the process of currency use and how it is used will be clarified and the project's impact evaluated based on this information.

Furthermore, while building on the results of Place et al. (2015), "No Small Change- How to evaluate your community currency, with accompanying work materials," explains the procedures and methods for analyzing the impact of CC projects from a theory of change perspective explicitly. It is useful because methods can be designed to measure user changes over time and evaluate projects effectively. Thus, empirical studies and practices have been attempted using various approaches; however, as mentioned earlier, only a few studies worldwide have attempted to utilize data analysis from the viewpoint of policy-making and evaluation. One example is the Community Dock developed by Kusago and Nishibe (2018). Community Dock is a practical policy instrument that enhances the effectiveness and validity of a given set of external institutions through spontaneous changes in internal institutions by self-evaluation and self-correction of community members. This study is constructive in considering EBPM using CC.

Based on previous empirical studies and recent trends in digitization, we examine the data analysis in detail and its application possibility of policy in the case of TARCA. The purpose of this experiment was to revitalize local communities by utilizing Information and Communication Technology and CC.

Specifically, the experiment aimed to simultaneously promote volunteer and regional economic circulation by exchanging value and disseminating information using DCC. One of the authors of this paper, Miyazaki, has been involved in the planning and operation of the TARCA project. He is working as a secretariat member and researcher since its inception. This study is the first attempt to link regional strategies and policy proposals through data analysis and DCC utilization in Japan.

2. The circulation experiment of TARCA in OTARU

2.1 What is TARCA?

DCC' TARCA' is an online account-type system employing technology that enables electronic payment for smartphones and tablets (**Figure1**). After registering as a member and logging in, four functions can be used: (1) exchange from cash to TARCA, (2) person-to-person transactions, (3) transactions at stores, and (4) display of the history of transactions (**Figure2**). Individual members obtain TARCA in return for volunteers at events and use it for mutual aid among members and to exchange local food, drinks, and merchandise sales at stores. TARCA can also be exchanged (recharged) for cash if necessary (1 TARCA = 1 yen).

Figure 1 Main Screen of TARCA application

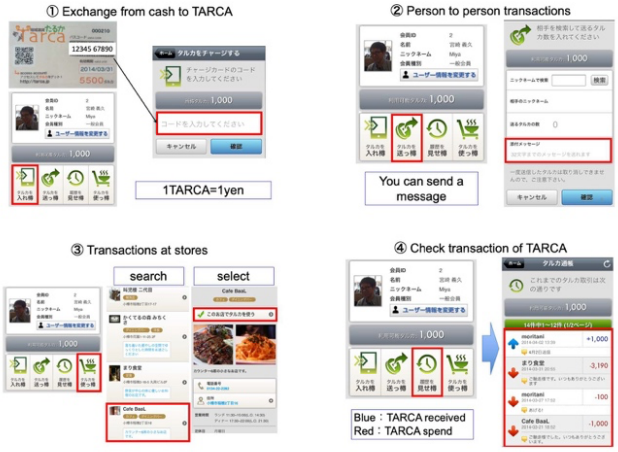

Figure 2　Four functions

2.2　Experiment overview and analysis method

This experiment targeted citizens and college students involved in volunteer and community development in Otaru. The organizer distributes TARCA as a reward for participating in activities and community contributions, and the recipients can use the DCC at local shops or restaurants (**Figure3**). For example, TARCA was circulated as an appreciation to the city's participants in canal clean-up groups and volunteers for various local events. Then, all information on volunteers and stores that accept CC was collected, recruited, and disseminated through the social networking service (Facebook).

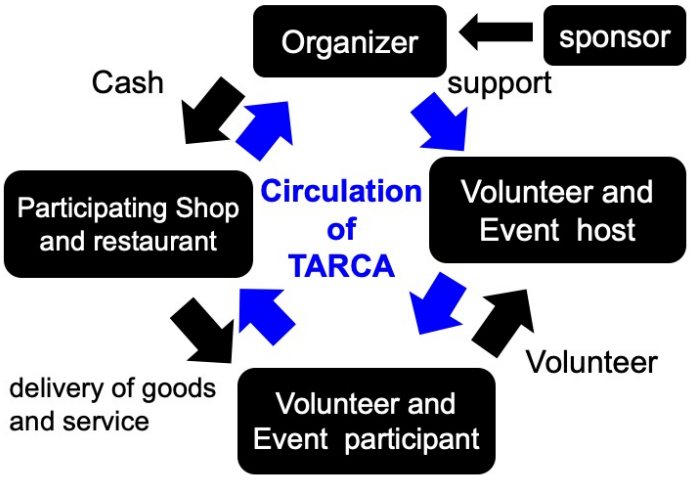

Figure 3　Circulation scheme of TARCA

The analysis was based on the transaction data of the DCC TARCA used from November 30, 2012, to February 28, 2013 (the first circulation experiment). The transaction data mainly included the settlement date and time, settlement amount, and counterparty (attribute information). Real-time transaction information can be downloaded in CSV format. In this study, we attempted several regional data analyses using this data.

2.3 Result of circulation experiment

In analyzing the data, we overview the outline and result of the circulation experiment TARCA, based on the policy-making process and evidence from Hayashi et al (2021). In the first phase, it is essential to indicate the vision and the goal that the project intends to achieve. Otaru once prospered as an industrial port city, but due to its declining population, falling birth rate, and aging population, the city has lost its former momentum and is in severe decline today. On the other hand, this city is well known as a tourist destination, and its events and community development are thriving. Therefore, the city faces the challenge of forming an intra-regional economic cycle that supports the daily lives of its citizens while simultaneously building a network with tourists and residents. It is considered that the discovery, transmission, and improvement of the city's attractiveness based on history and culture, or tourism, will lead to the sustainable development of the local economy. This project aims to support local revitalization and tourism community development by introducing the DCC.

The next important step is discovering the core problems and formulating policy objectives in Phase 2. In this study, a primary survey based on statistical data and a preliminary survey using questionnaires were conducted to understand the current situation in Otaru, the target area of the experiment. Miyazaki (2019) described the experimental background and outcomes in detail and identified two significant points. First, an examination of the regional economic circulation in Otaru reveals that the regional economy depends on funds from outside the region and that funds are flowing out of the region, using a regional economic analysis system called RESAS. Therefore, the reinvestment capacity in this city should be strengthened to prevent the leakage of funds and to promote intra-regional circulation.

Second, the outcomes of the questionnaire survey targeting the three entities of residents, NPOs, volunteer groups, and self-employed shopkeepers who are members of the shopping street revealed the following points. Although the self-employed are dissatisfied with the commercial district and business conditions and the residents are dissatisfied with economic aspects such as employment opportunities, income, and earnings, the outcomes show a somewhat high level of satisfaction with life in Otaru.

Based on these outcomes, we considered the introduction of DCC as a policy objective, and a citizen's group took the lead in planning and managing the introduction of TARCA. In the policy-making phase, the members of the TARCA Steering Committee, a citizens' group, and the author were also involved in the institutional design and circulation experiments while developing the strategy. This experiment was based on the circulation scheme described in **Figure3** and was expected to have three significant effects.

The first is to improve the convenience of payment using the DCC. Considering the spread and development of smartphones and the emergence and rise of electronic payments, we thought the DCC would facilitate payments and promote local consumption in the community. Second, along with DCC, one of the regular activities is to guide citizens by disseminating local information on stores and recruiting volunteers. While it is essential to increase consumption within the community, we believe that combining local information with a medium such as a DCC is an even better match and can effectively promote and guide people to stores and events. Finally, the message function promotes communication. Payment is not just an exchange of cash for goods and services but also a part of communication that connects people and stores and can be a trigger for new interactions. We believe that the message function has many possibilities for creating new connections beyond exchanges.

Based on these expectations, a circulation experiment was conducted, and in the final phase, the implementation of policy measures and evaluation of the project were discussed. The experiment was repeated for a period based on the expiration date. The outcomes of the first circulation experiment are shown in **Table1**, while the circulation transition is shown in **Figure 4**. The final issuance amounted to 355,300TARCA, although it was not large enough to boost the local economy.

Table1　Results of the first circulation experiment

1. Period	2012.11.30～2013.2.28（91day）
2. Participants	117 people
3. Participating shops	22 shops
4. Total amount of issue	355,300TARCA（About 3,000TARCA per person）
5. Total amount of transaction	798,470TARCA
6. Total amount of cashing	315,020TARCA（cashing rate：88.4％）
7. Velocity of circulation	About 9.0（time／year） ※method of calculation：（Total amount of transaction÷ Total amount of issue）÷0.2493（annualized）

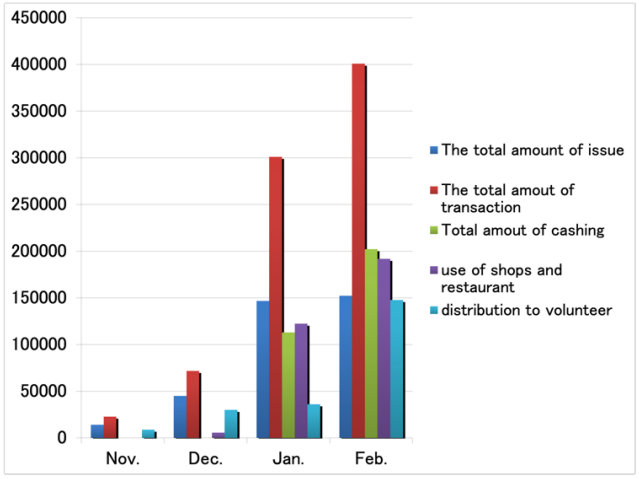

Figure4　Circulation trend（Unit: TARCA）

In addition to these outcomes, we analyzed the velocity and route of CC circulation. The velocity of circulation is calculated as the number of times money (or CC) passes from one person to another during a specific period. As shown in **Table 2**, none of the other regions exhibited such a high value, indicating a significant ripple effect. In addition, the circulation channels showed that approximately 70% of the volunteers and event participants received CC and used it at local stores and restaurants, and approximately 30% of the participants exchanged the currency with other individuals (**Figure 5**).

Table2　Issuance and redemption amount and velocity of CC circulation in Japan

Name	P		Genki	Aqua	TARCA
Place	Tomamae, Hokkaido		Neyagawa, Osaka	Nirasaki/Hokuto, Yamanashi	Otaru, Hokkaido
Period	91day（first）	173day（second）	153day	181day	91day
Total amount of issue	1,096,000	1,485,000	N/A	854,175	355,300
Total amount of transaction	1,385,500	2,458,500	381,300	1,210,650	798,470
Total amount of cashing	1,096,000	1,483,500	137,000	751,275	315,020
Velocity of circulation	5.0708	3.4948	6.6397	2.85816	9.0

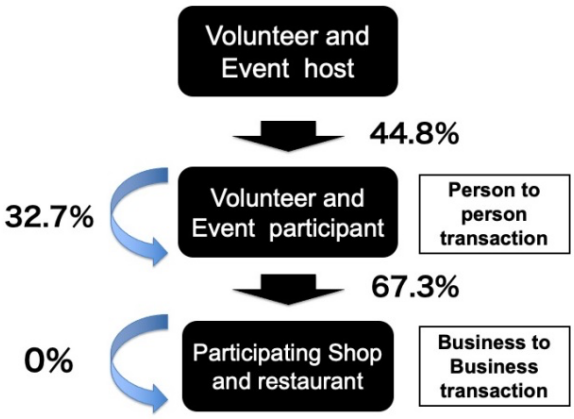

Figure5 Circulation route of TARCA

Although the data could not provide evidence, the steering committee found that the local currency, TARCA, became available at various events in Otaru, and a new network was established with DCC TARCA. For example, the participants were able to experience connections with people in the city through collaborations with local festivals and events, such as the "Moonlight Shops Tour" event in which they visited restaurants in the city at night to discover their charms and volunteer activities to distribute "Tarupon," a local information magazine in Otaru. This experiment's total number of participants was approximately 600 people, 60 stores, and ten events related to CC. Through involvement in various events linked to CC, a network of people, including the steering committee, gradually formed and played a role in building new relationships.

2.4 Discussion from basic data

The reasons for these results can be summarized as follows: First, the target audience, concept, and goal-setting for introducing the DCC are unclear. This is not necessarily limited to DCC, but one reason was that the members could not share why they were introducing CC in the first place, whose issues would be solved by using CC, and what kind of effects they expected from the digitalization of CC. In this experiment, few citizens and tourists used the system, as expected by the management, along with college students who were able to participate as volunteers. In the future, it will be necessary to clarify the purpose of the experiment, establish a system that allows the intended participants, and provide sufficient explanations to users.

Second, activities to promote and educate the public about the DCC system and the dissemination of information were weak. Several procedures (downloading the application and member registration) must

be followed to use the newly developed system. In addition, the penetration rate of smartphones and other devices was lower than expected, and we had to quickly prepare the necessary devices for payment. Consequently, it took time to set up and publicize these devices, and it was challenging to increase the number of users and sponsors who could use TARCA. Many of the users who obtained CC kept it until just before the expiration date because they "did not know how to use it" or "could not find a store where they wanted to use it," and finally used it at a convenient location. This was also evident from the distribution trends shown in **Figure4**.

Another reason for the failure to increase the number of users is the lack of information dissemination to those unfamiliar with CCs or electronic payment systems. It takes a considerable amount of time to explain the purpose and significance of CC and how to use DCC and TARCA to everyone, and it is difficult for users to understand. It is desirable to start with familiar types of currency, such as paper money and bank books, and then gradually shift to electronic currencies. Another strategy would be to increase the number of people interested in CCs by using them as a tool for financial education at events for schools and children, such as game experiences with CCs.

Finally, differences in attitudes toward volunteer activities may have affected CC circulation. TARCA was paid mainly as a reward for volunteer activities, and most of the people who could obtain it were college students. The fact that CC was given in exchange for activities that were essentially free of charge made people who were not accustomed to such activities uncomfortable to use and, as a result, did not lead to active use of CC. This is also clear from several other studies. Whether or not to accept CC as compensation for volunteer activities is related to whether people have a paid orientation, that is, they do not mind receiving a reward, or a gratuitous orientation, that is, they do not mind receiving a reward (Kurita et al. 2015). In the future, based on the results of the circulation experiment, it will be necessary to improve the DCC system further while also considering mechanisms to promote changes in the attitudes and behavior of people who use CC.

On the other hand, however, the limitations of this experiment were also observed. Although the steering committee played a central role in establishing the direction of the CC circulation scheme (institutional design), the smooth circulation of CC was not easy. Contrary to our expectations, we had to constantly monitor the situation, acquire new individual members and TARCA member stores, and deliberately create opportunities for TARCA to be obtained and used. It is necessary to deliberately create opportunities to obtain and use TARCA while constantly monitoring the situation. Consequently, it was difficult to derive an optimal strategy for the distribution scheme even before the initiative began, and the ability to understand the situation and respond to issues simultaneously was required. Furthermore, it was

impossible to sufficiently follow the logic and procedures of the verification process to verify the effectiveness of policies such as EBPM; as a result, time passed without achieving satisfactory results.

At the current stage, continuing to consider the best measures for CC circulation while repeating trial and error through demonstration experiments is essential. At the same time, it is important to consider what needs to be verified and how to do so. In addition, there is a lack of methods to acquire and analyze the circulation status in real-time and to utilize the data for policy purposes. Although it was possible to track the transaction history of CCs and measure the volume and speed of transactions after the demonstration experiment, no measures were found to objectively grasp the situation at the distribution stage, evaluate the situation, and consider and prescribe measures to deal with the situation. This is a significant bottleneck when considering the policy applicability of CCs and requires a solution.

In the next section, we investigate the possibilities and issues in verifying new effects using transaction network analysis based on transaction history information. In addition to the previous analysis, we conducted a transaction network analysis of TARCA to visualize participants' behavior according to their attributes and clarify the factors that promote or hinder the circulation of TARCA.

3. Evaluation and Issues of transaction network analysis

We analyzed transaction data from a demonstration experiment conducted between November 30, 2012, and February 28, 2013. We analyzed all transaction data, including TARCA issuances and redemptions. We categorized users into two demographic groups, "college students" and "others," and used network analysis to determine how they used TARCA. Gephi 0.9.2 was used for analysis and visualization.

3.1 Result of transaction network analysis

Figure6 shows a transaction network created from TARCA transaction data. Each node represents a user, and the nodes' edges indicate that transactions are made between users. The arrows on the edges represent the flow of TARCA in the direction of the arrow. TARCA was issued by three entities, represented by green, red, and orange nodes, respectively. User nodes are represented in purple for college students, yellow-green for others, and blue for stores.

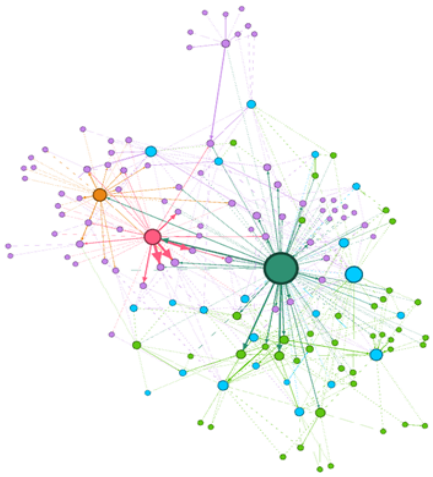

Figure6　Transaction network of TARCA

：The size of the node represents the size of the degree.

The average degree, which indicates the number of transactional relationships a user has, was 2.84, and the average path length was 3.256. The average path length of the random graph calculated using the same number of nodes and average degree was 2.572, which is similar to the average path length of the random graph. The average clustering coefficient is 0.325, an order of magnitude larger than that of 0.042 on the random graph, indicating that this transaction network has a cluster structure.

Figure7 shows that the attributes of the users receiving TARCA differ depending on the issuer (red, orange, or green). The red and orange issuers transfer TARCA mainly to college student nodes (purple), whereas the green issuer transfers TARCA to college students (purple) or others (yellow-green). The reason for this depends on whether the publisher is a volunteer organization with strong ties to college students or a publisher with ties to people other than college students. Focusing on stores where users use TARCA, there is a difference in the main destinations of TARCA use between college students and others.

The percentage of store usage attributes can be divided into three main categories, as shown in **Table3**. Calculating the average distance of each group of stores from the college, we found that the group with a more significant percentage of students using TARCA was closer to the college, while the group with a smaller percentage of students using TARCA was farther away from the college. It can also be seen that store groups with large percentages of other payments have locations scattered in the suburbs of Otaru.

Table3 Average distance from the store to college

according to the percentage of user attributes: Parentheses indicate standard deviation

Percentage of stores used by each attribute	Number of stores	Average distance from college
Group of stores with more than 80% of student user	4	0.81km（0.93）
Group of stores with more than 80% of others user	11	2.70km（1.43）
Group of stores other than the above	7	1.69km（0.25）

In addition to the regular demonstration experiment, a one-day store tour event using TARCA was held to promote its use. On the day, 107 TARCA transactions were conducted (556 during the demonstration period). **Figure7** shows the transaction network for that day.

Figure7 Transaction network of the event day

In this event, all participants gathered at a particular store and were then grouped to visit several stores. In **Figure7**, the node with the highest degree that appears in the center represents the store where they first gathered, and the blue nodes in the surrounding area represent the stores they visited afterward. Some groups consisted only of others, while others were a mix of others and college students. This event has created new encounters between people and stores through TARCA and new encounters between people.

3.2 Discussion of transaction data

Because there are differences in the stores used by different user attributes, we believe that expanding the number of stores where TARCA can be used based on the orientation of user attributes will improve user convenience. However, because most students used stores near their college, increasing the number of

student volunteers too much could lead to a concentration of transactions at certain stores. On the other hand, increasing the number of citizen volunteers is more complex than increasing the number of students; however, if we can increase the number of other users, there is a strong possibility that we can expand the distribution range of TARCA within Otaru.

However, simply having users use TARCA at stores where they use legal tenders is unlikely to discover new attractions and values in the community. The event analyzed in this study effectively used TARCA in the city and made them aware of new stores. The transaction network for this event (**Figure7**) was independent of the overall network, and "other" users who rarely participated in this event used TARCA in other stores during the demonstration. Although some user-to-user TARCA transfers were observed during the event, these were transfers for batch settlement at the store and were only practical transactions. In other words, "others' users who participated in the event did not use TARCA afterward. Unless a way to obtain TARCA outside the event is provided, transactions with TARCA will likely become transient and limited to the event. Providing users with information that encourages them to use TARCA will be the key to continued TARCA use.

Our analysis shows that there were almost no transactions between stores and users. We believe that one of the reasons for this is that TARCA was not sufficiently explained to users, including stores. The TARCA was perceived as a coupon that could be redeemed for cash. This is also an issue in other DCC.

4. Toward EBPM utilizing transaction data of DCC

In this section, we summarize the implications and considerations for EBPM using DCC transaction data based on a circulation experiment and its analysis. The following three points became apparent once we looked back at the experiment.

First, more accurate and objective data can be obtained in real-time. Until now, analysis has been conducted based on questionnaires and interviews with the concerned entities. However, conventional data collection and analysis are time-consuming and costly, and they take a lot of time and money before they are reflected in the subsequent measures. Therefore, collecting and analyzing new DCC transaction data will enable immediate, accurate, and objective evaluation. Furthermore, future technological developments will enable real-time data collection, analysis, and visualization, facilitating new policies and feedback to residents. The transition to new policy planning and implementation will be smoother and more accurate in the future, based on data analysis and policy evaluation.

Second, local information from the micro level (each actor in the community) to the macro level (the entire community) with CC transaction data can be grasped and analyzed in a complementary manner. Until

now, micro-level data for each actor and macro-level data for the community have been obtained and analyzed separately. The micro- and macro-structures can be supplemented mutually with trancaction network analysis, although the scope of users and communities is limited. Although the community of users and stores was limited in this experiment, we may be able to analyze spillover effects with objectivity and high accuracy of behavioral data in the future. Furthermore, it is possible to compare the results with those of users and communities that do not use CCs.

Third, by complementing the subjective information from questionnaires, interviews, and analysis results and understanding the community situation from various aspects, we can verify the hypotheses from new perspectives. In policy-making, it is possible to test meaningful hypotheses based on the actual conditions of the community rather than setting hypotheses based on conventional intuition, experience, and assumptions. For example, starting from an understanding of trends such as pay time, user attributes, and location of use through network analysis, residents, can formulate hypotheses on why these behaviors are adopted and develop an environment that is easy for users or stores to use, and incorporate innovations to promote intra-regional circulation and communication. It may be possible to develop an environment that is easy for users or stores to use or to incorporate devices to promote intra-regional circulation and communication. Thus, further verification is needed to determine how these barriers can be overcome through transaction data or network analysis and how they can be reflected in EBPM.

Despite these advantages, several issues remain to be addressed. Although transaction network analysis can grasp the history of behavior, it cannot grasp the reasons behind such behavior. In this respect, additional questionnaires and interview surveys should be conducted to supplement previous data analyses. There is no other best way to explore the combination of more sophisticated data analysis and policy-making through repeated hypotheses and verification.

In addition, the issue of handling regional data has always been an obstacle in discussions on EBPM. From the viewpoint of personal information protection and security, it is essential to establish strict rules on handling data for acquisition and analysis and to use the data safely and appropriately. In addition, establishing cooperation between the public sector, such as local governments, and the private sector and how to build a cooperative relationship with citizens will be an issue to be addressed in the future. Since overseas initiatives have not progressed and systems such as information banks are still in the exploratory stage, the future utilization of regional data and the diffusion and promotion of DCC will have a close relationship.

Lastly, there is concern that collecting local data will make analysis and feedback methods more complicated and complex. In addition to conventional data on economic and community conditions, using

data on CC transactions and their analysis as a basis for making decisions on the appropriateness and rationale of policy interventions or policy-making may confuse local governments and residents. Other studies have pointed out that experts tend to take the lead in policy-making and emphasize their professional skills and knowledge, which may cause difficulties in understanding, sharing, and utilizing data with the concerned parties (Colette Einfeld et al., 2021). Appropriate analysis and feedback are required for self-adjusting modifications with the intervention and support of researchers while keeping the residents as the main actors, as in the case of the community dock shown in the previous study.

Conclusion

In this study, we clarify the results and issues of the circulation experiment of DCC TARCA from the perspective of regional economic policy. We examined measures to further develop and elaborate regional economic policies from the traditional OBPM to the EBPM. The most crucial point is that transaction network analysis with CC transaction data can play a complementary role in regional information and simultaneously help establish a method for hypothesis testing based on more accurate and objective data.

Although this study was not able to develop deeply into causal relationships and causal inferences, which can be said to be the basis of EBPM in a strict sense, it would be desirable to be able to discuss these issues with citizens and local governments from the stage of designing circulation experiments in future studies, with the verification and policy-making of these issues in mind. In considering EBPM with transaction data of DCC, there is much work to be done. However, if we can accumulate hypotheses and verifications individually and use our past experiences, we can conduct experiments and formulate policies more precisely.

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Impact of digitalization of money on people's perceptions of community currencies: A gaming simulation analysis

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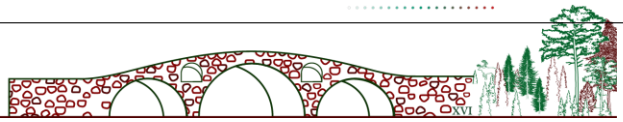
Abstract

The digitalization of community currencies (CCs) in Japan has progressed rapidly since 2016. The "Sarubobo Coin," used in the Hida region of the Gifu Prefecture, had approximately 24,600 users (including approximately 18,000 Japanese residents), approximately 1,700 member stores, and a cumulative value of approximately 5.1 billion yen by the end of 2021. There are more than 10 "sibling coins" in Japan that use a common format "*Money Eas*y" as the Sarubobo Coin. Therefore, digital CCs continue to attract increasing attention in Japan.

In Japan, digital CC issuers have an issuance philosophy that emphasizes the enrichment of the economic environment as compared to analog CC issuers. Furthermore, digital CC issuers evaluate their currency issuance as having resulted in fair and efficient transactions. Consequently, digital CCs have been found to operate more efficient payment systems.

We examined the transformation of perceptions regarding CC due to digitalization from the users' perspectives. Through an analysis using gaming simulation, we examined the changes in users' awareness and behavior in response to different forms of CCs, as well as their evaluation of different CCs.

The findings reveal that the introduction of a CC increases the ratio of purchases made within the community and the ratio of volunteering to provide the requested help in both analog and digital CCs. However, digital CCs were evaluated as stimulating the local economy whereas analog CCs were evaluated as strengthening the local community. Nevertheless, there are several types of analog CCs in Japan, including Banknote type and LETS type and users' evaluations of analog CCs differ between the two types. Therefore, this study examines the extent to which the characteristics of analog CCs impact the transformation of perceptions regarding CCs through digitalization by analyzing the relative evaluation of analog banknotes with digital charge type and analog with digital LETS-type.



Keywords

community currency, currency issuance form, digitalization of money, gaming simulation

1. Introduction

Since 2016, various digital community currencies (CCs) have rapidly emerged in Japan. The Sarubobo Coin, a representative example, is widely used in the Hida region of the Gifu Prefecture of Japan. By 2021, it had 24,600 users (18,000 residents), 1,700 merchants, and a cumulative total transaction value of 5.1 billion yen. Similar "sibling coins," based on the *Money Easy* platform, have been introduced in more than 10 regions of Japan.

In a questionnaire survey of CC-issuing organizations in Japan, Yoshida, Kobayashi, and Miyazaki (2021) found that organizations issuing digital CCs were more likely to have an enhanced economic environment than those issuing analog CCs. They found that organizations issuing digital CCs emphasized on the enhancement of the economic environment and rated their CC as promoting fair and efficient transactions than those issuing analog CCs.

From the user perspective, Kobayashi and Yoshida (2021) found that one of the reasons for evaluating digital CCs as a form of issuance that promotes local economic activity is the advantage of digitalization, such as the ability to view usage history and the fact that no calculations are required. However, the respondents also appreciated the manual work involved in analog payments, based on responses such as "transactions can be carried out based on mutual confirmation through communication" and "I would be happier if there were manual procedures," as factors that strengthen ties between communities. Therefore, analog-type CCs are highly valued as a form of issuance that strengthens local community ties.

The digitalization of CCs in Japan is expected to evolve into a more fulfilling economic environment that is more convenient for users. However, it can be inferred that the positive impacts of analog CCs provided in the past, such as the formation of communities and new connections, will possibly become more tenuous. While residents and local governments have traditionally been the main issuers of these currencies, as they go digital, private companies will be able to determine the distribution design and other aspects of these currencies, and more emphasis will be placed on enhancing the economic environment. So how can we create a digital CC that activates economic activities based on ties among communities that share common ideals and values?

There are several ways to consider this issue. The first direction investigated by Satoh et al. (2020) and Moriki et al. (2020) is to form social capital by improving the interface of the application used for CC payments. According to this approach, the use of digital CC applications can lead to forming new communities and ties. However, this approach raises the challenge of utilizing the research results accumulated on analog CCs.

The second possible approach is to focus on the variations in the issuance of analog CCs. Yoshida and

Kobayashi (2016) suggest that, even for analog CCs, Banknote type and LETS type currencies have different effects on user behavior and attitudes. Specifically, the paper currency type tends to increase the transaction amount of CC compared to the LETS type, while users are less likely to accept monetary diversity or change their attitudes toward community orientation. Conversely, although the LETS type currency is less likely to increase the transaction amount compared to the Banknote type, it is known to influence a greater degree of change in users' attitudes. This study examines the impact of these differences in the issuance of analog CCs in the backdrop of digitalization.

2. Materials and methods

In this study, the following hypotheses have been formulated and examined using gaming simulation:

Hypothesis 1: Digitalization of a Banknote-type currency strengthens its perception as a currency with local economic effects.

Hypothesis 2: Digitalization of a LETS-type currency weakens its perception as a currency with community-building and expansion effects.

The digitalization of CCs is expected to increase their convenience (Kobayashi and Yoshida 2021). The two hypotheses in this study examine how digitalization improves the convenience of two different forms of CCs: banknotes and LETS. Hypothesis 1 is based on the premise that the digitalization of the banknote-type currency, which has been effective in stimulating the local economy among analog CCs, will improve user convenience, promote transactions within the local community, further enhance the local economy, and be recognized by users as a currency with a positive effect on the local economy. Hypothesis 2 is based on the premise that the LETS-type currency, which has fostered a change in consciousness toward community orientation among analog currencies, will be recognized for its convenience more than for its community activation function when digitalized, and will no longer be recognized by users as a currency with a community formation and expansion function.

To test the above hypotheses, we used the gaming simulation method. Gaming simulation is a method used to promote participants' understanding of a specific social situation or to reveal the characteristics of a specific social situation itself. Its most distinctive feature is the formation of dynamic interactions from the real world (Yoshida and Kobayashi 2014).

Considering the case of a specific analog CC going digital, as examined in this study, the case of a real CC lacks robust examples and surveying actual users of the currency is difficult. In addition, it is necessary to conduct a controlled experiment on the experience of using the currency to investigate changes in the awareness and behavior of users because of changing the form of issuance from analog to

digital. A previous study that compared analog forms of issuance (Yoshida and Kobayashi 2016) employed a similar methodology, allowing for a comparative analysis with existing findings.

The gaming simulation used in this study is the "Community Currency Game" (Yoshida and Kobayashi 2014, 2016, 2018), a multi-player face-to-face analog game developed specifically for this study. The game was originally developed to examine the structure and concept of CCs and has been practiced in a workshop format for residents and stakeholders who intend to introduce CCs (Yoshida and Kobayashi 2018). In recent years, however, the gaming simulation has been used to identify how the use of CCs can transform the behavior and attitudes of people who have no experience in using them (Yoshida and Kobayashi 2014; 2016, Kobayashi and Yoshida 2021).

In this game, subjects take on one of five roles (businessman, student, restaurant employee, pottery studio employee, or hotel employee) as residents of a virtual community in groups of two or three, repeatedly buy and sell goods and services, and request and perform volunteer work using legal tender (unit: yen) and CC (unit: J).

The role of the dice determines the goods and services purchased for each role and the salary received. The game ends when the player receives a specified salary according to the roll of the dice, purchases the specified goods and services, and decides whether to perform the requested volunteer service. In the first two turns of the game, only the legal tender is used, and in the last three turns, both legal tender and CC are used. The legal tender can be used both inside and outside the region, whereas CC can only be used within the region.

The participants in the game are required to make three primary decisions: (1) whether to purchase goods and services inside or outside the region[1], (2) what percentage of the price of the goods and services to be sold should be in the CC[2], and (3) whether to accept volunteer work requested by other roles[3].

In addition to the analog Banknote-type and analog LETS-type CCs, which are the most common types of CCs issued as observed in previous studies, the current experimental design also includes new digital charge-and LETS-type CCs. Only one of these four types of CCs is employed in each game for a total of four games. The characteristics of the four adopted CCs are as follows:

[1] The game comprises items sold only within the region, items sold only outside the region, and items sold both inside and outside the region. Items sold both inside and outside the region are set so that the price is higher inside the region than outside the region. Prices are not negotiable in the game.
[2] In the turn after the introduction of CC, each turn determines how much CC will be received in exchange for items sold or services provided.
[3] Volunteering in this game takes the form of deciding whether other players who can solve a problem faced by one player will solve that problem.

- Analog banknote (Banknote) type: CC made of paper and issued by the CC issuing organization with a 10% premium and converted into yen for a 10% fee.
- Analog LETS (A-LETS) type: Everyone owns a paper passbook. The amount paid (negative) or received (positive) for each transaction is entered into the bankbook. Since there is no upper limit to the amount of deficit and surplus, the total balance in everyone's passbook is zero.
- Digital charge (D-Charge) type: CC that can be settled using a tablet and QR code. It can be used by charging the remaining balance to the tablet at the CC-issuing organization. Premium and redemption conditions are the same as those for the analog banknote type.
- Digital LETS (D-LETS): LETS-type CC using tablets and QR codes. Similar to the analog LETS-type, there is no upper limit to the amount of deficit and surplus, and the sum of everyone's balances is zero-sum.

This study developed a D-Charge type and D-LETS CC as a web application corresponding to the games implemented. *Com-Pay* was named after the first three letters of "community," as it is a payment method for communities (Fujiwara and Kobayashi 2019). This system is expected to be implemented the next fiscal year (February 2021) since the major electronic CCs in operation as of February 2021 (Sarubobo Coin, Aqua Coin, etc.) have adopted QR code payments to reduce implementation costs and fees on the store side, and it is expected that QR codes will continue to be used as a payment method for electronic CCs

All entities appearing in the "community currency game" used in the gaming experiment had a unique QR code, and the system automatically transitioned to the payment screen when the QR code of the payment partner was captured by the camera built into the tablet device during payment. By entering the amount to be paid and clicking the "Pay" button, a final confirmation screen appears, and the payment is completed by accepting the payment (clicking the OK button). (Figure 1).

Figure 1. Payment screen in Com-Pay

To ensure mutual recognition of the correct payment, the payer presents the authorization screen to the payee who updates the balance screen immediately to confirm that the correct amount has been credited to the app. All transactions settled with digital CC can be viewed at any time on the account history screen within the application.

Since charge-type CC cannot be paid without a balance in the app, it is necessary to pay a legal tender to charge the electronic CC to the app at the "community development organization" that issues electronic CC in the game to increase the balance of the electronic CC. Conversely, D-LETS-type digital CC can be paid even if the balance is zero or negative, and therefore, it can be paid without charging the electronic CC to the application at the "community development organization."

Only college students were included as participants to observe the interaction among relatively homogeneous participants who had never used a CC before. Therefore, no knowledge of CC was provided to the participants prior to the gaming. The games analyzed were CC games conducted in 2018 and 2019 using CCs with four different forms of issuance (analog banknote type, digital charge type, analog LETS type, and digital LETS type) with first-year students of the Joetsu University of Education[4] (Table 1).

Table 1. Status of game implementation

Game	Date	First Session	Second Session	Questionnaire
Ⅰ	2018.12.01	Banknote	D-Charge	Worksheet Ⅰ
Ⅱ	2018.12.02	A-LETS	D-LETS	Worksheet Ⅱ
Ⅲ	2019.12.21	D-Charge	Banknote	Worksheet Ⅲ
Ⅳ	2019.12.22	D-LETS	A-LETS	Worksheet Ⅳ

[4] There were 14 participants in 2018 and 17 in 2019.

Games I and II, conducted in 2018, included the same participants; Game I was conducted in the order of Banknote type in the first session and D-Charge type in the second session and Worksheet I was filled out for the participants after the completion of the two sessions. Game II was conducted in the order of A-LETS type and D-LETS type and Worksheet II was completed after all the sessions were over. Games III and IV, conducted in 2019, included the same participants; Game III was conducted with the D-Charge type in the first session and the Banknote type in the second. Game IV was conducted in the order of D-LETS type and A-LETS type and Worksheet IV was completed after all the sessions were completed.

Worksheets I and III consisted of (1) questions to rate the convenience of the CC, its contribution to the local economy, its contribution to volunteer activities, and its contribution to town activities on a 4-point scale for the two CCs used in the game that day, (2) a question to freely describe the characteristics of each CC used in the game that day, and (3) a question to be answered in the section asking the participants to select one of the two currencies they used that day to revitalize the local economy, form connections in the local community, or the currency they would like to use, and to describe the reasons for their choice.

In addition to the above questions, for Worksheets II and IV, respondents were asked to rank the four CCs with respect to each of the following three areas: revitalization of the local economy, formation of community ties, and the CC they would like to use, and to fill in a question section describing the reasons for their choices.

This study examined two hypotheses by comparing the Banknote type and D-Charge type (Games I and III) and the A-LETS and D-LETS (Games II and IV) types of CCs.

3. Results

3-1 Transaction Data

Tables 2 and 3 show the analog and digital currencies used in each game. Games I and III, which used the Banknote and D-Charge types of CC, indicate that yen expenditures decreased in both cases after the introduction of CC. However, yen income increased after the introduction of the CC, except in Game III, in which digital currency was used.

Table 2. Game transaction status (Banknote type and D-Charge type)

Transactions	Game Ⅰ		Game Ⅲ	
	Banknote	D-Charge	Banknote	D-Charge
Income per turn (yen) before the introduction of CC	47000	41700	45500	53150
Income per turn (yen) after the introduction of CC	49200	46733	52567	47400
CC revenue per turn (J)	5667	13400	10433	6400
CC as a percentage of revenue per turn	10.3%	22.3%	16.6%	11.9%
Expenses per turn (yen) before the introduction of CC	61700	66300	41700	41750
Expenses per turn (yen) after the introduction of CC	38133	33033	38867	38100
CC expenditures per turn (J)	4533	11733	9100	5400
CC as a percentage of expenditures per turn	10.6%	26.2%	19.0%	12.4%

Table 3. Game transaction status (A-LETS type and D-LETS type)

Transactions	Game Ⅱ		Game Ⅳ	
	A-LETS	D-LETS	A-LETS	D-LETS
Income per turn (yen) before the introduction of CC	51750	39050	51100	66750
Income per turn (yen) after the introduction of CC	45000	44733	38100	38100
CC revenue per turn (J)	9367	10800	4367	17367
CC as a percentage of revenue per turn	17.2%	19.4%	9.0%	31.3%
Expenses per turn (yen) before the introduction of CC	52300	51250	59700	39900
Expenses per turn (yen) after the introduction of CC	33200	31033	24100	24100
CC expenditures per turn (J)	7867	9300	3533	15867
CC as a percentage of expenditures per turn	19.2%	23.1%	7.3%	39.7%

When examining the amount of CC spent per turn, the highest percentage was in the digital currency in Game IV, and the lowest percentage was in the analog currency in Game IV. Examining CC as a percentage of income and expenditures per turn, the highest percentage was for digital currency in Game IV and the lowest was for analog currency in the same game.

Regarding the changes due to digitalization in terms of the types of CCs, it was found that the Banknote and D-Charge types, which are digitalized versions of the Banknote type, respond differently to

Games I and III. In Game I, the amount and percentage of CC use increased as a result of digitalization. After the introduction of the CC, expenditures in yen decreased while income increased. The effect of the changes due to digitalization on the local economy can be seen in that the use of CC not only increases within the region but also leads to an increase in income due to an increase in purchases within the region. In contrast, in Game III, the amount and percentage of CC use decreased due to digitalization. In Game II, where digital currency was used, the amount of yen spent decreased, as did income. This finding indicates that the digital currency in Game III did not generate positive local economic effects.

Conversely, in Games II and IV, which used the A-LETS and D-LETS types of CC, the amount and percentage of CC use increased in both games. Especially in Game IV, the amount and percentage of digital currency use were the highest among all games. LETS-type CC did not show any positive local economic effects in either analog or digital games.

3-2 Evaluation of Currencies

3-2-1 Relative valuation of two CCs

Regarding the evaluations of each CC by the game participants, Tables 4 and 5 list the ratings given to the analog and digital CCs used on each game day in the questionnaires administered at the end of each day. Each table shows the mean and standard deviations on a five-point scale with the highest and lowest ratings of 5 and 1, respectively. The four items evaluated were convenience, contribution to the local economy, volunteer activities, and neighborhood activities.

With regard to convenience, digital currency was rated higher than analog currency in all the games. This finding suggests that reading the QR code and paying with a tablet was considered convenient regardless of whether it was banknote currency or LETS-type CC. However, digital currency was rated higher than analog currency in terms of its contribution to the local economy in all the games. In the games, the local economic effect was positioned as the effect of decreasing yen expenditure and increasing yen income through the circulation of CC within the local community. From this perspective, only analog currency in Games I and III had a local economic effect. However, as indicated by the decrease in yen expenditure after the introduction of CC, it can be inferred that the participants recognized the contribution of CC to the local economy through the opportunity to pay for items with CC.

Both contributions to volunteer and neighborhood activities were rated higher by digital currency users, however, the difference was not very high.

Table 4. Evaluation of CC (Banknote type and D-Charge type)

Game Ⅰ n=14								
	Convenience		Contribution to the local economy		Contribution to volunteer activities		Contribution to neighborhood activities	
	Banknote	D-Charge	Banknote	D-Charge	Banknote	D-Charge	Banknote	D-Charge
Mean	2.57	3.86	2.93	3.5	3.07	3.14	2.93	2.93
Standard Deviation	0.51	0.36	0.73	0.52	0.83	0.54	0.48	0.48
Game Ⅲ n=17								
	Convenience		Contribution to the local economy		Contribution to volunteer activities		Contribution to neighborhood activities	
	Banknote	D-Charge	Banknote	D-Charge	Banknote	D-Charge	Banknote	D-Charge
Mean	2.53	3.47	3	3.24	2.65	2.76	2.76	2.88
Standard Deviation	0.8	0.62	0.71	0.66	0.86	0.75	0.83	0.7

Table 5. Evaluation of CC (A-LETS type and D-LETS type)

Game Ⅱ n=13								
	Convenience		Contribution to the local economy		Contribution to volunteer activities		Contribution to neighborhood activities	
	A-LETS	D-LETS	A-LETS	D-LETS	A-LETS	D-LETS	A-LETS	D-LETS
Mean	2.38	3.62	2.85	3.08	2.85	2.92	2.69	2.77
Standard Deviation	0.65	0.51	0.56	0.49	0.38	0.28	0.48	0.44
Game Ⅳ n=17								
	Convenience		Contribution to the local economy		Contribution to volunteer activities		Contribution to neighborhood activities	
	A-LETS	D-LETS	A-LETS	D-LETS	A-LETS	D-LETS	A-LETS	D-LETS
Mean	2.18	3.71	2.59	3.65	2.65	2.94	2.71	3
Standard Deviation	0.65	0.59	0.8	0.49	0.79	0.83	0.59	0.71

3-2-2 Impressions of the two currencies

Next, a textual analysis[5] of the free descriptions of the characteristics of each of the analog and digital currencies used on that day was conducted to analyze the co-occurrence relationships between the terms. Figures 2–9 illustrate these results. The color of each node indicates nouns in blue, verbs in red, and adjectives in green. The size of the node indicates the number of occurrences and the larger the degree of co-occurrence, the thicker the line.

a) Impressions of Banknote-type CC

Figures 2 and 3 show the co-occurrence of the terms used in the free descriptions for the Banknote-type CC used in Games I and III, respectively. Figure 2 shows that the characteristics of banknote-type currencies are that they can be transacted like cash, they can be used by a wide range of age groups, they carry a large amount of money, they can be lost, they cannot be broken like digital currencies, and they

[5] "User-local text mining tool (https://textmining.userlocal.jp/)" was used in the analysis.

increase the number of people involved. In Game III, the characteristics of the Banknote type were that it is labor-intensive, the conventional mechanism is friendly to older adults, it is less convenient, and it is more familiar (Figure 3).

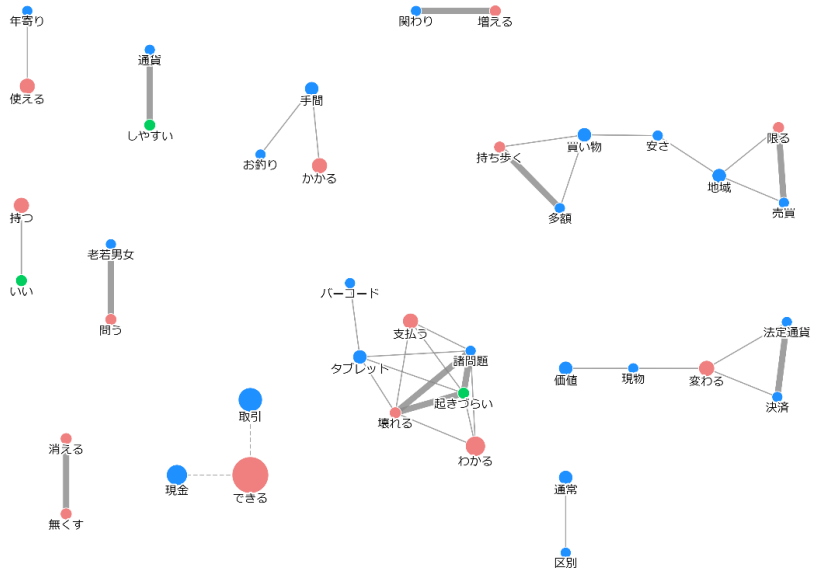


Figure 2. Impressions of Banknote-type CC (Game Ⅰ)

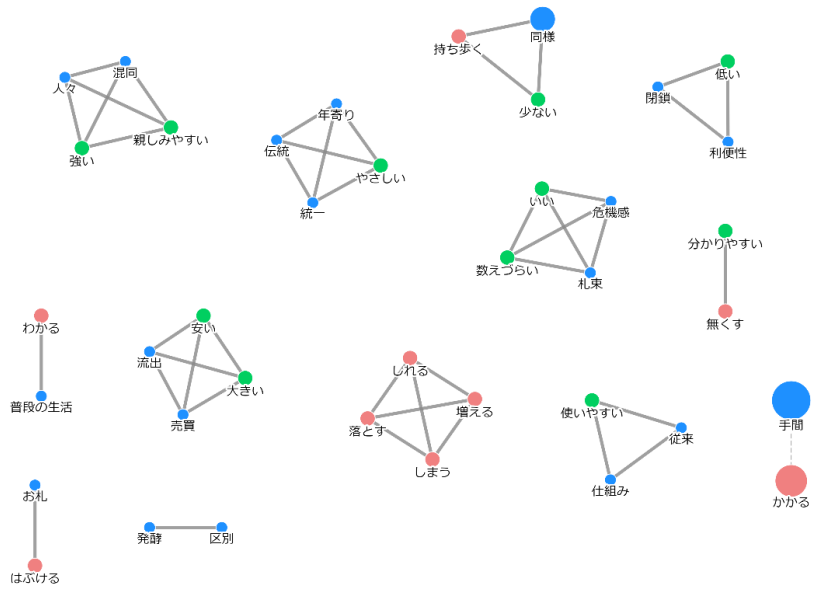


Figure 3. Impressions of Banknote-type CC (Game III)

b) Impressions of D-Charge type CC

Figures 4 and 5 show the co-occurrence of terms used in the free descriptions of D-charge-type CCs. Figure 4 indicates the following characteristics of D-charge-type CCs: transactions can be made with a tablet, easy settlement, easy understanding of transactions, balances, income, and expenditure unlike paper money, difficult to lose and does not need to be carried around, no need to carry cash, and the risk of data loss. From Figure 5, the following points have been derived: the ability to manage money, the ability to view the balance and transactions briefly, the ability to make transactions using a tablet terminal, the risk of overspending, and the convenience of the system.

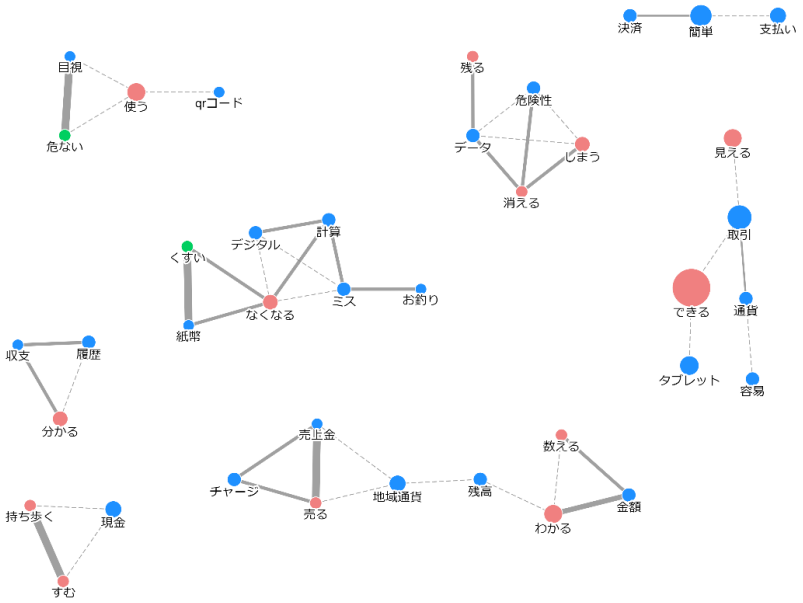


Figure 4. Impressions of D-Charge type CC (Game Ⅰ)

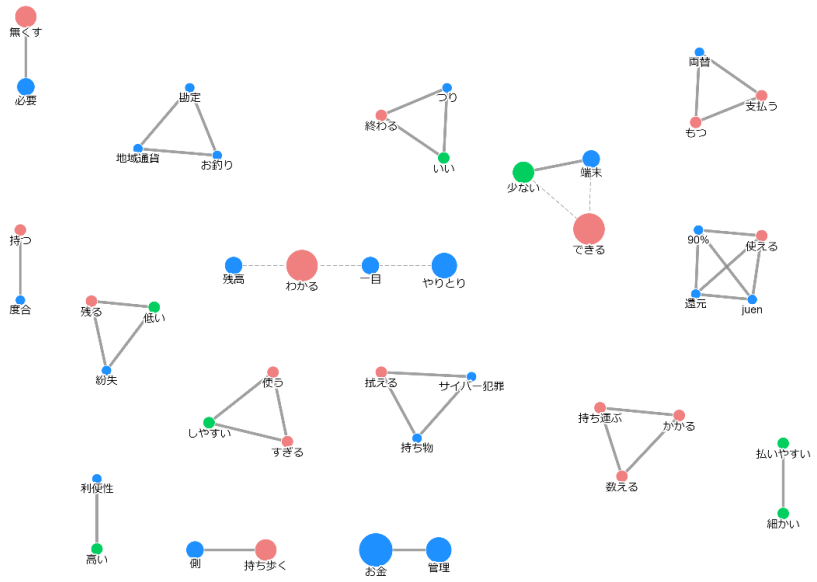


Figure 5. Impressions of D-Charge type CC (Game Ⅲ)

c) Impressions of A-LETS type CC

Figures 6 and 7 show the co-occurrence of terms used in the free descriptions of the A-LETS type CC. In Figure 6, the following points are mentioned: recording expenditures and income by hand, keeping a record of transactions, being able to use the system even with a negative balance, the need to check each other, cumbersome procedures, time consumption, difficulty in feeling the exchange, and being able to see the transactions briefly. Figure 7 indicates the following points: carrying a bankbook is troublesome, the results of transactions are visible for peace of mind, negative transactions are possible, a change in the sense of money occurs, increases, and decreases in funds can be observed, and the system is easy to use for both parties involved in transactions.

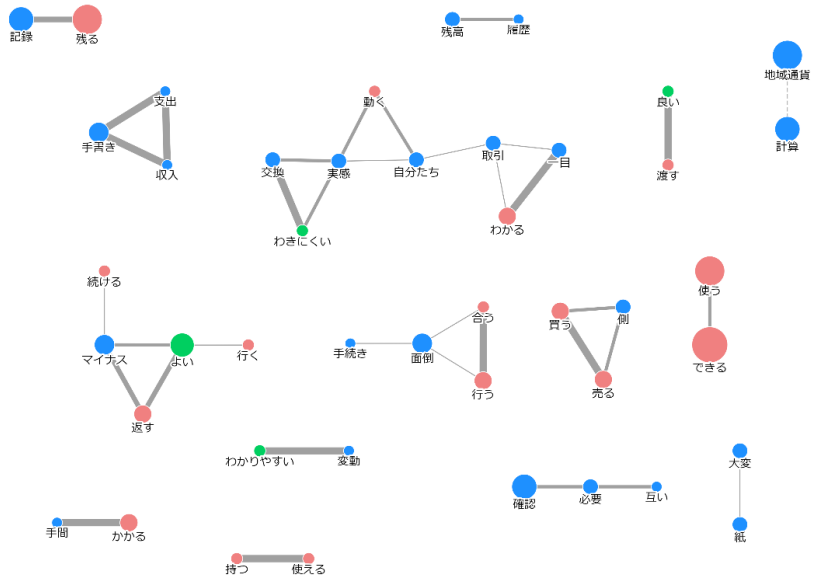


Figure 6. Impressions of A-LETS type CC (Game Ⅱ)

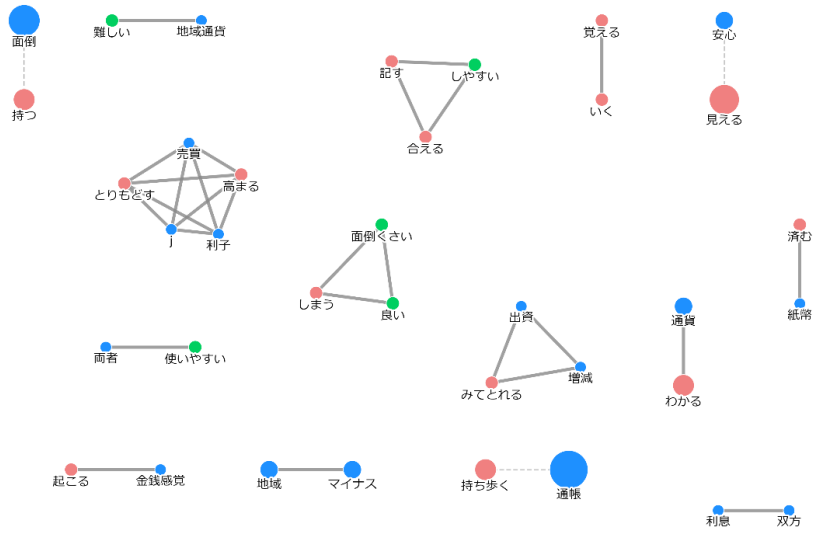


Figure 7. Impressions of A-LETS type CC (Game Ⅳ)

b) Impressions of D-LETS type CC

Figures 8 and 9 show the co-occurrence of terms used in the free descriptions of the D-LETS type CC. In Figure 8, the following points are mentioned: transactions can be made with a negative balance, calculations can be made on a tablet, calculations are automatic, easy, and convenient, input confirmation operations on an electronic device are necessary, writing is not required, and the history can be viewed

briefly. In Figure 9, the following points are mentioned: payment can be made with a tablet, transactions can be understood briefly, transaction history can be inquired, transactions of CC by multiple people are easy, and any amount can be spent without any sense of money.

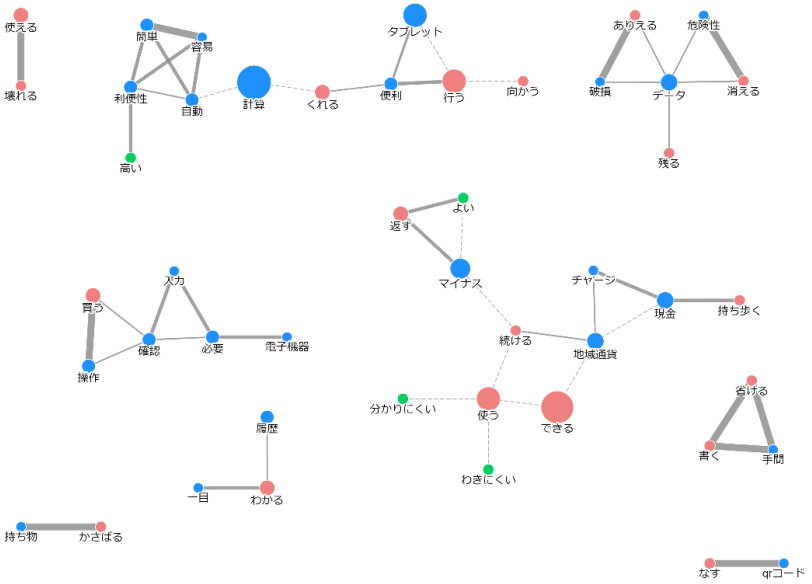


Figure 8. Impressions of D-LETS type CC (Game Ⅱ)

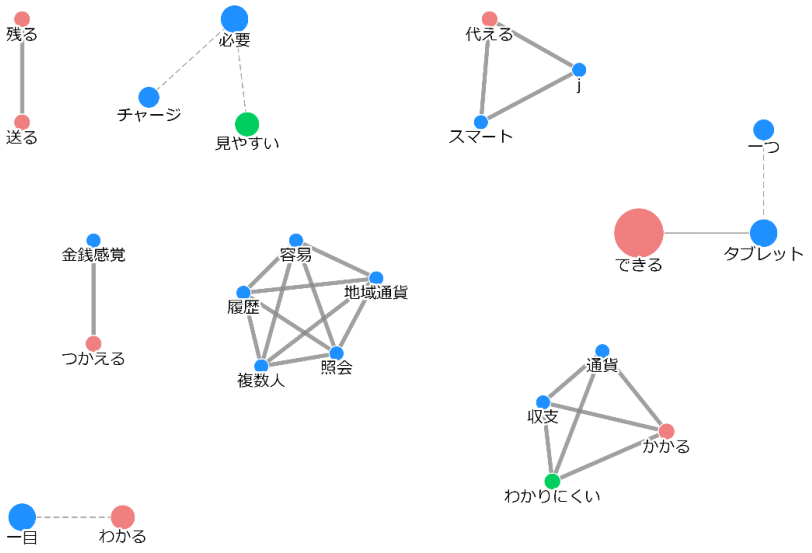


Figure 9. Impressions of D-LETS type CC (Game Ⅳ)

Regarding the co-occurrence of terms in the above free descriptions, the D-Charge and D-LETS

types of CC are similar in that they both cite high convenience as a feature, giving the impression that they do not reflect the original characteristics of analog currencies. Therefore, we categorized and compared the free descriptions of the two types of digital currencies[6] (Table 6). The numbers in the table indicate the number of descriptions that fit each category. According to the results, the features common to both the D-Charge and D-LETS types are high convenience, visualization of transaction data, retention of data history, smart, insubstantial, and smooth exchange, among others.

The characteristics unique to the D-Charge type, which is a digitalized version of the Banknote type, were that unlike paper currency, it is cumbersome to handle, it eliminates the risk of losing paper currency, it is cashless and bold in usage, it reduces communication, and the degree of happiness is subtle. The characteristics unique to the D-LETS type, which is a digitalized version of the A-LETS, are that transactions can be made even with negative balances, transactions can be made with a tablet, automatic calculations are easy, cash cannot be charged, there is no sense of money, the user does not feel a real sense of money, and transactions can be confirmed briefly.

These results indicate that convenience is the most frequently cited feature of digital currency, suggesting that it is recognized as an advantage of digitalization that eliminates the need to use paper money, record each transaction, and have the counterparty confirm it, as in the case of A-LETS type transactions. Furthermore, as a characteristic peculiar to the D-charge type, the advantages and disadvantages of eliminating the need to use banknotes were mentioned, while the characteristic of the feeling of happiness was also mentioned as a subtle feature of use. Regarding the features unique to the D-LETS type, the advantages of eliminating the labor required to record and calculate each transaction in the A-LETS type and the differences from the digital charge type were mentioned, as well as the feeling of not having a sense of money and not feeling a real sense of using the currency. In this respect, it can be inferred that the sense of use reflects the characteristics of each analog currency.

Table 6. Comparison of characteristics of free statements regarding digital CCs

Characteristics	Features of D-Charge type	Features of D-LETS type
Convenience	38	16
Risks of Digital Currency	12	4
Visibility of transaction data	11	6

[6] We used MAXQDA2022 in our analysis.

Cumbersome to handle	5	0
Cost of using cash	5	0
Data history saved	3	6
Cashless	3	0
Bold in usage	3	0
Smart	2	1
No substance	1	1
Smooth interaction	1	1
Unfamiliar	1	0
Digital divide problem	1	0
Reduced communication	1	0
Need to confirm with other people	1	0
Easy to pay small amounts of money	1	0
You are tempted to charge anyway	1	0
Liberating	1	0
I don't feel happy	1	0
Confirms the value of the CC	1	0
Transaction security	1	0
Can be used even with a negative balance	0	11
Money can be transferred using a tablet	0	7
Automatic calculation	0	6
Easy to operate	0	4
Cannot be recharged with cash	0	4
Cannot be redeemed for cash	0	3
Easy to calculate	0	3
Not much sense of money	0	2
No need to give money directly	0	2
No need to write	0	2
Easy to carry	0	2
No need to carry bulky items	0	2
No need to carry paper money	0	1

Easy to manage	0	1
Difficult to feel like you paid for it	0	1
Difficult to see the balance of money briefly	0	1
Easy to read the display	0	1
Can be done without facing people	0	1
Fast transaction	0	1
Difficult to know how much was spent on which product	0	1
Confirm with each other	0	1
Need to confirm with other people	0	1
Can send messages	0	1
Easy to save money	0	1
Can only be used within the community	0	1
Currency is not reliable	0	1
Can transact with several people simultaneously	0	1
Can be used at any time	0	1
No interest	0	1

3-2-3 Evaluation of Four CCs

Finally, this study examines the participants' evaluations of the four forms of CC issuance that they completed on Worksheets II and IV. Table 7 shows the results in which participants ordered the four CCs used in the game according to the issuance form in which they promoted local economic activity, strengthened community ties, and the form they wanted to use. The numbers are the averages of the rankings, with smaller numbers indicating higher rankings. The figures in parentheses indicate standard deviations.

Table 7. Evaluation of Four CCs

	Form of issuance that promotes local economic activity		Form of publication that strengthens community ties		Form of issue you want to use yourself	
	2018	2019	2018	2019	2018	2019

Banknote	3.42 (.99)	2.59 (.94)	2.38 (1.39)	1.75 (.78)	3.38 (1.04)	2.65 (.86)
D-Charge	1.92 (.64)	1.94 (.75)	2.77 (.73)	2.94 (1.12)	1.69 (.95)	1.59 (.71)
A-LETS	3.08 (.64)	3.65 (.70)	2.08 (.86)	2.38 (1.26)	2.92 (.86)	3.76 (.56)
D-LETS	1.54 (.97)	1.82 (1.07)	2.77 (1.36)	2.94 (.93)	2.00 (.82)	2.00 (.94)

Table 7 shows that the D-LETS type and the D-Charge type were the top issuance types that promote local economic activities, indicating that the convenience of digital currency was highly evaluated. Conversely, the Banknote type and the A-LETS type were the most popular forms of issuance for strengthening ties among local communities. As shown in Table 6, this may be due to the decrease in communication due to digitalization and the influence of the sense of use such as subtlety and the lack of a real feeling of happiness. Regarding the type of issuance that the participants would like to use themselves, the D-Charge type and D-LETS type are at the top of the list, which can be understood as a result of their high level of convenience.

4. Discussion

This study examined the impact of digitalizing CCs by evaluating the hypotheses:

Regarding Hypothesis 1, both the transaction data and the evaluation of the CC by the participants confirmed that the digitalization of the Banknote-type is recognized as having more local economic benefits. For Hypothesis 2, the D-LETS type was not selected as a form of issuance that strengthens community ties. Even when its characteristics were compared with those of the A-LETS type, the improvement in convenience was focused on, and it was not regarded as a form that promotes more communication than the A-LETS type.

The findings of this study indicate that while the digitalization of CCs is highly valued as a means of promoting the circulation of resources within a region by increasing their convenience, digitalization itself does not increase the fertility of the community-building function using such currencies. For digital CCs to continue to grow as a means of stimulating economic activities based on community ties through the sharing of common ideals and values, it may be important to provide users a sense of belonging to a community that shares common ideals and values using the currency, in addition to improving the convenience for users at the settlement stage. Since Com-Pay, the digital CC used in this study, does not have such a function, it is necessary to experimentally verify the kind of post-use feedback that will enhance the sense of belonging of users to a community.

Acknowledgments

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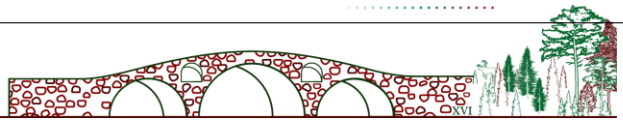

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Monetary ecosystems

LOCAL CURRENCY CHIEMGAUER AND THE QUANTITY THEORY OF MONEY

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Abstract

The roots of the Chiemgauer are closely related to the quantity theory, which has a long history and goes back in its modern form to David Hume and John Locke. Keynes admits a high value to the quantity theory. Despite extensive and diverse criticism of the quantity theory, it can be very helpful in the context of complementary currencies, especially if they are linked to an experimental character and to social und ecological goals. The empirical part begins with a data collection on the Chiemgauer and leads to experimental application via a contextual representation of quantity theory.

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1 THE COMPLEMENTARY CURRENCY CHIEMGAUER

The regional currency Chiemgauer was developed in 2003 in Prien am Chiemsee at a Waldorf school. Initially, only 20 companies and 30 consumers were involved. After one year, 100 acceptance points and 200 consumers took part. This dynamic growth continued in the following years. In 2022, more than 700 companies and associations as well as 4,000 consumers will be members of the Chiemgauer. The annual turnover has risen from 70,000 Chiemgauers in the first year to over 5.6 million Chiemgauers in 2020. The Chiemgauer is a reserve-backed complementary currency (Gelleri, 2020b). The most important reserve is the national currency euro. Each Chiemgauer issued is covered by one euro, and the value of the Chiemgauer unit of account is also one euro. In addition, there is also participation in local energy production, which can also be regarded as a reserve.

In addition to strengthening regional economic cycles, the largest share of the Chiemgauer fees is used to promote non-profit associations. Every year, more than 50,000 Chiemgauer are donated to charitable projects. Since the Chiemgauer's foundation, more than 850,000 Chiemgauers have been given to projects. These funds were financed from fees that were charged for the exchange of Chiemgauers into euros. The fees were returned to the money cycle via the non-profit organizations and provided further sales for the companies.

Since there is already a lot of descriptive literature on the Chiemgauer (Gelleri, 2008, 2009; Herrmann, 2005), this paper focuses on a monetary theoretical aspect. Integrated into the Chiemgauer is a special feature, i.e. a circulation incentive. Anyone who holds the Chiemgauer for a longer period pays a fee of 6% per year for the preservation of value. In the case of cash, this is implemented by stickers worth 3% each. With the electronic Chiemgauer, implementing the circulation incentive is carried out by a formula that is calculated daily and works exactly like calculating negative interest rates. One difference is that the fee is not due immediately but only after a certain amount of time. Recipients of the digital Chiemgauer have three months to pass it on before fees are due.

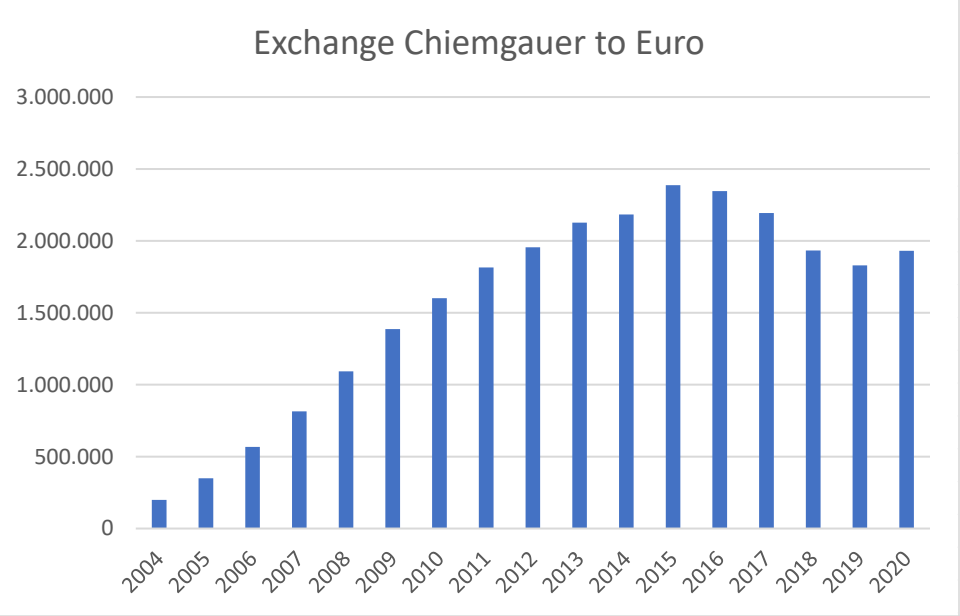
1.1 IDEA AND GOALS OF THE CHIEMGAUER

The idea behind this is to influence the speed of money in circulation (Assenmacher & Krogstrup, 2018, p. 10). To better understand the mode of action, it is necessary to present the theory behind this idea. This aspect covers only a small part of the living environment of the Chiemgau regional currency. We take a look under the bonnet, so to speak, and examine parts of the overall machine. Looking at the machine, we allow ourselves to explain part of the mechanism of action. A complementary currency is much more than a mechanism. It includes people, a network of institutions, relationships, feelings, and much more. Ideally, the mechanics promote the living environment of a complementary currency.

One of the goals of the Chiemgauer currency is to promote business cycles. The regional focus increases the turnover of the participating companies and leads to a better usage of the existing capacities. The number of unemployed in a place is suitable as a criterion for measuring the activity of a complementary currency. For this purpose, developments over time are examined empirically and analytically to check the operationalized measurement criteria. The Chiemgauer database is used for the analysis. The author retrieves the data from the system using SQL queries. For complex requests, programmers were involved who built the query according to the author's specifications. The execution and adaptation of the queries were again carried out by the author. For comparisons, statistics on the region are used, usually from the Bavarian State Office for Statistics. Economic data are used by common databases of the European Union (Eurostat), the European Central Bank, the OECD, and others. The respective data basis is indicated in the statistics.

1.2 Components of the Chiemgauer Cycle

The Chiemgauer cycle begins with consumers exchanging euros for Chiemgauers. This activity looks like this in total over time[1]:



Year	Exchange Cto€
2004	198,991
2005	349,917
2006	567,861
2007	814,402
2008	1,092,614
2009	1,386,880
2010	1,601,649
2011	1,814,953
2012	1,954,878
2013	2,127,225
2014	2,183,669
2015	2,387,405
2016	2,345,516
2017	2,193,007
2018	1,932,985
2019	1,829,153
2020	1,930,365

FIGURE 1: ANNUAL AMOUNT OF EXCHANGE FROM EURO TO CHIEMGAUER (BLUE) FROM 2004 TO 2020, GRAPH AND TABLE

The monthly exchange of euros for Chiemgauers had been on a continuous upward trend until 2015. From 2016 onwards, the number of monthly exchanges has fallen. This trend was interrupted by the Covid-19 pandemic, which can be explained by solidarity effects within the community, but also by an increased demand for high-quality food and other products from the region.

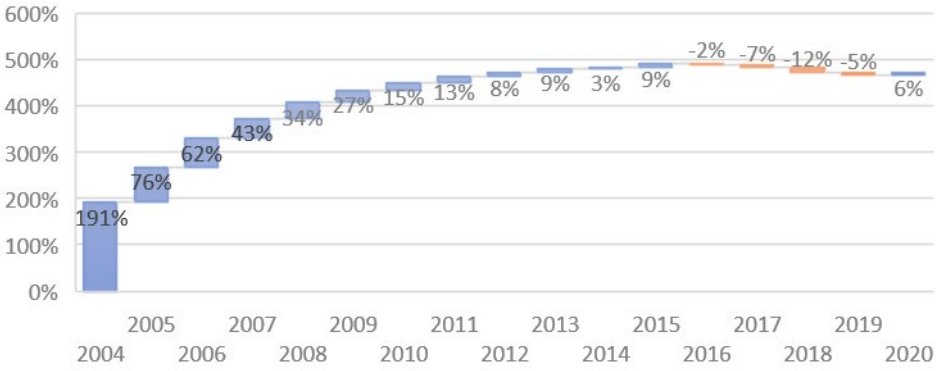


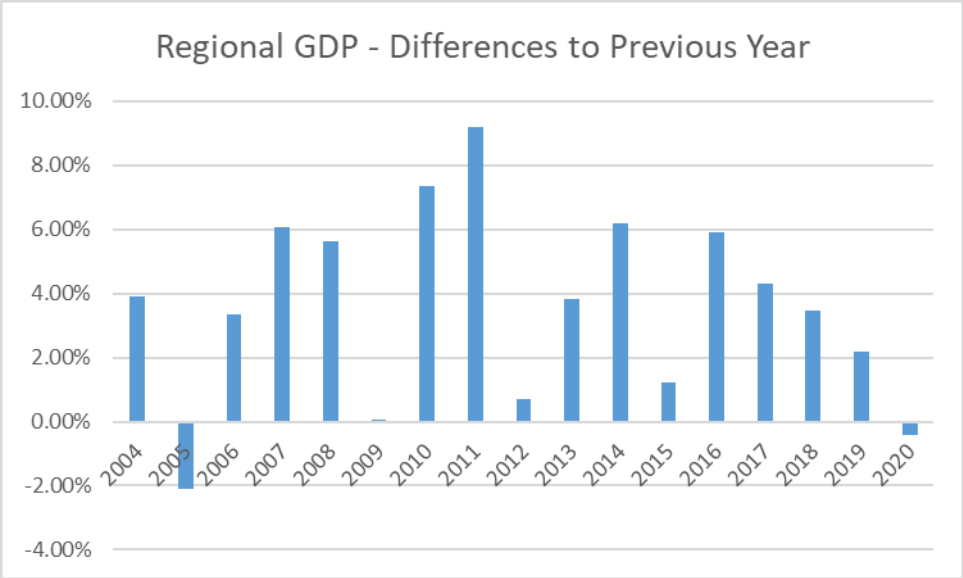
FIGURE 2: EXCHANGE WITH DIFFERENCE TO PREVIOUS YEAR IN PER CENT

Double-digit growth rates were achieved until 2011. In the following years, growth rates declined. This is because a high level of penetration has been achieved in sectors such as food retail. From 2016 onwards, there were saturation tendencies among companies, for example in the handcraft sector, which were related to an economic boom in the region between 2015 and 2019. In 2020, there was, surprisingly, a U-turn because consumers

[1] The data was collected by the author via SQL queries of the Chiemgauer database and evaluated in anonymous form. The graphics were created by the author.

placed higher value on regionally and organically produced goods in times of lockdown. The data for 2022, however, shows the opposite effect, and it is not yet clear what consequences the crisis year 2022 will have for the regional economy.

If the economic data for the regional value added in the region are included, changes in the Chiemgauer exchange can be partially explained. For example, the region's boom phase in the years 2016 to 2019 seems to have had a countercyclical effect on the Chiemgauer exchange.



Year	CHM M1
2004	33,329
2005	58,428
2006	75,428
2007	131,834
2008	227,640
2009	243,816
2010	400,757
2011	517,552
2012	574,777
2013	596,000
2014	724,097
2015	897,521
2016	913,054
2017	669,460
2018	672,572
2019	670,324
2020	791,251

FIGURE 3: REGIONAL GDP IN THE DISTRICT OF TRAUNSTEIN - DIFFERENCES TO PREVIOUS YEAR IN PER CENT

The study of regional economic data and the Chiemgauer variables is not further elaborated at this point. Reference should be made to econometric analysis, which was developed together with James Stodder of Boston University (Gelleri & Stodder, 2021). This approaches the Chiemgauer via existing data and initially does not require its own theory. Only data movements are compared with each other and checked whether there is a co-integration of these movements. In this article, an attempt is now made to find a possible explanatory approach to the mechanics of the quantity theory. For this, we need further empirical data on the Chiemgauer, above all data about the money supply. With the exchange in Chiemgauer, the main part of the money supply $M1_C$ is created.

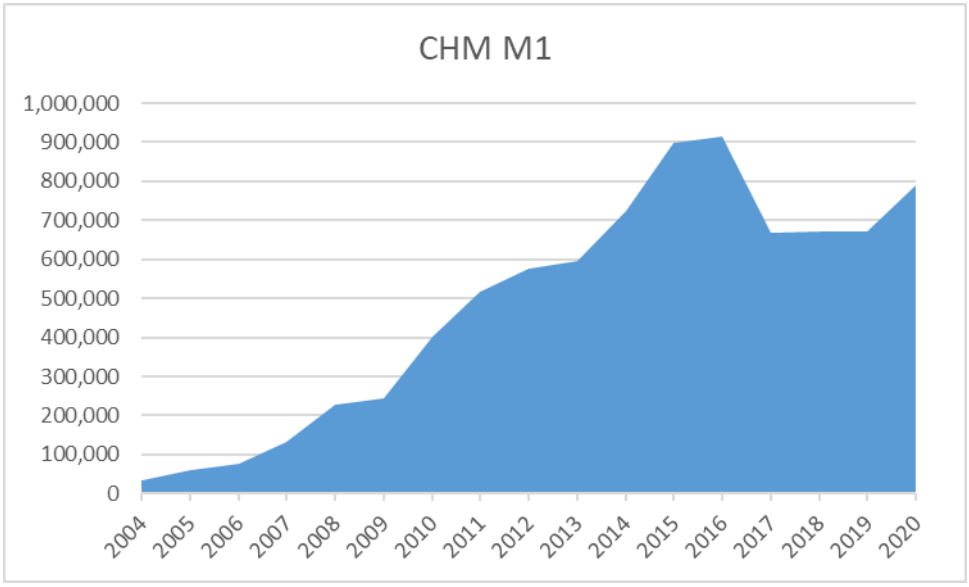


FIGURE 4: MONEY SUPPLY OF THE CHIEMGAUER M1 (DIGITAL + CASH)

The Chiemgauer money supply, consisting of cash and digital Chiemgauer, initially increased continuously. There were above-average increases in 2008 with the introduction of the digital Chiemgauer parallel to the financial crisis, and in 2010 with the beginning of the euro crisis. A second boost was recorded in mid-2014. The Chiemgauer money supply declined from the beginning of 2016 until the end of 2019, when there was a rebound, with an acceleration in 2020.

1.3 Relation between Digital and Cash Chiemgauer

When we compare the annual exchange of euros for Chiemgauer notes and the digital Chiemgauer, we can see an increasing importance of the digital Chiemgauer:

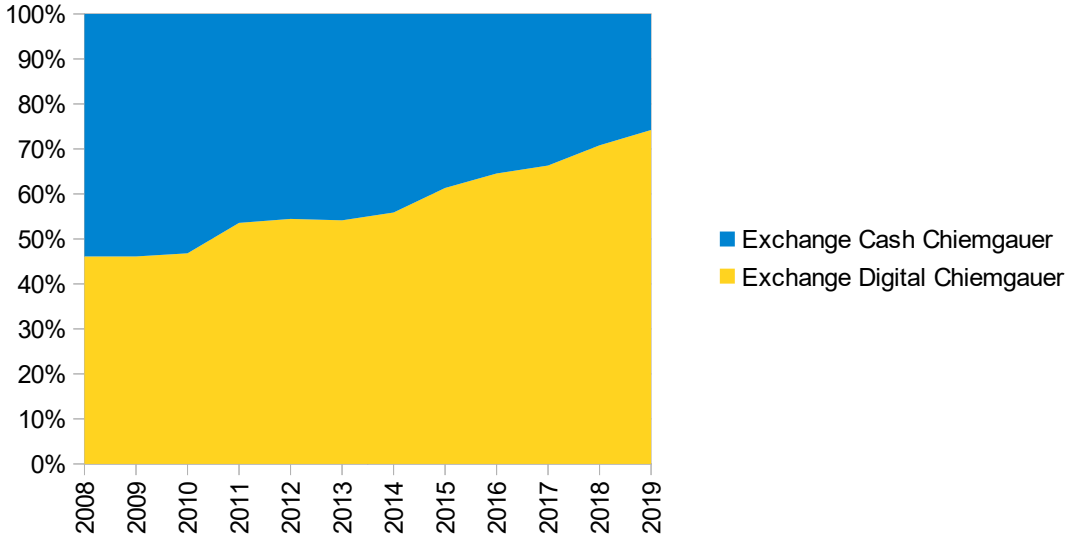


FIGURE 5: COMPARISON OF CASH CHIEMGAUER AND DIGITAL CHIEMGAUER

Since the introduction of the digital Chiemgauer in 2007, the share has steadily increased and now stands at three quarters of the total exchange. Despite the love of many members for the Chiemgauer paper currency, most consumers prefer the digital Chiemgauer in

everyday consumer life because it facilitates the processes and is therefore not perceived as an additional burden (Ziegler 2009, p. 57).

This is based on a general trend towards cashless purchases, which is visible above average among the younger generation, and also among the female population (Bundesbank 2018, p. 51). For the period from 2014 onwards, the Deutsche Bundesbank states: “The downward trend between 2011 and 2014 towards the substitution of cash by cashless payment instruments has thus accelerated somewhat” (Bundesbank 2018, p. 8).

The Covid-19 pandemic has caused another strong shift to electronic forms of payment. In the meantime, the share of cash in retail has fallen below 40%. At the end of 2019, the share of the Chiemgauer paper currency was only 25%. Of the participating Chiemgau companies, 128 acceptance points have so far offered the option of digital payment by Regiocard or to the Chiemgauer current account. This corresponds to 30% of the participating companies, which accounted for 75% of Chiemgauer sales.

In practice, this leads to a two-sided perception of the Chiemgauer. While the acceptance points that accept the digital Chiemgauer deal with a high demand, the points of sale that only accept Chiemgauer cash often feel like activity is decreasing. This feeling coincides with the actual sales figures for digital Chiemgauer and cash Chiemgauer. Nevertheless, the Chiemgauer Initiative continues to offer both means of payment, as Chiemgauer cash is still more widely perceived by the public. To this day, many do not know that there is a digital Chiemgauer at all. The symbolic significance of Chiemgauer cash should therefore not be underestimated.

1.4 CHIEMGAUER SALES

The collection of data on Chiemgauer sales is anything but easy. The simple part is to perform the database queries for digital Chiemgauer sales. The collection of cash turnover in Chiemgauer is much more difficult, as a full survey of more than 700 acceptance points is difficult and a voluntary survey leaves a gap.

Together with several students, the author has led surveys over several years, which included, among other things, the questions of the Chiemgauer cash turnover and how much of it was spent again in Chiemgauer (Cremer et al., 2020; Großschmidt, 2008; Ziegler, 2009):

Study	Year	Businesses	Sample	Spent again (w)	Error margin
Joerg Großschmidt	2006	540	106	61%	11%
Franziska Ziegler	2007	631	110	69%	11%
Alexander Christ	2013	627	145	66%	9%
Cramer et. al.	2020	491	28	80%	24%

To test the reliability of the surveys, the sample size was compared with the population size, i.e. the number of companies participating in the respective year. An average value was determined from the individual data of the entrepreneurial Chiemgauer expenditures (“w”). Due to the response rates (sample), there are error margins between 9 and 24% at a confidence level of 99%, although the last survey is probably an outlier due to the low response rate. The survey by Christ shows the highest accuracy with a transfer rate of 66% and a margin of error of +/- 9%.

Based on anonymized data summaries, an exact transfer rate can be determined for the digital Chiemgauer. The revenue share of the digital Chiemgauer was 69% in 2019 and therefore makes a significant contribution to explaining the quota:

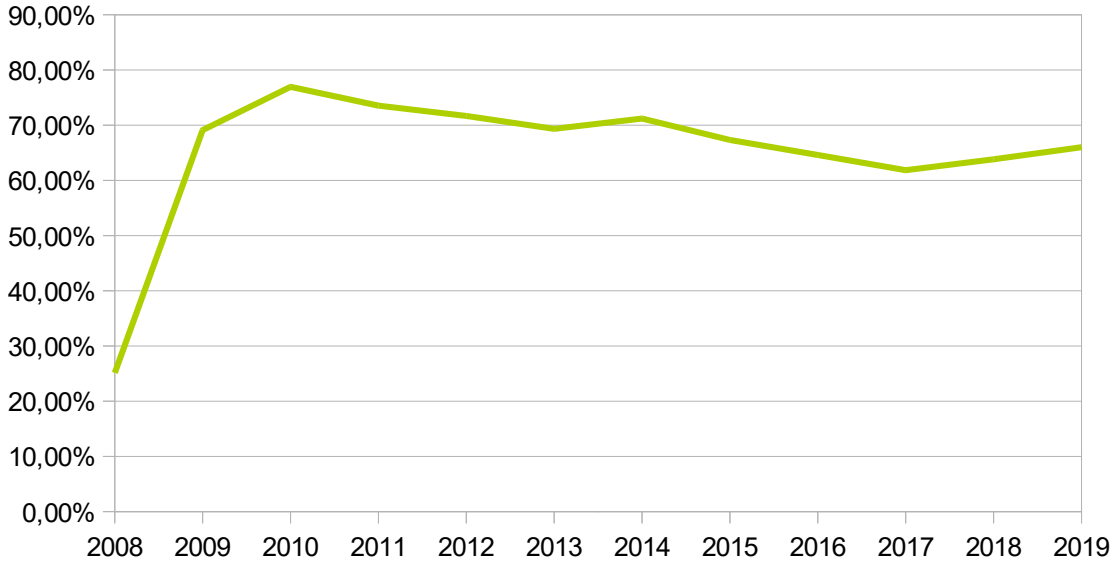
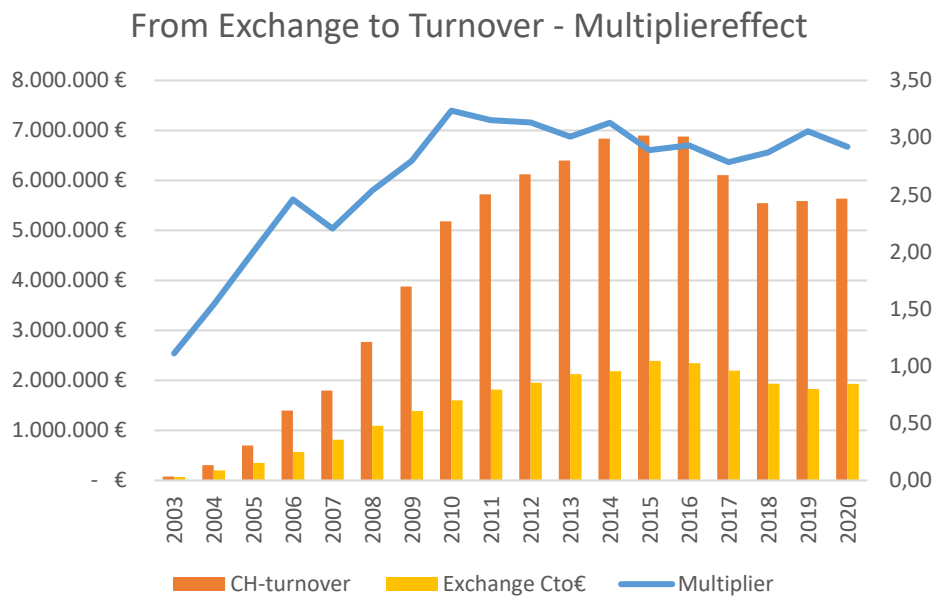


FIGURE 1: TRANSFER RATE OF THE DIGITAL CHIEMGAUER

In 2008, the digital Chiemgauer was launched and had only a few participants. Already in 2009, however, a high level of transfer was reached, which averaged 69%. The course has been relatively stable since 2009 in a range between 62 and 77%.

Based on the surveys and the data for the digital Chiemgauer, a quota is assumed for the cash Chiemgauer that corresponds to the average transmission rate of the digital Chiemgauer. If the lower margin of error of the Ziegler and Christ surveys were to apply to the cash Chiemgauer so that the transfer rate would only be about 57%, the influence on total sales would be minus 3.6%. Conversely, with a transfer rate of 75%, the upper deviation would be 1.8%. For further consideration, these relatively small deviations seem negligible.

The meta-evaluation results in an overall picture that leaves little doubt as to how many Chiemgauers are spent on average and how many are exchanged back after each sales process. The Chiemgauer turnover is calculated from the direct query of the digital turnover, the Chiemgauer cash exchange, and the multiplier effect, which arises from the fact that the cash income of companies is passed on to other companies.



Year	CH-turnover
2003	75,873 €
2004	306,140 €
2005	699,834 €
2006	1,395,705
2007	1,794,956
2008	2,769,896
2009	3,877,760
2010	5,181,911
2011	5,720,779
2012	6,121,513
2013	6,396,166
2014	6,834,431
2015	6,897,551
2016	6,877,490
2017	6,106,737
2018	5,546,780
2019	5,587,180
2020	5,634,903

FIGURE 6: EXCHANGE, MULTIPLIER AND CHIEMGAUER-TURNOVER

On the left side is the scale for the Chiemgauer exchange and the Chiemgauer turnover. On the right side is the scale for the Chiemgauer multiplier, which expresses that an exchanged Chiemgauer generates x times the turnover. A multiplier of 3 therefore means that the exchange of one euro causes a Chiemgauer turnover worth three euros (see also formalized description: 3.1).

In 2019, a Chiemgauer turnover of 5.59 million euros was achieved. The turnover consists of a digital Chiemgauer turnover of 3.87 million euros, a cash exchange of 0.53 million euros and a cash transfer worth 1.18 million euros. Total cash sales amounted to 1.7 million Chiemgauers. The multiplier was thus about 3. The risk of a larger deviation is very small, as the margin of error for the cash transfer is about 10%, which only amounts to about 0.1 million euros.

Now that we have compiled and explained the most important components, we can now turn to quantity theory. First, the theory is explained, then it is applied to the empirical data.

2 Fisher's Quantity Theory of Money

Irving Fisher formalizes the quantity theory. Accordingly, the nominal gross domestic product of a country results from the multiplication of the money supply by the velocity of money in circulation (Fisher, 1911/1922).

$$M \times V = T \times P$$

The transaction volume "T" valued in prices "P" is the result of the money supply "M" circulating in the national economy ("V"). Wicksell speaks of changing hands, i.e. how often a coin changes hands in a period: "We thus define the velocity of circulation of money simply as follows: the number of times that the existing coins change hands on average by way of purchase and sale (i.e. not by way of loan) during the selected unit of time, e.B. a year" (Wicksell, 1898, p. 46).

Excluded are, therefore, circuits with the purpose of brokering investments, gifts, and similar circulations that do not have the objective of the turnover of goods. If the money is not used, Wicksell calls this interval “rest period” of the money (Wicksell, 1898, pp. 46–47). The Chiemgauer is therefore about avoiding a too long rest period; for example, the electronic Chiemgauer sets a negative interest rate from the 91st day onward.

2.1 Quantity Theory of Money Extended by Complementary Currencies

In his remarks, Fisher differentiates between cash and book money created by banks. Accordingly, both have different amounts of money and velocity of circulation:

$$M \times v + M' \times v' = T \times P$$

M' stands for the money created by the banks, and V' for the velocity of the bank sight deposits. The Chiemgauer can also differentiate between the amount of cash (M_C) and the amount of digital complementary currencies (M'_C) as well as the respective circulation speeds. If complementary currencies are also considered in the formula, the following extension results:[2]

$$M \times v + M' \times v' + M_C \times v_C + M'_C \times v'_C = T \times P$$

The turnover valued in prices could be expressed as the sum of the turnover achieved in euro and in complementary currency. Since the turnover is included in the overall statistics, identity is expressed with transactions on a national level; therefore, no further subdivision is made.

Consequently, the turnover is the sum of the respective amounts of cash created (M_P), bank balances (M_B) including balances of the e-money and payment institutions as well as the complementary currencies. If a 50 euro note is collected five times from companies as a turnover, this corresponds to a cash turnover of 250 euros (50 x 5 = 250). The same applies to the balance on a current account, which is transferred three times to other accounts (50 x 3 = 150).

Since the turnover also includes intermediate consumption and thus the added value of a product is calculated several times, James W. Angell corrects the sales by the respective intermediate consumption (Angell, 1936/1969). This results in the gross value added “Q” and thus the formula M x V = Q x P. When calculating the orbital velocity, care must be taken to make sure that the same formula is always used. For example, in a research paper, the velocity of the euro was calculated using the “Q formula”, while for the complementary currencies the transaction-based velocity of circulation was determined (de la Rosa & Stodder, 2015). This error is avoided by converting with a correction factor resulting from the ratio of sales to gross domestic product (T/Q).

When banks create new money, central bank money is also created at the same time, which is not considered in the quantity equation because it does not circulate in the economy. For some years now, the opening of central bank money to the public has been the subject of discussion. Digital central bank money is already being used in some places in China, so these amounts of money would have to be included in M.

[2] The “C” stands for “complementary”.

Euro banknotes and coins account for 11.6% of the circulating money supply, and the daily balances created by banks are 88.3% (Bundesbank, 2019b). The role of the endogenous money creation of the banks is thus dominant and also dominates in the theoretical presentation of the common economic theoretical strands (Şener, 2014, p. 5).

2.2 Quantity Theory as Pure Tautology?

The role of quantity theory is questioned for various reasons. It is charged with being meaningless because the money supply results endogenously from the economic process. It is seen as merely a tautology:

“Indeed, it is a tautology, summarized in the famous quantity equations, that all changes in nominal income can be attributed to one or the other – just as a change in the price of any good can always be attributed to a change in either demand or supply. The quantity theory is not, however, this tautology.” (Friedman, 1987, p. 3)

The formula is “neutral” and contrasts the monetary side with the real economic side. Put simply, the sums of purchases (M x V) and sales (TxP) are the same. In this sense, quantity theory is tautological; however, the simplicity and clarity of the formula makes it possible to discuss monetary theoretical and monetary policy approaches from a normative and empirical point of view. Monetaristic representations assume a production potential that is optimally fully exploited by corresponding money supplies and money circulation. The velocity of money circulation is neglected because it is assumed that it behaves relatively steadily in phases of peace (Friedman, 1987, p. 28). This is also true for the USA in the period between the Second World War and the financial crisis of 2008. The velocity of circulation in Europe, Japan, and many other countries has been subject to a declining trend since the 1980s.

This is explained by high saving rates. If the banking system and the central banks do not succeed in exploiting the optimal production potential, there will be an output gap.

$$T_{opt} \times P_{opt} - M \times v - M' \times v' > 0$$

The Keynesian analysis cites a lot of reasons how an imbalance in this form can occur, and why full usage without economic policy measures is more of a special case (Keynes, 2013, p. 28). Typical examples are a slump in the credit creation activity of banks as it occurred during the financial crisis, but also a sharper decline in the speed of money in circulation. The cause of the decline could be manifold. A convincing explanation is provided by explanations that find the cause in the increased propensity to save, which are discussed under the keyword of saving glut. Empirical studies identify, above all, the savings of companies as relevant for economic fluctuations (Klug et al., 2021).

2.3 Combining Quantity Theory with Community Goals

To assess the macroeconomic situation, Bofinger proposes a social loss function that goes back to Okun in its origins (Bofinger, 2010; Brunnermeier & Sannikov, 2016). The focus is on unemployment and monetary stability, and, depending on the political focus, either one goal or the other is in the foreground. In the Misery Index, unemployment and inflation are equally weighted and added together (Bofinger, 2010, p. 301). This is an extremely strong simplification. Bofinger's loss function considers weightings with factors and considers target values such as the inflation target of close to but below the two percent target set by the

European Central Bank (Bundesbank, 2019a). For our purposes, we can use the Misery Index as an indicator to explain a region's need for a complementary currency.

Agnell, like Fisher, emphasizes the need to compensate for a declining velocity of circulation during recessions by increasing the money supply. Interest rate and open market policies are available as a means of monetary policy (Lee & Wellington, 1984, 973). Fisher and Angell also point to the minimum reserve as a strong lever for reliable control of the money supply (Lee & Wellington, 1984, p. 974). This led to the proposal of a state sovereign money and a simultaneous end to the endogenous creation of money by the banks (Huber, 2018). Keynes and Lerner, however, argue, in the event of a decrease in the velocity of circulation, for an expansion of the money supply through borrowing by the state to ensure an effective macroeconomic demand (Keynes, 2002; Lerner, 1943). Additionally, there are a variety of monetary, fiscal, and structural policy approaches to optimize the usage of potential output targeted by the analysis of the quantity equation (Samuelson & Nordhaus, 1998, pp. 692–717). The fundamental debates are partly reflected in the design of a complementary currency, even if this theoretical background is often not explicitly discussed.

Ultimately, it does not matter whether an output gap is triggered by failed exogenous management, restrained endogenous bank money creation, or a surprising externality. As soon as output gaps arise and persist despite economic policy measures, the question arises as to whether complementary currencies can help balance the balance temporarily or permanently.

Similar to regular monetary policy, complementary currencies can send signals to market participants. An increase in the money supply M_C means higher liquidity for those who participate in the complementary currency. The provision can be made via an interest rate that is lower than in the regular credit market. Especially for small and medium-sized enterprises, the differences can be even more significant if there are no more loan additions in the regular market. Such a “credit crunch” can be defined as follows:

“Accordingly, there is a credit crunch if there is a significantly higher credit demand surplus than the long-term average for a given economic environment and company creditworthiness. An essential feature of this credit crunch term is that both environment-related variables and company-related factors are taken into account.” (Reize, 2010, p. 6)

In this case, M_C can take on the role of M', i.e. the credit creation activity of the banks. It is also conceivable that a complementary amount of money is put into a network as exogenous money creation. Complementary currencies, which combine the approach with an unconditional basic income, give a certain amount of money in complementary currency to all participants each month. In experimental projects like Circles, Gradido, and Lindentaler, the amount of money is centrally controlled and put into circulation, often combined with high transaction fees or negative interest rates. The problem here is the real side of Q, because only a few businesses are ready to accept such monies. For businesses, the currency only has value if they can spend it again. A solution would be the state accepting the currency for taxes, but this would need a democratic decision that an unconditional basic income should be paid. Another solution could be that common property like land is used. Such projects show that the creation of money alone does not solve any problems. The quantitative theory of money focuses on the necessity that the monetary side has to be linked to the real side of the economy.

2.4 APPLYING QUANTITY THEORY TO CHIEMGAUER

In the case of the Chiemgauer, the increase in the money supply takes place through the purchase of Chiemgauers with euros. Rösl assumes a substitution of the euro by the Chiemgauer (Rösl, 2006); however, the euro money supply remains the same and continues to circulate in the banking system because the euro is deposited with a cooperative bank and the latter can make loans with it. Only if the bank deposited the deposit with the European Central Bank or if the amount were set aside as cash in a vault would the euro money supply be reduced. Hayek uses the example of the ducat to discuss whether a 100% deposit in cash, gold, or with a bank is required at all (Hayek, 1977). For the establishment of such a system, confidence-building is crucial, so he pleads first for a 100% reserve, which guarantees the money holder of an alternative currency to get paid the currencies recognized in the public (Hayek, 1977/1990, p. 49). Once trust is built, however, the currency issuer can work with the money, preferably by issuing loans in their own currency (Hayek, 1977/1990, p. 50). With the Chiemgauer, the 100% reserve was always retained, but possibilities were developed with banks to give loans directly from the reserves in euros or Chiemgauer to the network participants.

Another assumption made by Rösl is that the demand for money for euros (M ↓) decreases when the demand for money for Chiemgauer (M_C↑) increases. An empirical evidence for this statement is not presented. Instead, it is based on the assumption of “superneutrality” of money, which has no influence on the utilization of the production potential or even on the size of the production potential itself:

“This result, as in the traditional Ramsey and Sidrauski model, is independent of the growth rate of the money supply, i.e. money is 'super neutral' in the long run.” (Rösl, 2006, p. 30)

Accordingly, it would always be only a matter of shifts in means of payment, but no expansive impulses could be set by money. Monetary policy would therefore be an illusion behind the veil of which the real economy would always run as the potential provides. From Rösl's point of view, the money creation activities of the complementary currencies are a negligible residual ($T_{opt} \times P_{opt} - M_K \times V_K - M_B \times V_B = 0$).

An alternative to the Rösl model was presented by Guenther Rehme. This complements Sidrauski's model with two essential components: firstly, the tendency to own assets that create a benefit in addition to money. The propensity to save and the benefits realized by wealthy people through real estate and equities are taken into account (“Love of Wealth”). Secondly, fees on money are included as an influencing factor for holding money. The benefit functions show that perseverance costs on money change the behavior of those involved and lead to shifts in consumption (Rehme, 2018).

The Chiemgauer views money as a “production factor” (Binswanger, 2013). With money, production is merely set in motion, and sophisticated collective money designs are needed that optimally activate people's abilities (Desan, 2017, p. 111).

Within this view, a complementary currency does not only go beyond the perpetual motion view. For example, in the Sidrauski model, which relies on markets that are as self-controlling as possible (Polanyi, 1944/2001). Initially, output gaps are addressed, but it depends very much on the quality of the goods that are to be produced. Money becomes the activation factor of idle skills in the context of goals that may impose further limits on the

production of goods, such as the avoidance of environmentally harmful products. Money design itself plays a major role in what is produced in a division of labor and what is not.

In a large currency area such as the eurozone, it is by no means possible to close the output gaps and keep the losses caused by inflation, unemployment, and environmental damage at a satisfactorily low level. Heimberger and Kapeller estimate high output gaps, especially for the peripheral countries of the eurozone (Heimberger & Kapeller, 2017, p. 15):

	Output gap	Output gap**
Periphery countries		
Greece	−9.1%	−42.1%
Ireland	−1.1%	−25.2%
Portugal	−3.9%	−12.6%
Spain	−6.9%	−25.2%
Italy	−4.0%	−15.2%
Core countries		
Austria	−0.9%	−7.9%
Germany	−0.4%	−1.4%
France	−1.9%	−8.3%
Netherlands	−2.7%	−7.1%
Belgium	−1.0%	−8.0%

FIGURE 2: OUTPUT GAPS IN THE EUROZONE IN 2014

The first column presents output gaps based on current estimates for 2014. The effects of the 2008 financial crisis are “priced in”. They show large gaps in Greece and relatively large gaps in Italy, Spain, and Portugal. The second column assumes that there would have been no breaks in production potential as a result of the financial crisis; thus, if production potential is continued at the previous average growth rates, there are sometimes much larger output gaps. Only in Germany would the output gap be small in both considerations. Due to the different growth paths that are causing ever greater inequality in the eurozone, there are recommendations to coordinate economic policy so that it would be reduced again (Gräbner et al., 2020).

Complementary currencies open up a regionally differentiated view. In a region with high unemployment, the focus will be very much on closing output gaps (Gelleri, 2019). In the Chiemgau region, however, we have been dealing with relatively low unemployment for many years. Put simply, regions with severe underutilization are more concerned with “job-creating complementary currencies”, while the Chiemgauer views itself as an “awareness-raising” complementary currency and is more concerned with maintaining, strengthening and sustainably aligning regional structures and directing funds into cultural and social areas (Gelleri, 2020a). Nevertheless, it is intuitively obvious to assume that the volume of complementary currencies is likely to be greater in regions with severe underutilization.

3 APPLYING QUANTITY THEORY TO THE CHIEMGAUER

Quantity theory has certain weaknesses in the context of the prevailing monetary system. Milton Friedman in particular has contributed to a negative image of quantity theory by claiming that the money supply has a direct effect on the price level (Friedman, 1987). The quantity theory developed by Fisher counters this simplification by considering the velocity of circulation. This connection was known much earlier, when John Locke pointed to the

possibility of hoarding saved finances (Locke, 2020). But Aristotle and Plato were also beyond the ideas of a “naïve quantity theory” in their trains of thought (Aristoteles, 1911; Binswanger, 2009, p. 68).

Another reason quantity theory plays a less prominent role is the fact that money is created by commercial banks. For the most part, money is endogenous. Also, there is not just one form of money, but different forms and also other currencies, so that determining the money supply is difficult. Due to these limitations, the components of quantity theory are fluctuating and beyond control.

With a regional currency embedded in regulated contexts, the impact on components is much greater. For that reason, applying quantity theory in the context of complementary currencies is easier. If the price level is assumed to be external because the prices are 1 to 1 excellent, and it is possible to stabilize the circulation speed of the Chiemgauer, then the turnover can be changed by influencing the money supply. From a political economy point of view, this is particularly interesting when the money supply is externalized, i.e. when the amount of money supply is not determined endogenously by the exchange of consumers but by the circulation of money supplies, for example by municipalities.

The success of the “Miracle of Wörgl” can be traced back to two factors: firstly, the money circulation rate was fixed at a high level by the money circulation security, and secondly, new money was introduced into the local money cycle (Broer, 2013). While some critics try to reduce the success in Wörgl solely to the creation of credit money by the municipality, the control of the two variables M and V is decisive in an analysis of the quantity equation (Ottacher, 2007).

Based on the Chiemgauer data, we can understand these processes even more precisely.

3.1 Multiplier Effects of Chiemgauer and Quantity Theory

From an economic point of view, the Chiemgauer begins with the exchange of euros for Chiemgauers. At the same time, a money supply is created in the network. Since not every exchanged Chiemgauer is exchanged back immediately, amounts of money are created over time which consist of the exchange of the previous periods. The money supply M_C is the sum of all impressions made, which are reduced by all back exchanges:

$$M_C = \sum_{t=1}^{\infty} (X_t - R_t)$$

Since the Chiemgauer is limited in time, they lose their validity; however, they do not reduce the money supply if Chiemgauers that have become invalid are replaced by new Chiemgauers. The same applies to the periodic devaluation of the Chiemgauer. The devaluation of the Chiemgauer is not considered on the condition that the devaluation in the same period is replaced by new Chiemgauers. They are put back into circulation by the issuer in the form of expenses.

The exchange X in turn depends on the willingness of the exchangers. Economically, the exchange can be seen as a function of income. No exchange would take place if the entire income were to be collected in Chiemgauer, so another condition is that the income is paid out in euros or another foreign currency so that it can be exchanged for Chiemgauers at all.

$$X_t = f(Y_t^{€})$$

We first describe the exchange in general as a function of the euro income in the respective period and will specify this in more detail in the further course.

Chiemgauer sales (T) valued in euro prices (P) can be represented as a money supply multiplied by the speed of money in circulation.

$$T_t^C \times P_t = M_t^C \times V_t^C = X_t \times m_t^C$$

Money supply and exchange are known from above. Initially unknown were the Chiemgauer turnover and the speed of money in circulation. The revenues as a product of the transaction quantity T in the Chiemgauer network and the prices shown in euros can also be derived by multiplying the exchange of euros for Chiemgauers by the transfer multiplier within the Chiemgauer network.

$$T_t^C \times P_t = X_t \times m_t^C$$

This multiplier results from the income of the companies and the quota of the exchange or transfer in the Chiemgauer network. As a simple example, we take 100 euros, which are exchanged for 100 Chiemgauers. These are passed on in full by the consumers, which generates 100 Chiemgau revenues. The company then exchanges 50 Chiemgauers for euros and passes on 50 Chiemgauers. The second company also exchanges half back, etc. In this case, the transfer rate (w) is 50%, and the exchange rate is also 50%. The total turnover is 100 + 50 + 25 + 12.50 + 6.75 + 3.38 + 1.79 + 0.90 + 0.45 + 0.23 + 0.12 + 0.06 + 0.03 + 0.02 + 0.01 = 100 / 0.5 = 2.

The Chiemgauer turnover can thus also be written as:

$$T_t^C \times P_t = \frac{X_t}{(1-w)}$$

By forming and equating, we get the network-internal multiplier m:

$$\hat{=} \frac{T_t^C \times P_t}{X_t} = \frac{1}{(1-w)}$$

$$m_t^C = \frac{1}{(1-w)}$$

To determine the transfer rate, participating Chiemgau companies have been surveyed (see 1.4); questions were asked about the Chiemgauer turnover achieved per month or year and either the sum that was exchanged back or the sum that was passed on. With this data, the transfer rate w or the exchange rate (1-w) could be determined.

3.2 Calculating the Velocity of the Chiemgauer and Comparing it with the Euro

For the Chiemgauer, the quantity equation with the money velocity contains only one unknown, which can be calculated directly from the known variables. For 2019, the figures are as follows:

$$V_{2019}^C = \frac{T_{2019}^C \times P_{2019}}{M_{2019}^C} = \frac{5{,}621\ Mio.\ CHM}{0{,}615\ Mio.\ CHM} = 9{,}14$$

[15]

The sales volume of the Chiemgauer was determined from the statistics of the digital Chiemgauer plus the exchange of euros for Chiemgauers plus the estimate of the passed on cash Chiemgauers, which results from the transfer rate. The Chiemgau money supply contains the daily sight deposits on the Chiemgauer accounts and the cash volume of the Chiemgauer put into circulation by the Chiemgauer e.V. A comparison with the money circulation speed of the euro is possible. The transaction concept is used in calculating V; therefore, either the gross domestic product must be transformed into the transaction volume, or the sales must be determined directly. In statistics for small and medium-sized enterprises, the Federal Statistical Office directly reports the turnover for all types of companies, including large companies, which is why the transaction-based circulation speed can be calculated (Destatis, 2020):

$$V_{2019}^{€} = \frac{T_{2019}^{€} \times P_{2019}}{M_{2019}^{€}} = \frac{7008\ Mrd.Euro}{2648\ Mrd.Euro} = 2{,}65$$

The euro money supply contains the money supply M1 specified by the Deutsche Bundesbank and the cash put into circulation in Germany by the Deutsche Bundesbank as of end of 2019 (Bundesbank, 2020). The money supply M1 contains all sight deposits due on a daily basis. The usual definitions for M1 also include cash, but the Deutsche Bundesbank has been reporting cash in circulation separately in the monthly report for some time, so this sum must be added to M1 in each case (Bundesbank, 2019a). This addition makes both the money supply and turnover comparable. The money circulation speed of the Chiemgauer in 2019 was 3.45 times higher than that of the euro. This is because the euro is mainly used as a store of value, while the Chiemgauer is mainly used as a means of payment. The objective formulated by the Chiemgau community of emphasizing the created regional currency as a means of payment is thus confirmed. The same picture can be seen in a multi-year comparison:

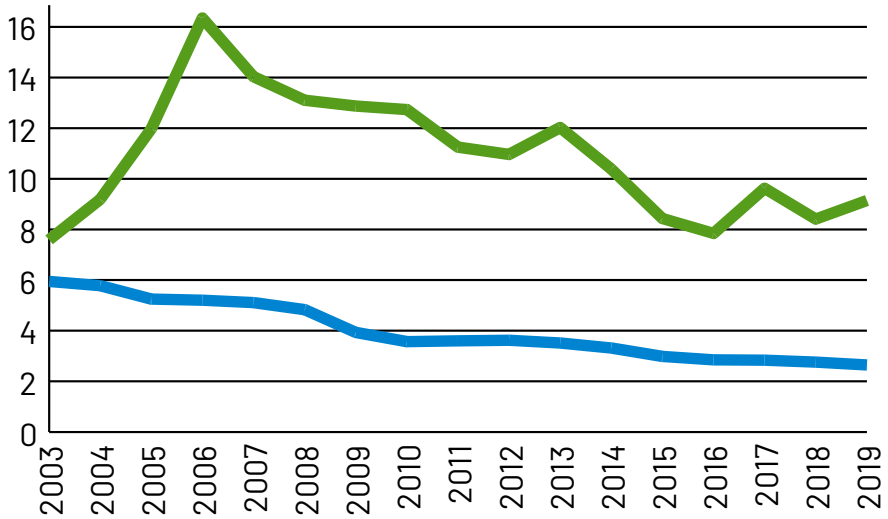


FIGURE 3: COMPARISON OF VELOCITY OF CHIEMGAUER (GREEN) AND EURO (BLUE)

In the early days, the money circulation speed of the Chiemgauer was still characterized by small volumes and a strong variance. This is typical for newly launched complementary currencies. The level between 2015 and 2019 corresponds to the initial level. Throughout the existence of the Chiemgauer, the payment function has dominated over the value retention function.

3.3 EMPIRICAL DEVELOPMENTS OF THE VELOCITY OF DOLLAR AND EURO

Due to well-established payment habits, Friedman assumed that the velocity of circulation was constant, at least in the short term (Friedman, 1987, p. 19). In the traditional Ramsey and Sidrausky model, it is also assumed that production automatically results in an optimum regardless of the choice of money supply growth (Rösl, 2006, p. 30). Under these assumptions, an excessive increase in the money supply results in inflation. The connection between M and P was first postulated by David Hume.

“According to the classical dichotomy, changes in the money supply affect the nominal variables, but not the real variables. When the ECB doubles the money supply, the price level, nominal wages and all other variables expressed in monetary units double. The real variables, such as production, unemployment, real wages and real interest rates, remain unchanged. This irrelevance of changes in the money supply with regard to real variables is called the neutrality of money.” (Mankiw & Taylor, 2008, pp. 740–741)

Evidence of the close relationship between money supply and price developments is mainly based on examples of hyperinflation, especially in Germany, Austria, and Hungary in the early 1920s (Sargent, 1982). Empirical data in the second half of the 20th century shows no constancy in the velocity of money in circulation, so a stable development trend is assumed in the meantime. Econometrics speaks of a stationary context (Auer & Rottmann, 2020, p. 539). For the monetary aggregate M2, Nobel laureates Engle and Granger state a corresponding correlation with the gross domestic product of the USA, but not for M1 and M3 (Engle & Granger, 1987, p. 274).

A closer look at the trend in the euro's velocity shows a downward trend, which is associated with a decline of 56% between 2003 and 2019 alone. This downward trend is not linear, but has a structural break in 2008 at the latest, which seems to be related to the financial crisis of 2008; however, the trend deviation begins as early as 2002:

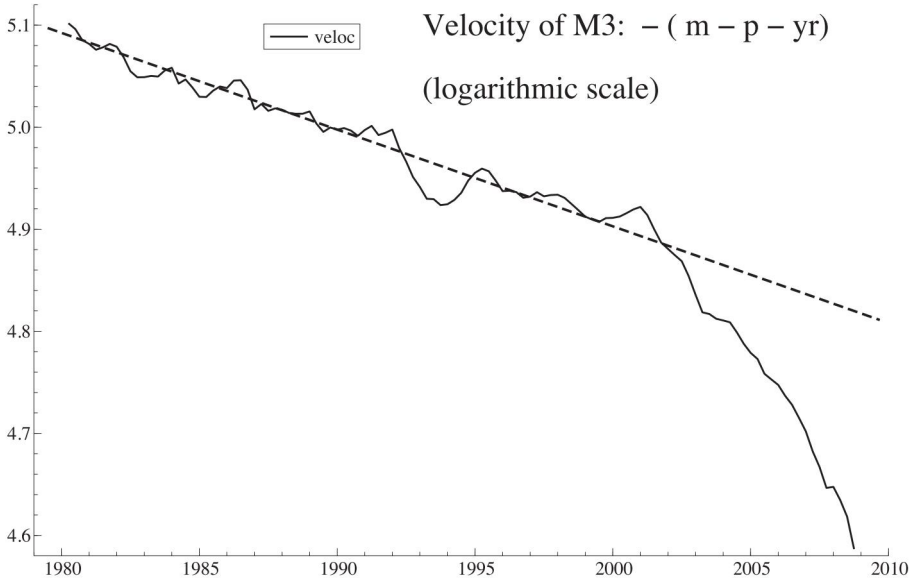


FIGURE 4: TREND BREAK OF THE MONEY VELOCITY M3 (BEYER 2009, S. 2010)

The money circulation speed was calculated for the money supply M3. Instead of transactions (sales), the gross domestic product was used. The trend break in the years 2002/2003 is striking.

A similar picture for the monetary aggregate M1 can be seen in the USA since 2008. A particularly sharp slump can be seen in 2020, when lockdowns were implemented in the USA.

FIGURE 5: ORBITAL VELOCITY OF M1 (SOURCE: FRED.STLOUIS.ORG)

In case of a surprising decline in the velocity of money in circulation, the other side of the quantity equation, i.e., the nominal demand for goods, decreases if the money supply develops unchangedly in the short term. Empirical studies show a procyclical relationship between money velocity and real gross domestic product (Leao, 2005). The velocity of money in circulation has a direct impact on gross domestic product and is the cause of its rise or fall (Tobin, 1970). With the help of vector error correction models, a cointegration between gross domestic product and velocity of circulation can be demonstrated in the main currency areas, which attribute changes, especially shocking declines in economic output, to changes in the velocity of circulation (de la Rosa & Stodder, 2015).

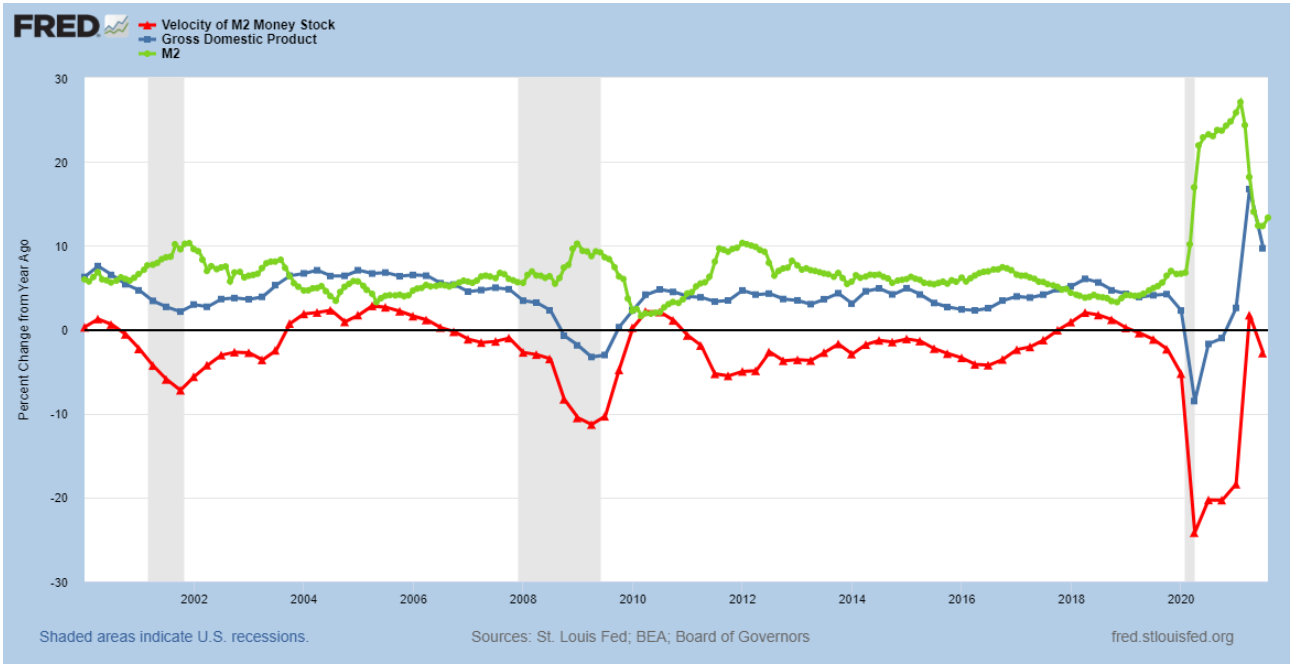


FIGURE 6: RELATIONSHIP BETWEEN GDP AND VELOCITY OF CIRCULATION IN THE USA

The connection can also be illustrated graphically. A decline in the velocity of circulation is followed by a decline in economic output. Although central banks can balance the money supply through monetary policy measures, there are time delays here because measures via the interest rate channel and also unconventional measures such as bond purchases by the central bank take time to increase the money supply and, as a result, demand (Tobin, 1970, p. 315). Changes in the circulation of money are seen as the cause of changes in investment behavior and, for the holding of money itself, the level of interest rates, which influence the holding of money as an opportunity cost. Low interest rates reduce the cost of holding money, thereby reducing the speed of money in circulation (Leao, 2005, p. 120). Above all, the highest decile of the population reacts sensitively to this and develops a higher need for money holding at low interest rates. From the point of view of equal opportunities, this is not necessarily a positive one (Beckert, 2007, p. 5); therefore, economists who are open to distribution theory have repeatedly pleaded for a redistribution of money from people with a low tendency to people with a high propensity to consume (Brunnermeier & Sannikov, 2016, p. 5).

3.4 Increasing the Velocity of Money and Its Policy Implications

The regional currency Chiemgauer tries to start directly at the velocity of circulation by setting the opportunity costs of holding money so high that the transmission of interest rate changes remains unaffected. The price for this, however, is that the Chiemgauer becomes unattractive as a store of value (Mersch, 2014). If only one currency were available as an option, it would have to be decided politically which property would have a higher weight. Since the Chiemgauer views itself as a complementary currency, the focus on the means of payment function is not a problem as there are other forms of currency that are dedicated to the storage of value.

The circulation incentive embedded in the Chiemgauer emphasizes the priority of the payment function and can be seen as an attempt to stabilize the speed of money in

circulation at a high level. Parallel considerations also exist at the macroeconomic level (Assenmacher & Krogstrup, 2018; Buiter & Panigirtzoglou, 2003; Kimball & Agarwal, 2019). In this sense, the Chiemgauer can be seen as an experiment to find out the optimal conditions and rules. The fact that the founding of the Chiemgauer coincided with the beginning of the structural break in the velocity of the euro is no coincidence, since the steadily declining tendency was one of the reasons to think about this aspect (Gelleri, 2005). This discussion played a significant role in developing Chiemgau's money design. Stabilizing the velocity of circulation is seen as a better alternative to a continuous increase in the money supply, because the great risk of pure control over interest rates and the money supply is that the velocity of circulation can rise again. If such a turn occurs, this can result in an accelerating development of the velocity.

The reason for a gradual reversal can be manifold, such as a shortage of supply in a submarket such as energy. By signaling scarcity from the supply side, price surges arise that can have a direct effect on spending behavior. The velocity of money in circulation is influenced by many factors such as consumer behavior, investment, and government spending. With the Chiemgauer, a reduction in the velocity of circulation is counteracted by associating the holding of money with costs. If the money supply of the Chiemgauer is determined endogenously, here by the voluntary exchange of euros for Chiemgauers, it can result in evasive behavior, so that not the velocity of circulation, but the money supply decreases; however, Yves Mersch’s prognosis has never materialized (Mersch, 2014, pp. 8–9). It would be necessary to investigate in more detail why this is not the case. A trace leads to the relationships between the Chiemgauer users. In crises, the willingness to show solidarity is increased. After the Covid-19 crisis and an appeal to members, more than 100 people were willing to change their funding projects to damaged small companies. The willingness to buy specifically at these companies also increased. A second trail leads to the communities. Similar to Wörgl in 1932, the city of Traunstein issued aid in 2020 and 2021 in the form of tailor-made vouchers and the local currency Chiemgauer. These subsidies for companies and citizens act like an external amount of money that comes into circulation.

By democratically adjusting the design of a complementary currency by the local people and adapting it to the time conditions, even an outdated theory such as the quantity theory can be revived. If money is understood as a “government technology” (Desan, 2017), or even better as a democratic community technology, the variables of quantity theory also become controllable; however, this also shows that the machine is more of a social technique that is related to the consciousness of people and can be democratically shaped by them.

3.5 Thinking Beyond the Mainstream

The next steps in the research are first to examine the link between transaction volume and local unemployment. At first sight, there is a cointegration for some places in the region of Chiemgau (Gelleri & Stodder, 2021). The increase in the transaction volume in Chiemgauer increases local GDP and decreases local unemployment.

The second step is to connect the quantity theory of money with the quantity theory of the environment. When we define the limits of the earth as given, we can calculate a GDP which is compatible with the environmental limits.

Humanity's influence on Earth is diverse, complex, and expanding. The ecological footprint has been too high for several decades. To make the excesses economically tangible,

individual components such as greenhouse gases can be used. Greenhouse gases are calculated by the IPCC as a residual quota and thus represent an absolute limit. Emissions of greenhouse gases result from resource extraction and from the resource cycle and the landfilling of resources. Each stage of value creation can be measured individually in terms of emissions. In addition, there are value creations that do not take place in monetary form, such as breathing or activities that do not take place as part of the official economy, such as, for example, the collection and burning of wood. Most emissions occur during the monetarily value-added stages, so it makes sense to focus on these large emitters.

The quantity theory of money can be subordinated to the goal of sustainability. This would mean that the transaction volume may only be as high as it corresponds to the available quota. This goal could be achieved particularly well if it were possible to stabilize the velocity of money circulation so that the money supply could be adjusted so that the economy could no longer emit due to the quantity limit. Economic actors could increase CO2 efficiency per unit of currency, thereby influencing the money supply; however, it should be assumed that the potential for technological efficiency is limited. Further potential lies in sustainable cycle management (consistency) and in sustainable behavior through sharing, extension of service life, repair, and similar approaches. Complementary currencies that focus on these goals are eligible for this purpose, while there is an urgent need to return the large monetary systems to a sustainable level due to their high emissions.

People who take the challenges of climate change seriously should agree to a goal that corresponds to the goal of a global maximum warming of 1.5 degrees. For a country like Germany, this would mean reducing emissions by 17% per year by 2030. Although technological efficiency is increasing and CO2 intensity is increasing by 3% annually, this would not only mean that the economy can no longer grow, but also that the German economy would have to shrink by 14% annually to meet the targets. In a democracy, such an approach seems hardly reasonable. The ecological objective would also contradict the objective of a high level of employment. Such a goal could only be achieved with a radical restructuring of society and the economy. We would all have to slow down, settle for less, work less than we do today, and, above all, people with a large ecological footprint would have to consume much less. This would go together with the reduction of the money supply, and this would have to start where there is a particularly large accumulation of money.

This approach is in stark contrast to approaches that see money creation as an opportunity to stimulate investment in climate-friendly technologies. Further growth in the money supply would inevitably be accompanied by further increases in CO2 emissions; therefore, limiting the amount of money should be the order of the day. Climate-friendly investments would have to be organized through the activation of existing money supplies or, if there is no willingness to do so, through redistribution. Complementary currencies could be used to control this redistribution process much better, as they can be influenced both in the creation of money and in the circulation of money. A regional currency like the Chiemgauer moves in sustainable regional cycles and therefore requires much less CO2 emissions per currency unit than a unit in a national currency.

Due to the challenges of climate change, the issuance of complementary currencies should not be seen as an addition to the existing monetary system; rather, they should replace it if they can reduce CO2 emissions. Wherever the national currency fails in large currency areas, such as in southern Europe, complementary currencies offer a historically unique

opportunity to build truly sustainable currency cycles. National currencies such as the euro or the dollar could be deposited as a reserve unit. Against this background, the issuance of digital central bank currencies makes sense because they would facilitate the decommissioning of euros (Martín Belmonte et al., 2022).

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Convertible local currencies as an economic development tool for businesses ?
Findings from an panel econometric analysis on french companies joining a Convertible ocal currency

Communication to the RAMICS 2022 Conference - online

28/10/2022

Foreword :

The following work is presently a doctoral dissertation chapter. It is originally written in French and, at this stage, I have translated it only very roughly in order to provide some support for the RAMICS presentation. I apologise beforehand for the poor quality of the translation and thank you in advance for your understanding in these particular circumstances. It will be further edited to produce an article in the months following the thesis defense in November.

I also wish to thank Vincent Carret for his precious help in the webscraping of the Siren numbers of CLC member companies, which was necessary for the realisation of this work. I would also like to thank the Nouvelle Aquitaine region, Sciences Po Lyon, and the Centre de recherche de développement territorial de l'Université du Québec en Outaouais, which, through the MoLoNa and TerMos research projects and a study grant, financed access to the Fare files at the Centre d'accès sécurisé aux données (CASD) and enabled the realisation of this study.

Introduction :

The number of convertible local currencies (CLCs) grew particularly quickly in France during the 2010s, with a tenfold increase in the number of CLCs in circulation between 2011 and 2019 (Blanc, Fare, and Lafuente-Sampietro 2020). Thus, 82 MLCs were circulating in France at the end of 2019, covering nearly 30% of French municipalities. The rapid spread of this phenomenon has awakened and been reinforced by the joint interest of public authorities, which legislated on their status in 2014, as well as activist circles that present them as potential tools for ecological and social transition, notably through films such as Demain (Dion and Laurent 2015) or the online training course of the Colibris movement . This proliferation of projects and the attention received by CLCs in France leads us to question their social, economic and environmental effects from a scientific point of view. While there is already an abundant literature on alternative currencies (Blanc 2018a) and on the potential theoretical effects of CLCs (Fare 2016), the measurement and empirical evaluation of these effects is still weak and deserves to be investigated. In this work, we adopt an approach similar to that of public policy evaluation, thinking of CLCs as devices used or not by actors and trying to measure their impact by comparing a test group using an MLC to a non-user control group. We therefore seek to measure the benefits in terms of turnover that companies derive from their use of a CLC.

Convertible local currencies (CLCs) are monetary instruments for specific purposes and circulating alongside national currencies in a given territory. They are created and managed by groups of citizens gathered in non-profit organizations or community banks, sometimes supported by local public authorities. These currencies can take different forms, depending on the project, from paper banknotes to digital payments by card, text message or mobile application. What distinguishes them from other alternative currencies is the way they are issued. The currency is issued through the exchange of national currency units for local currency units at a fixed exchange rate. The currency obtained can then be used in shops and at companies, associations or institutions in the territory that accept it as a means of payment. The national currency used to obtain the local currency is kept in a guarantee fund, allowing the local currency to be converted back into national currency under the conditions set by the issuing institution. This conversion is generally forbidden for individual users, but authorized for companies at the price of conversion fees or at least implicit costs.

The CLCs thus build a separate monetary circuit, forcing their users to exchange among themselves to spend the CLC units they receive. The managing associations also participate in this linkage by playing an intermediation role through the provision of tools and the animation of the user community. The use of the CLC also acts as a signal, identifying economic actors who share similar values and thus splitting the market. The redirection of demand from MLC users to businesses in the monetary community, either through the mechanical constraint of their spending ability or the signal sent by the acceptance of MLC, may result in additional demand for MLC member companies and thus enable them to increase their total turnover. This increase in turnover is, in our view, imperfectly correlated with the turnover achieved in MLC. Indeed, if the constraint effect on the place of expenditure of the monetary units received as payment applies only to the revenues realised in MLC, the signal effect relates more generally to the enterprise as such. Thus, it is likely that actors will choose to buy from one enterprise in the monetary community rather than another because of its acceptance of MLC, while consuming from it in national currency. The additional activity generated by the acceptance of MLC does not therefore seem to be perfectly measurable thanks to the activity carried out in MLC and must therefore be measured on the scale of the companies total accounts.

In order to measure these changes in economic activity, we have chosen to conduct the analysis at a micro level. Krohn and Snyder (2008) have previously attempted to measure the effects of local currencies on economic development by comparing growth in US cities with and without local currencies. However, they failed to show significant impacts of local currencies, but we believe that because of the low territorial coverage of CLCs, the municipal scale they chose is too large to measure a general effect (Michel and Hudon 2015; Matti and Zhou 2022). Moreover, CLCs do not necessarily aim to develop an entire locality, but rather a selected territorial community. We therefore propose to focus the study on the community that actually uses the MLC, and thus to concentrate on the companies involved and not on the municipality as a whole. Our analysis is therefore positioned at the microeconomic and individual level of the activity of MLC member companies.

In order to carry out the econometric study measuring the effect of the acceptance of MLC as a mean of payment on the turnover of companies, we used data from the Fare file, which contains all the tax data of French companies from 2009 to 2019. Since companies are identified by their national Siren number, we can follow the evolution of their activity over the years and use the data in panel form, simplifying the identification of effects.

In this chapter, we will first describe the data used for this study and then the methodology applied for their analysis. We will then present the results of these econometric models and discuss them as a conclusion to this last chapter.

1. Data

To carry out this study, it was necessary to combine several complementary data sources. We first needed to obtain a list of companies that had joined MLCs in order to identify them in other databases. We also needed access to the production information of these firms and of firms in a control group over several years surrounding the dates when the firms joined an MLC, which we obtained from the Fare file.

a. FARE data and their preparation

The Fare file is a file containing all the tax data of French companies in the market sector and involved in productive activity, except for the financial sector and agricultural activities. Companies are identified in the file by their Siren number, a 9-digit public identifier.
The Fare scheme has been in existence since 2008 and has one vintage per year until 2019. However, the first vintages have different variables from the following years, some of which are necessary for our analysis, and we have therefore chosen to use only the vintages from 2010 onwards.

Table 1 - Number of observations in each year of the Fare file

Year	Observations
2010	3 340 887
2011	3 737 728
2012	3 866 486
2013	4 224 263
2014	4 385 731
2015	4 052 206
2016	4 245 075
2017	4 188 215
2018	4 290 267
2019	4 456 558
Total	43 677 123

Each year contains about 190 variables, containing various information ranging from the statistical status of the observation, to the variables of identification and administrative description of the enterprise (Siren, name of the legal entity, legal status, type of enterprise, sector of activity) to the fiscal data of activity (turnover, profits, value added, taxes, assets, number of full-time equivalent employees). This information provides a fairly accurate picture of the companies' financial situation.

c. Experience design

We identify 1,895 companies belonging to 9 french CLCs them in the Fare data. We then had to develop a strategy for selecting companies that were not members of CLCs as control. As we did not have a list of the members of the 80 French CLCs, we had to develop identification strategies in order to be sure to select companies that did not use CLCs.

A first solution was to choose areas with no known CLCs. This solution had the advantage of ensuring the absence of contamination between member companies of CLCs and those of the control group. Indeed, it could happen that, by being located in the same area, the positive effects from which the companies in the test group could benefit would be to the disadvantage of their neighbours. Thus, the measured effect would be overestimated, since the cyclical variation captured by the control group would take into account the negative externality of the use of the CLCs. Furthermore, choosing firms in areas without available CLCs limits the self-selection bias in the schemes. Firms in the control group without access to CLCs did not voluntarily choose not to use them. However, information on all areas with or without a CLC is currently not systematised and we were only able to obtain a list of departments without known CLCs, rather than a finer grid of employment areas or municipalities. This very broad identification of areas without CLCs leaves little choice of areas without known CLCs for selecting the control sample, and these areas turn out to have characteristics very different from those occupied by the CLCs in the test group. Indeed, the fact that an entire department is currently free of CLCs is potentially correlated with many characteristics that may have a joint effect on its economic development. For example, departments without CLCs include far fewer large cities than those with identified CLCs, as these schemes are often located around metropolitan areas ((Blanc, Fare, and Lafuente-Sampietro 2020). It therefore seemed to us that the companies in these localities were probably facing different environments and exogenous shocks than those of the companies in the test group, which could bias our analysis. Moreover,

as the census of CLCs is still imperfect, it is not impossible that CLCs exist in some of these departments without our knowledge and could contaminate the control group.

We therefore abandoned this first solution in favour of selecting the control companies within the same employment zones as those of the test companies so that the companies in the test and control groups face similar exogenous contexts. Moreover, as the territories of the CLCs rarely overlap, we know that in these areas, firms not identified in our files are unlikely to be users of a CLC. However, this choice makes it possible for negative externalities to exist for the control group: the decision to enter the CLC of a tested firm could have a negative impact on the activity of firms in the control group in the same locality, due to a transfer of customers for example. As the coverage rates of CLCs in employment areas are still low, we believe that these externalities are minimal and unlikely to be observed at this stage of their development. Furthermore, there is a selection bias between the CLCs and the control group. Indeed, the latter have access to a CLCs, but have chosen not to join it, or have not been aware of it. The factors explaining this choice, such as the socio-economic environment in which these companies and their managers operate, are most likely not observed in the database and could have an effect on the turnover trajectories of these companies.

Despite these biases and in view of the impact identification method deployed, we have chosen the latter solution. We have thus restricted the analysis to companies present in the same employment zones as CLCs members and belonging to the same sector of activity, identified by their APE code, i.e. 1,997,832 controlled companies.

In order to increase the similarity between the control group and the test group, we choose to restrict the samples to the companies present in the 2019 Fare vintage. This choice allows us to avoid dealing with the bankruptcy situations of the companies, in the test group as well as in the control group, but above all to keep only the companies with a long-term activity, whose evolution can thus be analysed. Thus, with this decision, only 1,701 enterprises are retained in the test group, i.e. 90% of the enterprises in the sample. However, on the side of the control enterprises, this decision allowed us to keep only 1,054,053 enterprises, i.e. 53% of the enterprises in the sample. This drastic restriction bring the profiles of the companies in the control group and the test sample closer together. Indeed, it seems that the CLCs member companies have a more durable period of activity than a large proportion of the other French companies and this choice makes it possible to limit this type of difference.

Finally, two last steps of data restriction consisted in removing the data statistically imputed by the teams producing the Fare files for some companies and in keeping only the observations of enterprises aged at least one year and with a turnover different from 0. The imputations are particularly important for microenterprises, i.e. companies composed from only one individual, which are very present in the test sample. This restriction decreases the number of enterprises in 2019 in the test sample to 1,215 and in the control group to 784,846. The choice to keep only enterprises older than one year is explained by the comparability of the activities of enterprises in their first year. Indeed, some enterprises may have been created at the beginning of the year and others in the last half of the year and therefore do not have the same number of half-years to compare in their first year of existence, in particular in order to measure their own evolution with respect to the following year. The restriction to turnover figures other than 0 comes from the hypothesis that a turnover equal to 0 is similar to an absence of activity that year, without being linked to an immediately productive problem. All these choices result in a test sample of 1,281 firms in total, of which 1,182 can be found in 2019.

Tableau 2 - Nombre d'entreprises par millésimes de Fare

Year	**Open in 2019**		**Not imputes**		**Turnover ≠ 0 and Age >0**	
Sample	**Test**	**Control**	**Test**	**Control**	**Test**	**Control**
2010	663	495 933	543	386 197	529	360 121
2011	751	571 869	593	427 042	571	396 867
2012	807	624 037	651	457 040	629	423 809
2013	912	694 300	679	489 192	650	452 246
2014	1 017	765 746	734	519 841	709	478 718
2015	1 104	832 515	825	582 267	793	533 862
2016	1 257	930 083	912	631 779	872	575 630
2017	1 425	1 062 458	1 028	691 898	988	625 651
2018	1 570	1 197 250	1 089	748 978	1 053	668 560
2019	1 701	1 442 609	1 215	784 846	1 182	699 205
Observations	11 207	8 616 800	8 269	5 719 080	7 976	5 214 669

2. Methodology

The 9 files of the Fare data enable to construct a longitudinal database whose panel structure can be a real asset for identifying effects. The panel data thus make it possible to include individual fixed effects, controlling for unchangeable characteristics of firms that can explain both their membership of a CLC and their economic trajectory, such as the personality of their manager or their customer target. In this type of model, the control group is essentially useful for measuring as accurately as possible the external cyclical variations captured by a time fixed effect. It is therefore important to obtain a control group with sufficiently similar characteristics to the test group, in order to be convinced that the variations in the activities of the firms in the test group would have been on average similar to those of the control group, in the absence of the use of a CLC.

We therefore proceed with a two-stage identification strategy. The first step is dedicated to the selection of a control group using probabilistic nearest-neighbour matching, similar to the strategy used by Quantin, Bunel and Lenoir (2021) for their evaluation of the effects of the Young Innovative Company scheme, also using the Fare file with heterogeneous entry dates into the schemes. The second step consists in applying a double fixed effect model to the final sample (Imai and Kim 2021).

a. The selection of the control group by matching

The first step is therefore to select a credible control group, in order to take into account in the estimation of the variations in activity that the CLCs member companies might have had if they had not joined the schemes. To do this, we use the matching method based on observed characteristics used by Quantin, Bunel and Lenoir (2021), in order to approximate as closely as possible the characteristics of the control group to those of the test group, in particular their turnover trajectory prior to joining the CLCs of the test firms. As the dates of entry and first observations in the Fare file were heterogeneous, we applied a matching model by cohort, defined by the first year of observation and the year of entry of the test companies. Potential

controls were thus selected on the basis of their characteristics in the year of the first observation of the test firms and the year before they joined a CLC.

We selected three times as many controls as test firms in each cohort based on their propensity score. After various tests of methods, we opted for a classical nearest neighbour model, with distance measured by propensity score, itself estimated by logit regression. However, we forced an exact match by CLC region, the control having to be located in one of the employment zones of the CLCs in the cohort, by sector of activity in 17 categories and with a creation date of more or less 5 years similar to that of the test companies in the cohort. The objective of this model is not to predict the probability of a company joining a CLC, but to select companies with similar characteristics, whose turnover would have a similar variation over time outside of CLC membership.

The matching model used to calculate the propensity score was as follows:

$$\begin{aligned} P(CLV) = {} & \text{year of creation} + \\ & \text{Sector} + \\ & \text{Legal status} + \\ & \text{Employment area} + \\ & \text{Municipal density} + \\ & \text{Turnover}_{t1} + \\ & \text{Change in turnover}_{t2\text{-}t1} + \\ & \text{Number of employes}_{t1} + \text{Number of employes}_{t2} + \\ & \text{Profit}_{t1} + \text{Profit}_{t2} \end{aligned}$$

P(CLCs) is the probability of entering a CLC. In each cohort, the three controls per test observation are selected according to how close they are to the model score, combined with the restrictive conditions discussed above. If none or fewer than three controls score sufficiently well or meet the restrictive conditions, only those controls meeting the various conditions are selected. This procedure results in a sample of 3,368 control firms for the 1,281 firms in the test group.

In order to check the contribution of this sampling method and its potential impact on the final results of the study, we also selected a random control group of 3,843 firms.

In addition, due to the high variability of turnover in the upper echelons of the distribution sector, which affects the average turnover between samples, we chose to remove the 1% of companies with the highest turnover in the first year of observation in the Fare file, i.e. a

turnover of more than €16,000. We therefore obtained a final sample of 1,268 test companies, 3,334 matched checks and 3,821 random checks.

The descriptive statistics for the different samples confirm the similarity between the characteristics of the matched and test samples, compared with the random sample (Table 5).

Table 3 - Descriptive statistics of the sample

Indicator	Test (n=1268)	PPM Control (n=3 334)	Random control (n=3 821)
Mean turnover			
t1	439 857	399 169	361 963
t2	561 248	462 000	X
Median turnoer			
t1	151 385	156 295	97 920
t2	178 925	160 565	X
Number of employees			
t1	3,8	2,6	2,6
t2	4	2,5	X
Municipal density			
1	49%	52,3%	66,1%
2	20,3%	24,6%	17,5%
3	27,8%	21,7%	15,5%
4	2,9%	1,4%	0,8%
Area			
1	9,7%	10,2%	4,5%
2	8,4%	6,8%	2,7%
3	38,1%	30,5%	2,6%
4	3,9%	3,5%	1,9%
5	15,5%	22,1%	10,2%
6	8,1%	8,5%	3,5%
7	4,6%	11,4%	35,7%
8	6,7%	6%	3%
NA	0,5%	0,9%	35,9%
Sector			
C1	11%	7%	1%
C5	3%	2%	1%
DE	0%	0%	1%
FZ	2%	2%	8%
GZ	35%	36%	14%
HZ	1%	1%	4%
IZ	21%	19%	8%
JZ	3%	3%	5%
KZ	0%	0%	3%
LZ	1%	1%	6%
MN	9%	15%	22%
OQ	7%	10%	18%
RU	7%	6%	8%
Legal status			
1 Individual entreprise	19%	25%	35%
5 Commercial society	78%	74%	62%
6 Other moral person	1%	1%	2%
9 Private groupment	1%	0%	0%

As the variable of interest in the study is turnover, we have analysed its distribution between the different samples in more detail.

Tableau 4 - Décile de chiffre d'affaire

	All observations			First year of observations			Year before joining a CLC	
Decile	Test	PPM	Random	Test	PPM	Random	Test	PPM
Min	210	-3 780	-126 030	690	-850	-28 960	690	-850
10%	42 805	36 800	26 597	33 677	30 332	18 140	37 916	32 012
20%	75 142	63 320	46 085	58 562	55 384	36 570	65 464	57 702
30%	114 037	90 523	66 170	80 361	81 255	52 110	93 190	82 488
40%	165 826	128 580	90 676	111 942	113 968	71 420	135 654	117 952
50%	238 525	178 135	127 385	151 385	156 295	97 920	178 925	160 565
60%	337 118	248 412	181 992	211 128	214 264	138 390	261 652	225 304
70%	473 080	355 424	278 607	298 981	300 976	205 846	381004	316 465
80%	746 800	550 126	463 480	463 858	449 808	336 240	588 978	503 804
90%	1 439 504	1 087 142	1 035 555	878 066	876 117	738 280	1 170 864	976 484
Max	20 590 230	39 034 140	87 537 610	14 863 570	15 466 770	15 580 730	16 288 630	31 551 810

It can be seen that in the first year of observation in the samples, the distribution of turnover of the enterprises in the test group and the matched control group is close, more so than in the random sample. The characteristics of the test and matched samples diverge more in the years before joining a CLC, without causing extreme differences, except for the maximum, showing potential divergences in evolution. Information on the year before joining is only available for the matched controls, due to their selection by cohort, and not for the random control group. However, both samples will be used to estimate the models in order to compare the results.

b. The two way fixed effect model

The identification strategy of the effect of using a CLCs uses the panel structure of the data. As the CLCs entry dates are heterogeneous and range from 2012 to 2020, a standard double-difference model comparing the test group with the control group before and after a scheme entry and assuming similar variation can not be used.

In the absence of a common entry date for all test observations, it is not possible to define when the control group would have been treated if they had joined a CLC and thus compare their performance with that of the test group after treatment. The common solution in this case is the double fixed effects model (Stevenson and Wolfers 2006; Hoynes, Schanzenbach, and Almond 2016; Goodman-Bacon 2021; Callaway and Sant'Anna 2021), which consists of adding individual fixed effects to the linear model, allowing to control for all the invariant and unobserved characteristics of individuals that could influence both their economic activity and their choice of membership in a CLC, and annual fixed effects, allowing to control for the effects of economic conditions influencing both the test and the control groups. The fixed effects thus make it possible to reduce the risk of variable omission, at least for individual and unchangeable characteristics.

Table 7 - Treated and untreated enterprises in the test group by year of observation

Year	Not yet treated	Already treated
2010	517	0
2011	560	0
2012	596	22
2013	528	111
2014	539	159
2015	534	247
2016	480	380
2017	427	549
2018	305	736
2019	132	1 038

The linear model estimated using the R package plm (Hsiao 2014) is as follows:

$$Turnover = ß_1\ IdMLC_{it} + ß_2\ Characteristics_{it} + c_i + t_t + \varepsilon_{it}$$

IdMLC is an indicator taking the value 1 when the company is a member of a CLCs and 0 when it is not. The time-varying control characteristics are

- Demographic: age, statistical category of firm size, sector of activity, legal status of the firm, number of full-time equivalent employees
- Spatial: employment area, CLCs area and municipal density in 2018

Most of these characteristics show little temporal variation, however, over ten years of observations, companies sometimes move and evolve and these changes seem important to take into account in their development process. The interpretability of the control coefficients is however rather weak, as they potentially reflect more the effect of change than that of status, sector or geographical area.

The matched control group also allows for the addition of a variable from the matching method and thus brings the control group firms closer to the test group firms with which they were matched. Thus, if each test firm does not have at most three directly dedicated control firms, we know which control firms were chosen for each cohort. This specification allows the variable T1 to be added to the model, taking the value 1 for all firms in a cohort when the test group firms in the cohort have joined a CLCs and 0 the rest of the time.

The double fixed effect model has a particular interpretation. It consists of calculating for each variable in each observation year, their deviation from the individual's mean for that variable. It thus measures the correlation between the variations of the dependent variable at the individual mean with the variations of the other characteristics of the individual at their individual mean. The addition of a time fixed effect makes it possible to remove from this first difference the annual variations of each year with that of the average of the years.

$$(TO_{it} - TO_m - TO_{mt} + TO_m) = ß(x_{it} - x_{im} - x_{mt} + x_m) + (c_i - c_{im}) + (\varepsilon_{it} - \varepsilon_{im} - \varepsilon_{mt} + \varepsilon_m)$$

It thus removes the invariant characteristics ci, since ci is constant $c_i - c_{im} = 0$, as well as their correlation with the explanatory variables and the individual and time invariant error terms. The new conditions of validity of the model are then that the covariance of the variation of the variable of interest with respect to its mean with the variation of the individual residuals varying in time with their mean is equal to 0.

$$Cov((x_{it} - x_{im} - x_{mt} + x_m),\ (\varepsilon_{it} - \varepsilon_{im} - \varepsilon_{mt} + \varepsilon_m)) = 0$$

This condition remains relatively strong, since a change in unobserved and variable firm characteristics that affect turnover, such as a change in management, may well also influence the choice of using a CLCs for example.

To test the appropriateness of using the fixed-effects model, it was compared with a simple linear model and a random-effects model, which assumes that the individual and invariant error terms are uncorrelated with the explanatory variables and therefore do not need to be removed. The Fisher test comparing the fixed effects model and the simple linear model is significant. The results of the two models are therefore different, proving that the fixed effects are not zero. Similarly, the comparison of the fixed-effects model with the random model is carried out using a Hausman test (Hausman 1978), testing the similarity between the two models. As the test is not significant, the null hypothesis of similarity is rejected and the random effect model is considered unreliable compared to the fixed effect model.

We also tested the heteroscedasticity of the fixed-effects model using a Breush-Pagan test (Breusch and Pagan 1979), which tells us that the data are heteroscedastic. Similarly, we found that the residuals of the regressions suffer from autocorrelation. These two findings prompted us to calculate the precision of the estimated parameters by taking into account individual and temporal aggregations, through the use of a correlation matrix incorporating these two dimensions (Cameron and Miller 2015; Thompson 2011), using the vcovDC function of the plm package (Hsiao 2014).

3. Results

We systematically tested the model with the control selected by matching and with the randomly selected control, to determine if this choice was important or not.

Table 5 - General results

Model	Control PPM	Random Control
Absolute variation		
Without T1	39 516 ; s.e. = 21 752	49 821 ; s.e.= 38 357
With T1	62 470* ; s.e. = 26 136	T1 non disp.
Logarithmic		
Without T1	0,11*** ; s.e. = 0,02	0,15*** ; s.e. = 0,02
With T1	0,09** ; s.e. = 0,03	T1 non disp.

The general model, with all observations, does not give significant results. There is a positive trend in the effect, but the variance is too high to be able to conclude convincingly that the effect is strictly greater than 0 and, above all, precise.

Incidentally, we also estimated the model by transforming the dependent variable, turnover, into logarithmic form. This transformation enable to estimate the variation in turnover as a function of the model's parameters. Applying the transformation to obtain the percentage of variation to the estimators obtained, we obtain an average increase of 12% in turnover linked to the use of a CLC with the matched control sample and 16% with the random sample. It is also interesting to note that the results with the two samples are close enough to be consistent, but that the matched sample gives slightly weaker effects, potentially due to the closer proximity of the company profiles to those of the test sample and therefore taking better account of cyclical effects.

This difference in significance between the absolute and rate of change results leads us to the hypothesis that despite the limitation of turnover to the lowest 99%, a high variability in high turnover, potentially without causal link with the use of a CLC, could bias the average of the absolute effects. By looking at variation, very strong absolute effects on high turnover and potentially just temporally correlated with CLC use but not really explained by it become less important and bias the estimators less.

We therefore decided to use the model on sub-samples created on the basis of company size. We selected all the companies that have ever had the chosen status, i.e. microenterprises, small and medium-sized enterprises (SMEs), intermediate-sized enterprises (ISEs) and large companies. These two categories are grouped together because of the small size of the remaining sample.

Tableau 6 - Results according to the companies size

	Control PPM	**Random Control**
Microentreprises :		
Absolute	34 064* ; s.e. = 13 884	43 501** ; s.e. = 13 645
Logarithmic	0,09*** ; s.e. = 0,02	0,11*** ; s.e. = 0,02
Small and medium companies :		
Absolute	214 811** ; s.e. = 78 312	180 710 ; s.e. = 155 973
Logarithmic	0,12*** ; s.e. = 0,03	0,15*** ; s.e. = 0,04
Intermediary and large companies :		
Absolute	-881 553 ; s.e. = 712 805	-680 716 ; s.e. = 1 028 013
Logarithmic	0,00 ; s.e. = 0,08	0,11 : s.e. = 0,11

The above hypothesis seems to be confirmed on the sub-samples. This time we observe small but significant effects for microenterprises, around €34,000 per year, but larger effects for small and medium companies, consistent with their size. The rates of change are similar, at around 10%. For intermediary and large companies, the effect becomes negative and insignificant, both in absolute terms and in terms of the rate of change, confirming the greater volatility of turnover in the upper echelons of distribution and the much less perceptible effect of CLCs for this type of company.

These differentiated effects allow us to propose interpretations of the effect of CLCs on activity. Thus, it is possible that microenterprises and small and medium companies, with smaller production volumes, benefit more from inclusion in a territorial network in terms of the internalisation of demand. Their production potentially corresponds more to activities oriented towards the domestic sector and perhaps responds more to local demand, which the CLCs are more successful in redirecting. Similarly, the effect of CLCs, even if small in magnitude, has a larger relative share in the initially smaller turnover of these companies and is therefore more easily perceptible and significant. Thus, in the context of intermediary and large companies, the marginal contribution of CLCs is potentially invisible in the face of an already very large

volume of production. Moreover, the variation in the activity of these large companies is potentially subject to important exogenous events not causally linked to the use of CLCs, but which may occur simultaneously with their use and have a strong impact on the turnover of certain companies.

In order to complete these initial results, we conducted additional analyses to study a possible differential effect of the size of the CLCs and their time of use.
To do this, we created a first variable separating the CLCs into three categories. The first is the Eusko alone, due to its number of user companies being at least twice as high as the others. The second combines the CLCs with between 400 and 500 user firms, i.e. the Cairn, the Doume and the Gonette, and the third the remaining CLCs, with less than 300 user firms.
The model is run on the whole sample, but replacing the indicator of membership of a CLC with this variable.

Table 10 - Results by CLC size

CLC Size	**Control PPM**	**Random Control**
Absolute		
Big	14 811 ; s.e. = 30 231	28 739 ; s.e. = 38 597
Medium	12 292 ; s.e. = 27 373	24 536 ; s.e. = 37 046
Small	133 249 . ; s.e. = 68 565	132 501 : s.e. = 97 754
Logarithmic		
Big	0,1*** ; s.e. = 0,02	0.13*** ; s.e. = 0,02
Medium	0,11*** ; s.e. = 0,03	0,14*** ; s.e. = 0,04
Small	0,14*** : s.e. = 0,03	0,19*** ; s.e. = 0,04
Microentreprises		
Big	21 481 ; s.e. = 25 057	31 845 ; s.e. = 25 391
Medium	31 177 ; s.e. = 22 566	40 038. ; s.e. = 22 587
Small	67 834 . ; s.e. = 36 249	76 218* ; s.e. = 35 780

With these specifications, the absolute effects observed are not significant, partly because of the smaller sample sizes for each modality of the variable of interest and the high variability within each category. However, it is interesting to note that there are significantly larger effects, both in absolute terms and in terms of the rate of change for the small CLCs members. These are the only ones for which the effect is weakly significant in absolute terms with the matched control group and in both samples for microenterprises. Although the low significance of these results does not allow us to draw very strong conclusions, we can nevertheless propose an interpretation of these differences in magnitude.

For example, it is conceivable that, contrary to popular belief, small CLCs have a greater effect on the activity of the firms using them. This greater effect could be due to a network effect. Large CLCs, by integrating many providers, potentially reduce the number of additional clients for each user firm. Thus, in a large network, consumers and businesses have more choice in how they spend their CLC units and member businesses are therefore more likely to compete to meet this demand. For example, it is highly likely that several firms will have similar activities in the network and will therefore compete for the additional customers brought by the use of CLCs, and other characteristics of the firms, such as their location, reputation or prices, may come more into play. In a smaller network, users are more constrained in their choice and the acceptance of CLCs is potentially a more important criterion for the selection of a provider or supplier. This hypothesis leads us to consider the question of the optimal size of a CLCs and its territorial coverage. For example, would a CLC covering all the businesses in a locality have any effect on its users?

Another, potentially complementary, interpretation can also be considered. Some currencies might rely heavily on social and transactions networks that are already implemented in the territory. However, the existence of prior interpersonal networks, while facilitating the establishment of the CLCs, can limit their own effect. For example, the recruitment of service providers by going up the chain facilitates the circulation of money, but does not directly provide new customers for the businesses, since the suppliers of the user businesses are recruited. The CLCs are therefore superimposed on a network of pre-existing transactions and have a weaker intermediation and internalisation effect on transactions. It can therefore be assumed that in the context of a small CLC, the difficulties of the CLCs in developing may be due, among other things, to a less developed social network. Thus, the CLCs participate more in the activation of proximities and the creation of an ad hoc community and would therefore have a greater economic impact on the members of this new community.

Although this result cannot be given the firmness of a conclusion at this stage, it does allow new hypotheses to be put forward, which it would be interesting to study in greater detail during more in-depth case studies. It also makes it possible to question the quasi-systematic study of the Eusko as a model currency, and for which this thesis was no exception. In the end, the results obtained may not be so much overestimated because of the exceptional size and location of this currency, but perhaps underestimated because of its particular territorial context and the size of its network.

Similarly, we created a variable categorising the time spent in the CLCs between the first year, the second year and more than two years.

Table 11 - Results by time in the CLCs

Time in CLC	Control PPM	Random Control
Absolute		
0-1 year	35 251* ; s.e. = 16 952	44 946 ; s.e. = 29 709
1-2 year	50 716 . ; s.e. = 29 134	56 685 ; s.e. = 38 454
+ de 2 year	35 992 ; s.e. = 31 628	50 865 ; s.e. = 57 049
Logarithmic		
0-1 year	0,08*** ; s.e. = 0,01	0,11*** ; s.e. = 0,01
1-2 year	0,12*** ; s.e. = 0,02	0,16*** ; s.e. = 0,02
+ de 2 year	0,15*** ; s.e. = 0,02	0,2*** ; s.e. = 0,02
Microentreprises		
0-1 year	27 380* ; s.e. = 12 675	33 240** ; s.e. = 12 509
1-2 year	37 466* ; s.e. = 14 781	47 001*** ; s.e. = 13 287
+ de 2 year	40 685 . ; s.e. = 21 545	55 869* ; s.e. = 22 622

As with the previous complementary results, we have difficulty in finding significant absolute effects, notably because of the small sample size within each category and the high variance of the dependent variable. The rate of change effects are significant and increasing, in similar orders of magnitude to those found in the previous model specifications. Focusing on microenterprises, the effects are more significant due to the lower variability of turnover in this sub-category, as in the original model. As before, the coefficients are not precise enough to interpret their difference robustly. However, for microenterprises at least, there appears to be an increase in the effect over time between the first and second year of use. This difference may be due to the time spent using the CLCs in the first year, as some firms may have joined in the last quarter of the year and thus observed almost no effect, while others will have already had a full year of use by the time they report. The coefficient for companies that have been members for more than two years is even less accurate than for the other two categories. Except in the full sample model with matched control, where it is much lower than that of firms using CLCs for more than one year, it remains at a level relatively close to the category that precedes it. It is therefore not possible at this stage to conclude either that the effect of using a CLCs has decreased or increased over time.

4. Discussion

In this work we measured the effect of using a CLC on the companies turnover. To do this we used the natural experiment of their self-selection into a CLC to assess changes in their turnover before and after this event.

We obtain relatively large and significant results, although not very precise, for micro, small and medium-sized companies. The magnitude of the results, in the order of €30,000 for microenterprises and €200,000 for small and medium-sized companies, should be interpreted in the light of the turnover scale declared by the companies (Table 6). Indeed, the average turnover in the first year of observation of the companies and in the year before joining the CLCs varies between €350,000 and €550,000 and the median turnover is between €100,000 and €150,000. As a result, the rate of change effects are quite high, ranging from 8% to 16% increase in turnover between the years when a CLC is used and the previous years, which are statistically significant results. This amplitude seems to us to be particularly strong, especially when put into perspective with the feelings expressed by the companies in the Mouvement Sol survey, where 59% of the companies said they had not observed any effect on their turnover and 33% declared a marginal effect. However, it is possible that companies do not perceive the link between the increase in their business and membership of the CLCs. Indeed, as mentioned above, users often do not pay in CLCs to their suppliers or providers who accept CLCs and are chosen for this. As a result, companies may not be aware that this new customer base is due to their acceptance of CLCs.

Furthermore, we only have fiscal information from firms and while the double fixed effect model best controls for unchanging firm characteristics and aggregate business cycle effects, it is possible that the uptake of CLCs is correlated with a changing firm characteristic, whether it is a change in management or production methods, an adjustment to poor firm performance or conversely an additional commitment for firms in a growth period. All of this information is missing and constitutes potential omitted variable bias, which the dual fixed effects model is not sufficient to correct.

Moreover, this lack of more qualitative information on the companies is reflected in the selection of the control group. The control group is essentially used to calculate the annual fixed

effect, which removes the effects of the business cycle from the measure. The matching model does allow for the selection of a control group with characteristics closer to those of the random sample of companies tested. However, there are unknown characteristics of the test companies that are unchangeable and that may explain their use of a CLC. These characteristics, such as a commitment to the organic production, which has been growing in recent years, or an interest in cooperating with other territorially-based businesses, may also have an effect on variations in their economic activity. The matched enterprises, although very similar in terms of known characteristics, may have different profiles on these dimensions and thus have different economic trajectories over the years of the study, and not only because of the non-use of CLCs. The use of the matched control group already reduces the magnitude of the measured effect compared to the random sample. It could therefore be assumed that a better control group would improve the measurement of annual business cycle effects and could reduce the size of the estimated coefficients. For future research, it could be envisaged to pre-select control firms for fewer CLC cases, but based on a more detailed qualitative knowledge of their territory, which would then be selected in Fare in the same way as the list of CLCs member firms.

We also decided to avoid the management of bankruptcies and attrition by keeping only the companies still active in 2019 in the population studied and therefore potentially with a more solid activity. While this choice reduced the control population much more than the test population, it potentially removed firms with declining trajectories from both sides, on which we cannot therefore estimate any effects. Similarly, the absence of associations and agricultural enterprises from the Fare file reduces the population analysed significantly and unfortunately does not allow us to generalise our results beyond the non-agricultural market sector.

Despite these methodological limitations, these results are encouraging. Indeed, such a study had never been conducted before and the question of the contribution of the use of a CLC for businesses is central, both for the actors in the CLC field, the public authorities who may choose to support this type of project or not, and for academic research, for whom these conclusions provide information that was previously lacking regarding the effectiveness of CLCs. Thus, the measurement of a significant positive effect at least for small businesses raises the question of the use of CLCs as economic development tools.

This first observation opens up the field of questioning on the network effects and the coverage rate of CLCs. For example, at what level of coverage of all the businesses in a locality or territorial community would the CLCs no longer have a positive effect? Similarly, is the use of

a CLC by certain actors in a locality and the increase in their activity at the margin to the detriment of the activity of other companies in the area? All of these questions open up new avenues of research, which we chose not to address in this thesis, but which it could be interesting to address in further research, possibly beyond CLCs to other phenomena of territorial intermediation.

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Organising Money

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Mainstream market economy literature argues that it is through productive development that societies will achieve economic wellbeing. The market economy is an "economic system controlled, regulated, and directed by markets alone; order in the production and distribution of good is entrusted to these self-regulating mechanisms" (Polanyi, 1968:26). To initiate and maintain society's market economies, financial systems perform fundamental tasks as identifying and monitoring entrepreneurial opportunities, easing exchange of goods and services, and allocating money (King and Levine, 1993); however, not everyone can access formal financial systems. Financial inclusion can be understood as the responsibility by financial institutions in offering affordable, convenient, robust, and secure financial services; this while assuring quality, open access, and the protection of the costumers (World Bank, 2018).

A recognized approach to financial inclusion is micro-credits, which got international recognition with Nobel prize winner Muhammad Yunus' and his ideas of banking of the poor (see Yunus, M., 1998). The idea of this type of credit system was to enable small enterprises to access small loans on easy terms and make use of community peer monitoring to make use of local knowledge of the members of the group (Stiglitz, 1990). Yunu's proposal has transformed in the last years, and it has been co-opted by ideas of the market economy. As research shows, if profitability is set as a priority, it is common to find companies charging

~~interest rates up to 240% a year depending in the formality of the lender (Sandberg, 2012).~~ Studies have found ambiguous results suggesting that micro-credits bring modest positive impacts (Buckley, 1997; Banerjee et al. 2015; Banerjee et al., 2015-2), extends individualists behaviours instead of adopting systemic approaches (Barinaga, 2014, Bateman et al. 2019), and presents potential exploitation on the consumers (Sherratt, 2015). Still form a market logic, more recently, there is a raise in the adoption of mobile money, which is "a pay-as-you-go digital medium of exchange and store of value using mobile money accounts"[1], for financial inclusion. Recent studies show that 71% (Muthiora, 2015) of Kenya count with mobile money services (cf Hughes & Lonie, 2007; and Morawczynski, 2009 for accounts on Kenya's M-Pesa[2]) as praised mechanisms for financial inclusion. However, still with mixed evidence of its impact (cf Wieser et al., 2019; Batista & Vicente, 2021). Beyond the mentioned concerns, research also highlight the importance of being critical to the economic ideas which are reproduced through the financial services used in context of socio-economic vulnerability (cf. Bateman, 2012; Barinaga, 2014; Mackenzie & Louth, 2020; Kemp & Berkovitch, 2020), because as Clinton (1977) warn one must "be careful of the thought-seeds you plant in the garden of your mind for seeds grow after their kind".

Considering the significance of financial inclusion and with limited institutionalized solutions, it becomes important to comprehensively study how to organize different approaches to those proposed by a market economy, one of this being complementary currencies (Seyfang, 2006; Longhurst, N., & Seyfang, 2013). Broadly speaking, complementary currencies can be defined as an agreement within a community to use a standardized unit of account as a means of payment and with the objective of incentivizing pre-defined social, economic, or environmental behaviours (Lietaer, B., and Dunne, J. ,2013; Blanc, J., 2011). Studies have shown that the use of complementary currencies can increase the economic resilience of communities since these currencies can serve as a community-based credit system that increases monetary liquidity during an economic recession (Ulanowicz et al, 2009; Stodder and Lietaer, 2016). Complementary currencies have emerged in different contexts around the world (cf. Jakob et al, 2004; Kennedy et al., 2012; Sartori, 2016; De Rosa, and Stodder, 2015), and there are some examples of complementary currencies improving's people wellbeing in context of socio-economic distress. For example, the use of a complementary currency in Brazil, increased the local commerce a 73% in twelve years of usage (Cernev & Diniz, 2020:489) and "promoted a

[1] As defined by the Financial Access Survey developed by the International Monetary Fund

[2] M-PESA is a financial innovation an innovative payment service for the unbanked where customers can use his or her mobile phone to move money quickly, securely, and across great distances, directly to another mobile phone user.

~~sense community and solidarity" amongst the users; or in Kenya the use of complementary~~ currencies increased the access to food and jobs in excluded populations (Ruddick, 2011; Barinaga et al, 2019; Ussher et al 2020).

Research has studied challenges in already developed complementary currencies. For example, Schroeder (2015) explains that there is a substantial amount of work and challenges in creating and maintaining complementary currencies which is often not recognized; Gómez and Wit (2015) write about the heterogeneous political perspectives that Argentinian designers/users had and how unresolved issues contributed to the end of these complementary currencies; and Barinaga (2020) warns about how the way complementary currencies are designed can have unexpected influences in local decision-making practises. Because of the suggested challenges of implementing (creating and maintaining) complementary currencies, there is a need to study the implementation process in situ, as it gets done. Reflecting on this phenomenon the research question guiding my study asks: ***In the context of informal urban settlements, how are economic ideas materialized through the creation and maintaining of complementary currencies?***

Depending on the use money that is prioritized – that is as payment, exchange, store of value, or standard- money can vary in their design (Polanyi, 1968). For example, some are grounded in a relational understanding of money which highlights the importance of the community relations of reciprocity and redistribution; and others on a commodity understanding of money which favours the use of currency as a commodity and its capacity as a store of future value. To study the differences in the design of money, Christine Desan's (2015) constitutional approach to money becomes relevant. Desan recognizes money as a project engineered from the start and highlights the importance of depositing the attention in the actors and relations in the constituting of money. Consequently, Desan (2015) investigates how through coercion and the control of materiality (i.e., coinage and minting) in the constitution of money, central authorities (i.e., governments) can govern populations and influence the distribution of resources. Desan's constitutional approach offers a good starting point, but it needs to be adapted to study the organization of on-the making complementary currencies, with not necessarily a clear central authority in command.

A methodological lens in line with Desan's approach on studying the process of how material elements, human actors, and their relations constitute a project (in Desan's case money) is actor-network theory. Latour (1999:375) argues that it is through the connection of these actor-

networks that one can explain the attachment of certain practices that control or interfere in one another and "no explanation is stronger (…) than providing connection among unrelated elements or showing how one element holds many others" (ibid:375). This methodological lens provides a language to investigate the strategies that leads human and non-human actors to create those connections (Callon, 1984; Latour, 2005). Moreover, it enables a discussion on translate their economic ideas by embedding them into materiality (Latour, 1999; Czarniawska & Joerges, 1996). To study the assembling of relations Law (1994:100, cursive in original) suggests one should "(…) like to tell stories and trace *histories* rather than tending to take synchronic snapshots". Latour (1996:378) defines this 'storytelling' as a network-tracing activity, where an actor defines a world view in which it "traces, delineates, describes, files, lists, records, marks, or tags a trajectory that is called a network" (ibid). The use of this sociological approach with helps us complement Desan's constitutional approach to money by studying the actors in the field who are tracing, delineating, and describing the process of an on-the making of a complementary currency.

Africa is a continent in which the challenge of economic exchange, money, and capital allocation has been approached in different ways. Even though African innovativeness is not valued enough by the mainstream western research (Adebayo, 1994; Sinclair, 2004; Mavhunga & Dessler, 2007; Mavhunga, 2017), there are accounts of African precolonial unique monetary systems (cf. Polanyi & Dalton, 1968; Johnson, 1970; Mwangi, 2002) and innovative financial practices as rotating credit associations (cf. Geertz, 1962; Ardener, 1964; Adebayo, 1994). Recent studies show that 71% (Muthiora, 2015) of Kenya count with mobile money services (cf Hughes & Lonie, 2007; and Morawczynski, 2009 for accounts on Kenya's M-Pesa[3]) as praised mechanisms for financial inclusion. Considering Kenya's context, it is not surprising to find development organizations and FinTech companies exploring ways of leveraging on local knowledge to introduce financial technologies in search of economic wellbeing and poverty alleviation (cf. Global partnership for Financial Inclusion, 2016; Pénicaud & Katakam, 2019; Fishbane, 2014; Oh & Rosenkranz, 2020).

This ethnographic study investigates an action-research project introducing a digital complementary currency in informal urban settlements in Kisumu, Kenya. In 2017, a group of

[3] M-PESA is a financial innovation an innovative payment service for the unbanked where customers can use his or her mobile phone to move money quickly, securely, and across great distances, directly to another mobile phone user.

~~scholars researching grassroot innovations in Kenya, became aware of the Kenyan's rotating~~ credit associations and, with the aim of improving's people's socio-economic wellbeing, proposed some of these associations to co-create their own complementary currencies. Starting in 2018, this project, anonymized as the Grassroots Financial Innovation Project, brought together scholars from Scandinavian and Kenyan universities, local merchants from the Kibuye market in Kenya, and FinTech entrepreneurs with the goal of implementing a complementary currency in Kisumu, Kenya. Just in the start of the project, Covid-19 interfered and changed people's lives and the project's plan. The merchants participating in the project were struggling to sell their products and during the curfews the government demolished the market with the excuse of future renovations. People were suffering and the critical situation influenced the decisions and actions that unfolded during the project's coming years.

The empirical material was constructed following the tensions emerging since the begging of the project in 2017 until summer 2022, time where I achieved data saturation. Since my participation in the project in 2019 and despite the Covid-19 related travel restrictions, I have been able to gather more than 20 in-depth online and on-site interviews; more than 50 hours of participant observations of recorded video meetings; fieldwork notes of a stay of 13 days during November 2019 and a second one of 10 days during September 2020; and, project proposals, teaching materials, meeting minutes, and internal communication messages. In the tracing of *histories*, the categories of monetary ideas and claims for ownership were salient and guided the analysis of the empirical material.

The first tension that emerged in the project related to deciding between two different payment software that could be used in the project. By comparing how commodity or relational understanding of money are configured in a payment software, I investigate how is that economic ideas are materialized. By following this discussion, I theorize that a payment software favours specific economic ideas, since each software had inscribed accounting methods and algorithms which prioritize certain uses of money and affords certain behaviours. This chapters emphasises the performative effect of economic ideas in the construction of reality.

The second tension emerges from the differences that emerge in the different moments of translation of economic ideas into a monetary model that includes the payment software and the regulation of its use. In this chapter, I follow how the researchers and traders mobilized their programs through different inscription devices and financial and social resources. The

researchers made use of education and training material and their privileged access to financial resources. However, as experienced entrepreneurs and organized group, the local traders had control over their own economic practices and the final inscription of their regulation documents. In this process, I theorize on how control over the monetary configuration can be disputed and strategies that enable actors to be included or excluded in the materialization of economic ideas.

The last and final tension looks at the way in which the traders were using the complementary currency versus the behaviours that were supposed to be promoted by the monetary model. Grounded on field visits, this chapter analyses the challenges that project encountered when combining their own practices and the use of the payment software and theorises about the limitations on the configuration of money and the money in use. Finally, I reflect on the difficulties of introducing different economic ideas to populations with different backgrounds and contexts.

The aim of my research is twofold. First, I want to equip policy makers and practitioners with insights on the challenges, risks, and opportunities of creating complementary currencies for financial inclusion and socio-economic wellbeing while still allowing local people to speak on matters of their concern, since it's not possible to tell anybody how to live their lives, if one has never felt the pain before (Bradley, 2011). Second, to develop further the field of studies researching on how money is designed by looking into the dynamic process of constituting money and how the financial ideas embedded into technology and the practices of users interact.

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CCS - Review and renew

Paying salaries in local currency: legal alternatives

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Keywords: Local currencies, employee remuneration, legal alternatives.

ABSTRACT: In general, countries legislations prohibit the payment of salaries or wages in amounts that are not denominated in fiat currency. This is a measure to protect the worker. In this sense, the article aims to analyze the legal alternatives available so that Municipalities and companies would pay the remuneration of their employees, or parts of these remunerations, with local currency. It will also be investigated which amounts received by employees fall within the concept of salary or not, according to Brazilian legislation. Furthermore, the legal provisions that oblige remuneration to be paid in fiat currency will be analyzed and, as an alternative, the possibility of companies and municipalities to sign contracts with their employees for the acquisition of local currencies, in which employees would voluntarily opt for the purchase of an amount of local currency with part of their salary, in exchange for incentives. Finally, practical cases will be examined in which employee remuneration is made using local currencies.

1. What is local currency and the challenges to improve its circulation in municipalities

Local currencies, as well as their best-known species, social currencies[1], are complementary currencies, which allow "localities and regions to create real wealth in

[1] Social currencies, as an alternative means to facilitate access to social rights provided for in article 6 of the Federal Constitution of 1988, are "alternative instruments or payment systems created and

their local economy by combining unmet needs with underutilized resources. They are a way for wealth that is produced locally to benefit local people rather than being appropriated by distant companies" (LIETAER and HALLSMITH, 2006). An aspect that differs one currency from the other is its issuing agent, as the local currency can also cover those currencies issued directly by the Municipalities, acquiring an official character for being linked to the public power, regulated by law, while the social currency is usually issued by community banks, being associated with social projects and third sector organizations (CABIDO, 2021). However, both aim to function as a complementary currency to the Brazilian national currency, the Real, being characterized, therefore, as complementary and not as substitutes.

In addition, they aim to strengthen the local economy of small neighborhoods or municipalities by increasing monetary circulation at the local level, causing a retention of wealth in the region where it is valid, thus having an economic bias that implies the fight against the evasion of money and wealth of the territories, especially with regard to household consumption. Still in the conceptual aspects of local currencies, other characteristics are highlighted: they are not legal tender, that is, no one is obliged to use or accept local currencies; operate legally in more than 35 countries; they are controlled by the communities themselves; circulate only in a certain geographic region and the system must work in an anti-cyclical way (CABIDO, 2021).

In Brazil there are more than one hundred social currencies in circulation[2]. Regarding examples of local currency issued by the municipality itself, there is currently only the Froes in circulation, issued by the Municipality of Bonfinópolis in the state of Minas Gerais. However, the municipality of Resplendor, also located in the state of Minas Gerais, has recently sent to its City Counsil the Bill n. 16 of September 5, 2022, which intends to establish a local currency, issued directly by the Municipality of Resplendor.

Although local currencies are not legal tender, it is essential that the local community accepts them so that they can function as an instrument for the economic and social development of the region (FREIRE, 2011, p.26). This acceptance is only

managed by users themselves through non-profit associations, based on economic activities based on the cooperation and solidarity of the participants of a given community" (FREIRE, 2011, p.7)

[2] Available in: <https://www.terra.com.br/economia/operacoes-cambiais/operacoes-empresariais/alem-do-real-brasil-tem-103-moedas-sociais-em-circulacao,4955b8356e35f310VgnVCM4000009bcceb0aRCRD.html#:~:text=Palma%2C%20Santana%2C%20Maracan%C3%A3%2C%20Par,ligada%20ao%20Minist%C3%A9rio%20do%20Trabalho>. Accessed on: September 14, 2022.

possible through the recognition of the legitimacy of this instrument, thus emphasizing the importance of the law in its regulation regarding the creation of rules that discipline the local monetary systems.

Furthermore, it is essential for the success of such coins to create a mechanism for putting them into circulation. This can occur through the action of the citizens themselves, who choose to exchange fiat currency for local currency, however, in Brazil it has been more common to put it into circulation through incentives from the municipal government, especially through the payment of assistance benefits. On the other hand, other possibilities have been debated as a means of putting such coins into circulation and encouraging their use, like the payment of salaries in local currencies which can be an important means of promoting the massive use of such currencies in municipalities.

2. The concept of salary in Brazilian legislation and the obligation of its payment in fiat currency

The various transformations of production processes and the consequent exploitation of work meant that workers no longer accepted barter as labor consideration. Faced with this new reality, remuneration became to be made in currency, and in general, these remunerations are known as remuneration or salary.

Remuneration comes from *remuneratio*, from the verb *remuneror*. The word is composed of *re*, which means reciprocity, and *muneror*, which means to reward. The word salary comes from the Latin *salarium*. This word comes from salt, from the Latin *salis*; from Greek, *hals*. Salt was the payment method for the Roman legions; later, other means of payment of wages were used, such as oil, animals, food, etc.[3].

Brazilian legislation suggests different meanings between salary and remuneration. This is because remuneration is understood as the gender of the payments due to the worker as a result of the provision of the service or the employment contract itself. The salary would be the most important part among the payments made to the employee, which is the price paid for the workforce made available to the employer[4].

[3] MARTINS. Sérgio Pinto, **Direito do Trabalho.** 28ª ed. São Paulo: Atlas S.A. 2012. p.231.
[4] DELGADO, Mauricio Godinho. **Curso de Direito do Trabalho.** 18 ed. São Paulo: LTr. 2019. p.842.

The set of what the law calls remuneration is composed of the set of base-salary, salary complements, gueltas[5] and tips. It is not included in this concept, for example, the amounts paid to the worker with the purpose of indemnifying losses perpetrated by the employer and of reimbursement of expenses arising from the service.

It is also important mentioning the existence of payments that are not considered as part of the labor relation but that are related to the employment contract, since they do not have the power to remunerate the employee, but occur through the employment relationship. Included in this category are stock options, the right to use images, among other institutes.

The payments referring to the salary, in accordance with article 457, §1, of the Consolidation of Labor Laws (CLT): “The salary includes the stipulated fixed amount, legal bonuses and commissions paid by the employer. "

In addition, it should be clarified that in the legal doctrine the expression salary can have several complements, which individualize its application in each situation. In this regard, for the present study, it is necessary to highlight the main expressions that complement and expand the concept of salary.

The law establishes the minimum salary, which is the minimum value due and paid directly by the employer to every worker, including rural workers, without distinction of sex, per normal day of work, and capable of satisfying, at a given time and region of the country, their normal needs for food, housing, clothing, hygiene and transport (Art. 76, CLT).

Salary can be calculated per unit of time, which considers the time spent to perform the service or the time that the employee is available to the company, whether in hours, days or months. It so happens that the calculation per unit of time must be based on the minimum salary or the legal minimum salary proportional to the time worked, according to court precedents guidance[6].

According to article 458 of the CLT, the salary can be considered in two different ways:

[5] Gueltas are premiums paid by suppliers to third-party employees as a sales incentive. Gueltas are similar to tips as they are amounts paid by third parties unrelated to the employment relationship.

[6] Court Precedents 358 of the TST's SDI-1. MINIMUM SALARY AND SALARY FLOOR PROPORTIONAL TO THE REDUCED WORKDAY. POSSIBILITY. If there is a contract to fulfill a reduced working day, less than the constitutional provision of eight hours a day or forty-four hours a week, it is lawful to pay the minimum wage or minimum wage proportional to the time worked. (DJU, 14-3-2008).

> Art. 458. In addition to payment in cash, salary, for all legal purposes, includes food, housing, clothing or other "*in natura*" benefits that the company, by virtue of the contract or custom, usually provides to the employee. In no case will payment with alcoholic beverages or harmful drugs be allowed.

The payment of the salary can be made, therefore, (i) in cash or (ii) in *in natura*, being certain that the proportion between these two forms of remuneration must respect the rules imposed by the legislation.

The salary paid *in natura* is the legal possibility of replacing the money, in which the employer makes utilities available in favor of their employees. It is worth mentioning that it is not the preferred method, and payments *in natura* occur when there is a contractual agreement.

Salary utilities are goods susceptible of economic appreciation that could be acquired by employees through the salaries received, but which, through an agreement with employers, are offered to them as a substitute for money[7].

The possibility of paying the salary in cash or in *in natura* is limited by article 82 of the CLT, which determines that at least 30% (thirty percent) of the minimum salary must be paid in cash, that is, a maximum of 70% (seventy percent) of the salary can be paid through *in natura* goods (the so-called “utility salary”). Examples of utilities that can be paid for *in natura* are: clothing, food and housing.

In any case, according to the CLT, salaries must be paid in the country's fiat currency:

> Art. 463: The payment of the salary will be made in the fiat currency of the country.
> Sole paragraph: The payment of the salary made in breach of this article is considered as not made[8].

It is important to understand that the main purpose of cash payment is to avoid the truck system, that is, payment in vouchers, coupons, bonuses, etc., and also payment in foreign currency. Martins[9] explains that the basis for using the currency is that the salary cannot be subject to fluctuations in the currency of another country, in addition to the employee having to pay a discount when selling foreign currency.

[7] MARTINEZ. Luciano, Curso de direito do trabalho. 7ª. ed. São Paulo: Saraiva, 2016. p. 806.
[8] BRASIL. Decreto-lei nº 5.452, de 1 de maio de 1943. Aprova a consolidação das leis do trabalho. Available in: http://www.planalto.gov.br/ccivil_03/decreto-lei/del5452.htm Accessed in: August, 15th, 2022.
[9] MARTINS. op. cit. 2012, p. 237

However, the sole paragraph of that article is criticized, since the nullity of the salary paid in disregard of the legal system generates the need for a new payment, however, this type of sanction violates the good faith of the contracts and could imply enrichment without cause.

In view of all the above, the next chapter intends to discuss mechanisms for payment of salaries (or components of salary) through local currencies, in accordance with Brazilian legislation that regulates labor relations.

3. Legal alternatives

3.1 Payment of utility-salary in local currencies

As explained before, it is possible to pay salaries in utilities, which are goods of a different nature from money.

Given that utility-salary is intended to meet the individual needs of the worker, the CLT brought some examples such as food, housing, clothing, hygiene products and transport (except for the one destined for commuting to and from work). It so happens that the list is not exhaustive, therefore, there are possibilities to include other utilities.

In practice, there are specific cards (tickets) that are used only for certain utilities. This is the case, for example, of food cards, which are only accepted in places where food is sold, and the purchase of alcoholic beverages is prohibited. There is also the restaurant card, pharmacy card, credit cards intended for utilities that the worker would have to spend part of his salary to acquire them.

This card, commonly used by companies as utility-salary, is made and distributed by card operators who make it available through companies to be used by their workers.

In view of this scenario, although social currencies cannot be used as payment of the employee's base salary directly, there is a legal possibility for this payment to be made through the salary *in natura*. In these circumstances, the employer has the discretion to choose the means he wants to pay the utility salary.

Among the items that can be provided through the utility-salary using local currency, the payments for food expenses deserves special attention. After the reform of the labor legislation in 2017, the payments for food expenses was not considered as part of the salary anymore. Therefore, under the terms of article 467, §

2 of the CLT, the amounts, even if customary, paid as subsistence allowance, food allowance, its payment in cash, transport vouchers, prizes are not included in the employee's remuneration.

In addition, in the case of food, as a utility, the salary cannot exceed, respectively, 25% (twenty-five percent) and 20% (twenty percent) of the contractual salary.

The payment of food allowances to employees is quite widespread in the corporate culture in Brazil, therefore, its payment in local currency would be an important instrument to enhance its use in the municipal territory.

3.2 Payment of gratuities and bonuses in local currencies

Gratuities are amounts paid voluntarily to the employee as a way of rewarding a certain fact. With the 2017 labor reform, premiums, gratuities and bonuses are no longer recognized as an irreducible part of the salary, as was previously the case.

The payment of bonuses is not obligatory: it is made spontaneously by the company, based on previously established criteria. Likewise, there is a requirement for the participation of employees, as this must occur voluntarily.

The bonuses can be granted by the employer to the employee through goods, services or cash value and are linked to personal factors of the worker such as productivity, which allows payment in local currencies. In this regard, according to article 457, § 22 of the CLT:

> §22. Bonuses are considered to be payments granted by the employer, up to twice a year, in the form of goods, services or cash value, to an employee, group of employees or third parties linked to their economic activity due to performance superior to that ordinarily expected in the year of your activities.

In this type of remuneration, even if carried out using local currencies, there is an incentive for the employee. This is because the local currency is backed by the country's current currency, with no financial loss, making the employee feel encouraged to achieve goals.

Thus, according to the law, it can be concluded that the employer can pay a premium to the employee through local currencies, once the requirements set out in the aforementioned paragraph are met.

3.3 Contracts with employees for the acquisition of local currencies

The Bill no. 16 of September 05, 2022, of the Municipality of Resplendor, in the State of Minas Gerais, brings in its article 2 important mechanisms to encourage the use of the local currency of the city, which is intended to be implemented through the aforementioned bill. See:

> Art. 2 The Municipality of Resplendor, with the help of the Local Monetary Council, shall encourage the use of the Local Currency of Resplendor, through the following actions:
> I – Payment of assistance benefits made by the Municipality of Resplendor through the Local Currency of Resplendor.
> II – Institution of the Resplendor Local Currency Purchase Program for the municipal civil service, establishing incentive mechanisms for voluntary adhesion to this program by municipal public agents;
> III – Payment of suppliers of goods and services to the Municipality of Resplendor through the Local Currency of Resplendor, with preference being granted in bidding procedures to those who voluntarily accept to receive part of the payment in Local Currency of Resplendor.
> IV – Support, including through tax incentives to be established through specific legislation, for the implementation of the Resplendor Local Currency Purchase Program by private employers, which establish incentive mechanisms for voluntary adherence to this program by their employees;
> V – Support, including through tax incentives to be established through specific legislation, to companies located in the Municipality of Resplendor that make part of the payment of their suppliers and employees through the Local Currency of Resplendor.
> VI – Allow the extinction of tax credits and other debts to the Municipality of Resplendor by the Local Currency of Resplendor.

For the purposes of this article, it is important to highlight what is contained in item IV of article 2, which provides for employers the possibility to adhere to the Resplendor Local Currency Purchase Program, including through tax incentives to be established by the municipal government. Through this program, employers could encourage their own employees to buy local currency with part of their salary, for example, by guaranteeing them the payment of their salary in advance. Thus, if their employees agreed, they would receive part of their salary in Real and part in local currency, corresponding to the part they chose to buy in local currency directly from their employer.

Conclusion

In view of the above, it can be observed that in Brazil there is a relevant difference regarding the concept of salary and remuneration given by the Law. In this sense, the salary is understood as the most important portion paid by the workforce made available to the employer. On the other hand, remuneration can be understood as the totality of payments made to the employee as a result of the employment relationship, including salary.

The discussion of this paper aimed to demonstrate how the Brazilian legislation is positioned in relation to the characterization of the salary and the forms of remuneration to the worker, in order to understand in the end about the possibility of payment of remuneration parts in local currencies.

With the study, it became clear the need to pay the employee's salary only in fiduciary currency, as provided for in art. 463 of the CLT. The purpose of this article is to protect the employee from variations that could occur due to exchange rate variation. However, it is possible to pay part of the salary with utilities.

In view of this, it is possible to use local currencies as a form of payment of the salary *in natura*. This is because the CLT provides non-exhaustive examples of what could be used as payment of the salary *in natura*, and there is, therefore, the possibility of including other utilities. To this end, it is proposed to use local currencies to pay, for example, food aid, pharmacy, among others. It is noteworthy that the current use of local currency in a virtual way, enables its promotion and facilitates the direction of utility.

In addition, it was possible to differentiate the other forms of remuneration described in the legislation, such as premiums, gratuities and bonuses. It was found that the bonuses, as mentioned, are a liberality of the employer and do not have an obligation, being a good option for the use of local currencies as a form of remuneration in individual employment contracts.

In the end, an innovation created by the Municipality of Resplendor was analyzed, which allows the payment of the salary itself with local currencies, based on a contract for the purchase and sale of local currencies, signed directly between employee and employer.

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