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The Comparison in Transaction Efficiency between Dispersive and Concentrated Money Creation

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0. Introduction

The market is usually visualized as a 'concentrated' market with an auctioneer, however, the market where we really need the money as a means of exchange is not the one but a 'dispersive' market without such an auctioneer or an invisible hand, that is a network of bilateral transactions, buying and selling, formed during a certain time. Most of the markets we face in daily life are surely the 'dispersive.' Money matters in such a realistic market.

The important function of money in there is decoupling: separating buying from selling of a commodity temporally or spatially as mutually independent processes. Then money holders can obtain freedom to buy any commodity in any time and any place or to keep on holding it without buying anything. Money thus establishes autonomy in decision making of an economic agent. But 'Say's Law' which ensures equilibrium between supply and demand of all commodities does not hold in the situation. Neither do 'law of one price.'

In a large-scale economy, all economic agents face bounds of rationality, so they have to decide the price and the quantity in such negotiated transaction as buying and selling, and then dispersively and sequentially execute transactions by using money for payment. They cannot start it over even though they regret later on. Accordingly, money is thought of as a communication medium that reduces complexity of outer environments so that agents can make autonomous decisions and conveys 'value' form a buyer to a seller. Money thus generates a dispersive market as a network of transactions.

Money usually reminds us of cash or banknotes. But the main form of present money is deposit money based on bank credit. It is created when banks make "loans." Banknotes are monopolistically issued and controlled by central banks. We call such a method of banknote issue 'concentrated.' On the other hand, deposit money based on bank credits are separately created by many private banks. We call such a method of creating deposit money as 'dispersive'. We now have two sets of

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classifications of market and money creation (currency issue) as ‘concentrated’ and ‘dispersive.’ Mutual credit clearing association and LETS (Local Exchange Trading System) are thus classified as ‘dispersive’ money creation. While only banks can create money in the former, all participating individuals, groups and legal persons can create money in the latter.

Money as information medium can exist prior to medium of exchange. Then necessary condition of money is not the general acceptability of money as in the means of circulation. Even if only a few people receive stand-alone information medium as measure of value, we could call it “money”. In this sense, each electronic money, shopping point, mileage, exchange coupon and community currency should be all called “money”.

Community currencies (CC) have such features as ①negotiated transaction, ②free negotiation of price and quantities ③relatively small sphere of circulation ④inconvertible or hard to convert into legal tender, ⑤freely issued and shared administrative cost by citizens or citizen groups,⑥bearing zero or minus interest rate. ① and ② are the features in common with legal tender observed in a large commercial sphere, and ③-⑥ are the general features of local currencies.

LETS stands for Local Exchange Trading System. This system represents one of the most popular account type CCs; it was initiated in 1983 by Michael Linton in Comox Valley, Vancouver Island, Canada. This is a mutual credit system based on dispersive money creation. Other than account type, there are the paper money type CCs. Modern legal tenders consist of cash and deposit money. Cash money is central banknote (as inconvertible paper money, IOU) exclusively issued by central banks and subsidiary coin minted by governments. Deposit money is bank money created by the bank credit (credit creation) of private banks under the constraint of reserve deposit rate.

Community currencies are classified into such paper money type as Ithaka Hours based on the concentrated money creation by the administrative committee and such account type as LETS based on the dispersive money creation by individual participants. Legal tenders are also classified into the concentrated money creation in the case of cash money and the dispersive money creation by private banks in the case of deposit money. Truly, there is a big difference between community currencies and legal tenders in view of their basic features, however, it cannot be denied that there is certainly an important similarity between them. The paper money type CC is similar to cash money and the account type CC including LETS is similar to deposit money in terms of methods of money creation.

In this paper, we would like to compare concentrated creation of money and dispersive creation of

money in general, rather than to compare legal tenders and communities currencies as usual, and try to show, by using the results of computer simulation, the advantage of the method of dispersive money creation embodied into LETS in comparison with concentrated money creation. We also estimate the effect of different rules of restricting upper limits of debits (negative balance or red ink) of all participants in LETS on the rate of realized transactions in order to prevent free riding.

First, we give an overview of LETS. Second, we show using the computer simulation that the rate of realized transaction to attempted transactions under money stock constraint (budget constraint by money stock held) is determined by such factors as the ratio of agents initially holding money to agents holding no money, and the amount of initially holding money per capita.

For details, when the distribution of the initial money held by each agent follows uniform distribution, the amount of realized transactions increases with initial money stocks held among all agents. Simulation results suggest that each agent has to hold about 17 times of initial money stock as much as the average amount of transaction per capita in order to realize all attempted transactions. However, suppose agents have no upper limit of the deficit, in the case of mutual credit and the dispersive money creation like LETS, the realized transaction rate is 100% at all times even if the initial money held is empty. Finally we show that LETS as medium of exchange has a superior transaction efficiency in terms of the rate of realized transactions.

1. What is LETS ?

LETS is one of account type Community Currency for whoever want to use. Transactions using LETS are recorded in each participant's account. Participants can buy and sell products and services 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 plus deposit in account, you will not gain any interest from your savings. 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 without any limit or with a certain upper limit according to the rules of each LETS. This is completely different from conventional money issued based on value of commodity as money or authoritative power of governments as issuers. LETS has properties similar to those found both in money and credit. It is money in the sense that it can function like conventional national currencies, as a means of circulation to mediate exchange, as a measure of value to provide the standard for exchange, as a means of hoarding to store value.

In the case of a transaction in 1000 dollars, the account of a seller is recorded plus 1000 dollars and

the account of a buyer is recorded minus 1000 dollars. LETS adopts an accounting system that credits black to a seller and debits red to a buyer on each transaction, so that the sum of all participants' accounts constantly equals to zero. Because of the zero sum principle, money exists only in the accounts with credit as black at the micro level, but does not exist in the association as whole at the macro level. Besides, their accounts (both black and red) bear no interest.

As for the paper money type CC, an administrative committee has the exclusive right to issue CCs. Therefore, participants have to hold more CCs than the total amount of payment to buy some goods or services in the same way as using cash money. In contrast, each participant of LETS has the right to create money freely so that he/she can buy goods or services even if his/her account is zero or minus. This is the advantage for LETS. Current money creation (cash money and deposit money) is synonymous with issuing IOU. Conventionally, a buyer has to pay preexisting money stock to a seller in order to purchase goods and services. If the seller may accept credits from the buyer, the buyer incurs the debt to the seller. The debt is generated on the side of the payer. When the central bank issues central banknotes, it gives the certificate of indebtedness stating that I (the central bank) owe you (a recipient). Thus legal tender is called IOU.

However a buyer is not in debt directly to a seller in LETS. Rather, the buyer is thought to be in debt to the community composed by all participants in LETS. The buyer should have ethical responsibility to repay the debt to the LETS community. In such mutual credit systems as LETS, debts and credits not bilaterally but multilaterally balance out. That is to say, LETS adopts not bilateral netting but multilateral netting. We therefore would like to call this kind of money like LETS not IOU but IOC, which means that "I owe Community".

Under this circumstance, the larger the community of LETS becomes in terms of the number of its participants, the more the degree of anonymity will increase and the harder it will be to maintain trust among participants in it. Then there is some potential risk of moral hazards that, if there is no limit to the maximum of debit, some participants are apt to expand their debt as much as possible and create too huge amount of money to repay. We call them 'free-riders.' Thus the size of a sphere of circulation of "IOC" that depends on the extent in which each participant can have ethical responsibility to the community should be smaller than that of "IOU". Thus each LETS should set up its own rule in order to constrain the volume of money that each participant can create and prevent free riders from parasitize the community. The rule clarifies how to determine a certain upper limit of debit for each participant. It can be various, and the simplest rule is that the upper limit may be fixed to a uniform amount. There is the rule which set the upper limit be determined as a linear function of a participant's total volume of transactions during a certain period. The merit of

"IOC" is that unrealized transactions caused by money constraint can be reduced or eliminated even if a buyer has no currency stock to pay to a seller.

Accounts in LETS bear no interest, so participants have no incentives to be in the black or to avoid the red. LETS is interest-free and issued freely by participants, and then there is no such thing as transactions, precautionary and speculative motives for holding money that originated from 'The General Theory' written by John Maynard Keynes in 1936. Therefore, there is no money demand depending on liquidity preference, so such real demand as consumption and investment demand should be encouraged. As a result, speculative financial transactions apart from real demand or self-propagation of capital for accumulation are hard to be generated in LETS. This is quite a big difference between current legal tender bearing plus interest and LETS, and it is another merit of LETS.

2. Acceptance and market area

Money with high acceptability circulates in a wide sphere. The reason that money is accepted by people varies with each type of money. In the past, acceptability of convertible paper currency was ensured by convertibility into gold coin or bullion. Acceptability of present inconvertible money is self-sustained by people's expectation of maintenance of its future acceptability and people's belief in continuance of its past acceptability, and it is finally secured by ①financial solvency of central banks and financial policy for stable money value, and ②mandatory circulating power by cabinet order or government decree so that it should keep circulating in a nation-wide area.

In contrast with this, acceptability of LETS based on mutual credit is ensured by neither convertibility into any good nor mandatory circulating power, but mutual trust that other participants would accept the currency of LETS as long as they belong to the community or confidence in continuance of the community itself. At present, it circulates in relatively a small sphere, but the communities vary in value and interest, and their numbers are large.

In order to maintain the acceptability of any type of money including legal tenders, community currencies, and so on, it is indispensable for issuers not to invoke moral hazard of excessive money creation. If a central bank and a government are unified, the seigniorage is vested in the government by way of the central bank. In this case, the government tends to insist that the central bank should buy deficit-covering government bonds for financing the budget deficit. As a result, the central bank is apt to be exposed to the strong pressure from the government to issue excessive money. However since excessive money creation causes side effect of destabilizing money value leading to inflation,

the central bank has to resist pressure to create excessive money and, in order to do so, needs independence from the government.

Because the right of issuing money belongs to participants in LETS, there is the danger that a debtor issuing excessive money never tries to repay and escape from the community. Such an individual would eventually ruin trust of creditors in the community and encourage unfair treatment of participants so that the participants might dislike it and withdraw from the community. Such a problem could knock the bottom out of mutual credit system in the community. In case of paper money type CC, excessive money creation by an administrative committee reduces its money value, so that it would blemish participants' trust in the money and the community. As shown above, there is a possibility that both CCs and legal tenders invoke moral hazard, but the method to prevent it should vary in types of money. In legal tenders, rigid government rules or laws prescribing fines and punishments are supposed to regulate moral hazard. In CCs, such inner disciplines as ethics and norms, and such outer disciplines as rumor/ reputation and expulsion/ ostracism are expected to softly control moral hazard. The different ways of preventing moral hazard makes difference in their circulation spheres. Anonymity in legal tender is high, but participants in CCs make much of face-to-face relationships. We summarize the different characteristics between legal tender and community currency as in Table 1.

（Table 1） The compared characteristics in legal tender and community currency

	Acceptability	Availability	Moral hazard	Countermeasures against moral hazard	Circulation sphere
Legal tender	High	General	Government banks	Law, act, fines, punishments	World-wide, Nation-wide
Community Currency	Law	Specific	Participants	Ethics, norm reputation, expulsion	Local area, Community

3. A comparison between legal tender and LETS as means of payment using random network simulation

In this section, we draw a comparison between legal tender and LETS in view of transaction efficiency of means of payment. Legal tender plays two roles both as means of exchange and as means of payment. Settlements of transactions are made in two ways. In the first phase, the settlements between debts and credits are made between individuals by banks and, in the second phase, between banks by a central bank. Private banks and the central bank can settle the accounts with less money than the amount of transactions by using netting. But the settlement using legal

tender needs money (cash or reserves) in advance. Due to lack of money stock in advance, we often cannot make necessary transactions. In comparison with legal tender, accounts of LETS ideally have no constraint to create money, and then participants can realize all necessary transactions because they equally have the rights freely to issue money. Next, we investigate, by using computer simulations, the ratios of the realized transactions to the attempted ones using legal tender.

We study the transaction efficiency of legal tender as means of payment using random network simulation at a simple model. Firstly, we would like to confirm the technical terms of the network theory. A network is a series of points interconnected with lines. The points and lines are called ‘nodes’ and ‘links,’ respectively. We assume firms or individuals in transactions as nodes and transactions between firms or individuals as links.

In the simulation, we select a buyer and a seller at random from K nodes every period and then the buyer pays the money for a good or service of the seller. We model a T period setting, where T is the number of total transactions. We assume for simplicity that the volume of all transactions is set 1 and the price of the goods or service is set 1. Time is represented by t. However, if the selected buyer has no money, the transaction cannot be realized. In this case, we select a new couple of buyer and seller randomly until they can settle. We call the number of selected transactions ‘the number of attempted transactions’ and the number of settled transactions ‘the number of realized transactions,’ respectively. We also define “the rate of realized transactions” as the rate of the number of realized transactions to that of attempted transactions.

We performed simulations with a random network model of 100 agents (nodes) by varying the uniform distribution of initial money holders who possess the same amount of money. If all agents have 1 unit of money in the initial condition, the aggregate money stock amounts 100. We define ‘the rate of initial money holders’ as ‘the rate of the number of initial money holders to that of all agents.’ The rate of initial money holders represents how equally money is distributed among all agents in the initial condition. If the rate is 100%, the money distribution is completely equal and as the rate approaches 0%, the distribution becomes most unequal.

We examine the changes in the rate of realized transactions by decreasing the rate of initial money holders gradually from 100% to 50%, 25% and 10%. In the simulation, when we keep the aggregate money stock 100, the initial per capita money stock is increasing from 1 to 2, 4 and 10. We repeat the simulation 100 times so that we can obtain the ensemble average. Table 2 shows the average results.

According to Table 2, as the rate of initial money holders decreases, the rate of realized transactions decreases. We thus find that the distribution of the initial money holders strongly influences the realization of attempted transactions.

(Table 2) The distribution of the initial money holders and the rate of realized transactions
（The aggregate money stock is constant）

The rate of initial money holders	100%	50%	25%	10%
The aggregate money stock	100	100	100	100
The initial per capita money stock	1	2	4	10
The number of attempted transactions	1000	1000	1000	1000
The number of realized transactions	550.9	518.6	472.7	335.2
The rate of realized transactions	55.1%	51.9%	47.3%	33.5%

Next, we examine the effects of the changes of aggregate money stock on the rate of realized transactions keeping the per capita initial money stock constant as 1. In the simulation, as the aggregate money stock decreases from 100 to 50, 25 and 10, the rate of initial money holders decreases gradually from 100% to 50%, 25% and 10%. We repeat the simulation 100 times so that we can obtain the ensemble averages. Table 3 shows the average results. Keeping the per capita initial money stock 1, as the rate of initial money holders decreases, the rate of realized transactions decreases sharply.

According to Table 3, the average results are influenced by both inequality of the initial distributions and the decreasing aggregate money stock. The result shows that the rate of realized transactions decreases as the rate of initial money holders decreases.

(Table 3) The distribution of initial money holders and the rate of realized transactions
(The initial per capita money stock is constant)

The rate of initial money holders	100%	50%	25%	10%
The aggregate money stock	100	50	25	10
The initial per capita money stock	1	1	1	1
The number of attempted transactions	1000	1000	1000	1000
The number of realized transactions	550.9	358.1	206.0	92.5
The rate of realized transactions	55.1%	35.8%	20.6%	9.3%

Finally, we estimate the amount of the initial per capita money stock required to realize all the attempted transactions.

In order to keep the number of per capita attempted transactions constant as 10, although the number of total participants increase from 100 to 250, 500 and 1000, we need to increase the number of attempted transactions from 1000 to 2500, 5000 and 10000 in the simulation. We show the results in table 4. In the case of 100 participants, to realize all the attempted transactions, each agent has to hold 15 units of money stock in advance. As the number of total participants increase, the initial per capita money stock increases to realize all the attempted transactions. However, its rate of increase gradually diminishes to 0 as the number of total participants increases to 1000. As a result, the initial per capita money stock required to realize all transactions is saturated around 17 units of money on the condition that the number of per capita attempted transactions is 10. This result shows that each agent has to hold 17 times the money stock in advance as much as per each transaction value, or 1.7 times the money stock in advance as much as the total per capita attempted transactions. In normal transactions using legal tender, agents have a great amount of money buffer to fulfill all necessary transactions. The initial per capita money stock required to realize all transactions increases, but the rate of increase of it diminishes as the number of per capita attempted transactions increases.

（Table 4）The number of total participants and the initial per capita money stock required to realize all attempted transactions

The number of total participants	100	250	500	1000
The rate of initial money holders	100%	100%	100%	100%
The number of attempted transactions	1000	2500	5000	10000
The number of realized transactions	1000	2500	5000	10000
The rate of realized transactions	100%	100%	100%	100%
The initial per capita money stock required to realize all attempted transactions	15	16	17	17

Table 5 is created by taking the first column of Table 3 in order to show the comparison between legal tender and LETS in terms of the rate of realized transactions. The number of total participants is 100 people, and the number of attempted transactions is 1000 times. The initial per capita money stock is 1. In LETS, the rate of realized transactions is always 100% if there is no rule to restrict upper limits of debits of accounts so that there can be no constraints of money to hinder all attempted transactions from realizing. According to the table, it is 1.81 times as high as that (55.1%) using legal tender. We can now understand that the certain amount of money buffer in advance is necessary for the dispersive market to function smoothly with 100% of the rate of realized transactions. But such a high rate of realized transactions is almost impossible in case of legal tender because the reality is that nonuniform and uneven distribution of initial money holders makes the

rate of realized transactions lower, and that shortage of effective demand in consumption and investment in the period of depression, which is intrinsic in the dispersive market, reduce it, though the increases of per capita money stock in hoarding or saving is supposed to have the effect of increasing it according to the discussion above.

（Table 5） The comparison of the rates of realized transactions between legal tender and LETS

Type of money	Legal tender	LETS
The rate of realized transactions	55.1%	100%

We can see from Table 2 through Table 5 that LETS need much less money buffer than legal tender. LETS thus exhibits high transaction efficiency. On the other hand, however, because every participant has the right to freely issue money, there are naturally some who might not be able to resist the temptation to create excessive money or even others who might be ill-intentioned to do so from the outset. Such risk of moral hazard invoked by a part of participants restricts circulation sphere to a relatively small area.

It should be noted, however, that, even though such free riders on the community should be ethically criticized, it does not really cause a devastating damage to LETS as a monetary system because participants cannot tell the money created by free riders from other ordinary money. Accordingly, such money, which becomes shared by all participants, can circulate exactly in the same manner as other money in LETS.

Nevertheless, administrators of LETS had better set a certain rule to restrict upper limits of debit (negative balance) to prevent such side effects caused by such moral hazard as loss of confidence in LETS and the community, expansion of feeling of unfairness and withdrawal of participants.

4. The necessity of designing the rules to restrict the upper limit of debit of an account for each participant in LETS

The simplest rule to restrict the upper limit of debit in LETS is to fix it to some constant value. For instance, the limit is completely fixed as, say, minus 100 green dollars for every participant all the time. But this merely wastes the merit of LETS since it is not so much different from the case of uniform distribution of initial money stock for legal tender discussed in the last section, except the ways of money creation. There are such other rules that effectively utilize the advantages of LETS so that it can increase the rate of realized transactions as: 1) the step-by-step alteration method and 2) the continuous alteration method. The step-by-step alteration method alters the upper limit of debit

depending on the duration of membership or the distinction between provisional membership and full membership. An example is to set minus 100 green dollars for a provisional membership of less than a year and minus 200 green dollars for a full membership above a year.

Such a method is realistic and easy to adopt, but too rough to make the most of the merits of LETS. Then it would be desirable to design and adopt the more sophisticated rules to determine the upper limit of debits as long as it is practicable so that it can utilize the data that administrators are supposed to possess and estimate the difference of each participant in its past performance and activate total transactions as much as possible.

Now we will explain the 'transaction indexation method' as such a possible method. The upper limit of debit of an account is calculated according to the following linear equation where ***R***: the upper limit of debit, ***z***: aggregate transactions of a participant, ***a***: the variable factor of the upper limit of debt, ***b***: the constant factor of it.

$$R = -a*z - b \qquad (1)$$

Let us here observe how the rate of realized transactions changes as the parameter *b* only is altered with the parameter *a* constant and compare two cases (*a*= 0.2 and *a*=0.05) on the condition that the number of total participants is 100 and the number of attempted transactions is 1000, that is, the number of per capita attempted transactions is 10. Table 6 and Table 7 show the results of two cases as the ensemble average of 100 times experimentations.

(Table 6) The rate of realized transactions and alteration of parameter *b* (*a* = 0.05)

Parameter *b*	1	2	5	10	15
The number of realized transactions	747.41	853.17	967.47	998.88	999.98
The rate of realized transactions	74.7%	85.3%	96.7%	99.9%	100%

(Table 7) The rate of realized transactions and alteration of parameter *b* (*a* = 0.2)

Parameter *b*	1	2	5	10	15
The number of realized transactions	750.88	853.86	981.06	999.46	1000
The rate of realized transactions	75.1%	85.4%	98.1%	99.9%	100%

First, we take a look at the first columns of Table 6 (*a* = 0.05, *b* = 1) and that of Table 7 (*a* = 0.2, *b* = 1) in order to compare those with the results in Table 5. It is conceivable that the case for legal

tender can be now interpreted as the case of the equation (1) with a =0, b=1. To set the parameter a at some positive value instead of zero in the 'transaction indexation method' can drastically increase the rate of realized transactions from about 55% to about 75%. The increase of the parameter a from a = 0.05 as in Table 6 to a = 0.2 as in Table 7 only makes only a small increase (0.4%) of the rate of realized transactions. These results show that the 'transaction indexation method' that prevents moral hazard as to excessive creation of money can remarkably enhance the rate of realized transactions with relatively a small parameter a as long as it is positive. The initial per capita money stock required to realize all transactions can also be reduced to around 10 from 17 for legal tender. This case study exemplifies that such institutional design of rules is essential for community currencies including LETS to function well enough to attain its original goal.

5. Conclusion

In this article, we have examined and compared the characteristics of dispersive and concentrated money creation observable both in community currencies and legal tenders, rather than just having contrasted community currencies and legal tenders. Both ways of money creation have peculiar merits and demerits. Concentrated money creation causes the problem of restricting transactions by the need of money stock in advance, and it requires more money buffer to realize transactions smoothly. Concentration of money creation can prevent free riding and have a broad sphere of circulation, and it creates maneuverability for monetary policy of a central bank. At the same time, its arbitrariness might lead to a great danger of excessive money creation. On the other hand, dispersive money creation without any constraint exhibits transaction efficiency as in LETS with no upper limit of debit, but it bring about moral hazard of free riding taken by some participants. Finally, we have demonstrated the validity of 'transaction indexation method' to set the rules of determining the upper limit of debit in LETS to avoid free riding and to enhance transaction efficiency. We simultaneously presented the possibility of institutional design of money by this exemplification.

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