Modeling An EPM-token Experiment
– Accounting System Dynamics Analysis –

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Abstract

In our previous research, we have discussed the Electronic Public Money (EPM) based on blockchain and distributed ledger technology is money of the futures. As a first step toward its implementation, we have proposed an experiment of EPM-token that can be converted to cash with one-to-one exchange rate, and a roadmap for conducting the experiment in Japan.

Following the proposal, the purpose of this paper is to build a generic model that can analyze the experiment as a successful business model. Accounting system dynamics method is applied to the the construction of the model. The experiment consists of three players: EPM Users Association, EPM-token Exchanges and EPM-token users such as shops, retailers and consumers. EPM Users Association organizes a consortium of these players. Consortium participation fees, community service fees and transaction fees are main sources of their revenues and expenditures. The success of the experiment depends if they can find sustainable fees that can be simultaneously competitive in the market against the existing electronic payment systems such as credit cards. Our generic model thus constructed turned out to be robust enough to answer these experimental simulations.

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1 An Introduction: What is EPM-token?

What is EPM-token we propose to experiment? To answer the question, we have to revisit our classification of money, especially, blockchain-based money made available after the introduction of Bitcoin in 2008. Four types of such blockchain based money are classified in [4, 2017]; that is, crypto-coin, central bank cryptocurrency (CBCC), crypto-token and electronic public money (EPM). Crypto-token is further broken down into M_1-backed token and M_0-backed token

Table 1 shows our classification of money. To understand EPM-token, let us briefly review our classification of these blockchain-based money.

Classification of Money (after the Year 2008)

	Public Money	Debt Money	
Media	Money as Legal Tender		Functional-Money
Non-metal Commodities	Shell, Cloth (Silk) Woods, Stones, etc		
Metal Coinage	Non-precious Metal Coins Gold, Silver & Copper Coins		Metal Ingots (such as Gold)
Paper Notes	Public Money Notes by PM Admin.	Goldsmith Certificates Central Bank Notes	
Digital Cards & Accounts	Digital Public Money (PM)	Digital Cash Central Bank Digital Currency (CBDC)	Bank Deposits (Credits by Loans)
(After 2008)	< **EPM** >	< CBCC >	< Crypto-coin >
Blockchain & Distributed Ledgers	Electronic Public Money issued by PM Admin. (Peer-to-Peer PM)	Central Bank Cryptocurrency (issued as Base Money)	Bitcoin and approx. 800 Altcoins
		< Crypto-token (as Notes)	(as Deposits) >
		· M_1-backed Bank token: MUFG coin (Japan)	
		· M_1-backed Non-Bank token: Zen token (Japan)	
		· M_0-backed EPM token (cash)	

Table 1: Classification of Blockchain-based Public and Debt Money

Crypto-coin

Crypto-coins, consisting of Bitcoin and Altcoins,[1] are what is often referred to as cryptocurrrencies. Before Bitcoin, electronic money (digits) stored in digital cards and other substitutes issued in exchange for *currency* (cash) were the only digital cash or e-cash.[2] Bitcoin must be distinguished from legal tender or

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[1]Crypto-coins could further be classified into permission or permission-less (public) types, depending on whether a validating node is required a permission to join the network. Permission-type crypto-coins allow more functionality such as higher transaction throughputs. For the purpose of this paper, however, the distinction between these two may not be needed.

[2]Debit cards and credit cards such as Visa are not digital cash. They are payment instruments used in exchange for deposits at banks through card-issuing companies (non-bank

currency because we can refuse to accept it in our payments. In this sense, it is more appropriate to regard it as "digital ingot" or "crypto ingot" generated by crypto-miners similar to gold ingot, which can only be accepted as long as both parties in transaction agree. Accordingly, Bitcoin as crypto-coin is categorized as functional-money in the classification of money in Table 1, since it functions as money similar to bank deposits under the debt money system. Other crypto-coins (Altcoins), issued by different security models and consensus algorithms, are also not legal tender, and only play a role as functional-money under the debt money system.

As of Mar 24, 2018, top 10 crypto-coins according to their scales of market capitalization are the following[3]: Bitcoin, Ethereum, Ripple, Bitcoin Cash, Litecoin, EOS, Cardano, NEO, Stellar and IOTA.

Central Bank Cryptocurrency (CBCC)

CBCC is the cryptocurrency (blockchain-based money) issued by central banks through brockchain and distributed ledger technology, and stored in the wallets of its users along with or in replace of central bank notes. It should not be confused with CBDC (Central Bank Digital Currency) issued by central banks and stored electronically as database digits in their reserve accounts. Thus, CBCC and M_0-based EPM-token (discussed below) become similar type of blockchain-based money in the sense that all EPM-tokens are backed by base money under the current debt money system. To implement CBCC, some technical proposals are already made such as RSCoin (a permission-type blockchain)[1, 2015].

Crypto-token

To avoid price volatility of crypto-coins such as Bitcoin, crypto-token has been recently proposed such that one unit of crypto-token is exchanged for one unit of money stock at any time. In Table 1, this type of crypto-token, similar to real money, is further broken down into the following three groups according to different types of money with which crypto-token is backed.

- M_1-backed Bank token

- M_1-backed Non-Bank token

- M_0-backed EPM token

M_1-backed Bank token

This is the crypto-token issued by banking institutions, and backed by money stock M_1; that is, currency in circulation and demand deposits. As an example, MUFG coin is proposed by the Bank of Tokyo-Mitsubishi UFJ (MUFG), Japan's largest bank, with an exchange rate of one MUFG coin for one Yen. According to several media reports, MUFG coin is under its experiment, starting May, 2017,

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payment service providers) by transfer of bank deposits.

[3]Source: https://coinmarketcap.com/

among about 27,000 employees of the bank, and planed to be made available to the public this year.

Another example is the Bank token issued by Santander, a part of the Spanish Santander Group, which is using the Ethereum Blockchain technology. Santander will be the first bank, its officials confirmed, that utilizes the existing public blockchain for issuing digital currency (or Bank token in our classification) [4].

In addition, big Japanese banks and financial institution such as Mizuho and SMBC are also considering M_1-backed Bank tokens. We predict that global Bank token wars for issuing their own crypto-tokens will break up sooner or later in order to enclose bank clients towards their own crypto-token networks. However, as long as crypto-tokens are backed by M_1, their stability as blockchain-based money is destined to system design failure of boom-bust banking crisis under the debt money system.

M_1-backed Non-Bank token

To avoid the volatility of crypto-coin values, another type of crypto-token backed by money stock M_1 is issued by non-bank consortium, consisting of fin-tech startups and other non-banking companies. For instance, Zen token issued by the Japanese non-bank consortium, called Blockchain Collaborative Consortium, is now under its experiment.[5]

M_0-backed EPM-token

M_0-backed EPM-token is the third type of crypto-token that is backed by M_0; that is, base money. In other words, this type of crypto-token is issued only in exchange for base money. Base money consists of currency in circulation and central bank reserves. Therefore, EPM-token, which is considered in this paper, is issued in exchange for currencies (mainly central bank notes) at the designated EPM-token Exchanges such as local financial institutions. In return they are obliged to keep these exchanged bank notes at their vaults or their reserve accounts at the central bank for future conversion into currency.

By confining the issuance of crypto-token this way, EPM-token has the same functional feature as EPM itself, that is, 100% reserve ratio for demand deposits or "100% money" as described by Fisher [2, 1935]. Hence, crypto-tokens issued and backed only by base money are classified collectively as M_0-backed EPM-token even if whatever blockchain and distributed ledger technology is applied in the future to the underlying transaction system.

EPM-token is introduced as a half way towards the full implementation of the EPM as money of the futures. Due to this feature of 100% money, EPM-token is expected to attract bank depositors as the most stable crypto-token for P2P payments as well as the safest crypto-money in the coming financial crises against crypto-coins and M_1-backed crypto-tokens under the current debt

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[4] https://cointelegraph.com/news/santander-confirms-fiat-backed-token-project-on-ethereum-blockchain

[5] According to: http://bccc.global/ja/articles/20170705.html (last access on Sep 2, 2017).

money system.

EPM, Electronic Public Money

EPM (Electronic Public Money) is nothing but Public Money issued electronically as blockchain-based money. It is claimed to be money of the futures [4, 2017]. Both EPM and CBCC will be issued by the similar blockchain and distributed ledger technology. Yet CBCC is put into circulation under the current debt money system. Accordingly, it cannot fix the system design failures of debt money system such as boom and bust business cycles and government debt accumulation, etc. On the other hand, EPM is put into circulation under the public money system that is designed to attain monetary and financial stability, liquidation of government debt, and reduction of income inequality.

EPM-token is proposed as a step towards this EPM system. Hence, the successful introduction of EPM-token is crucial for our new social design. In other words, the experiment of EPM-token payment system becomes the most important step toward our ultimate monetary reform of EPM system.

2 Experimenting EPM-token in Japan

Understanding the importance of EPM-token this way, we have invited the reader to our proposed experiment of initiating EPM-token in Japan in [4, 2017]. Let us revisit this experimental proposal briefly as follows.

******* EPM-token Proposal 2017, quoted from [4, pages 34-35] ********

The EPM-token experiment is proposed as a business-oriented project[6] to provide such opportunities, while helping to revive regional economy of Japan simultaneously. To the best of our knowledge, the EPM-token project is the first "cash remittance" business model ever proposed on the basis of blockchain-based money system under the current debt money system.

The EPM-token project in general has to go through the following steps:

Step 1. Establish EPM Users Association (EPM-UA) as an incorporated company that manages the EPM-token project. EPM-UA issues EPM token in exchange for central bank notes, free of charge, at the one-to-one fixed rate.

Step 2. Find the associated token exchanges, who are wiling to provide the exchange service between bank notes and EPM token, preferably among local cooperative banks and financial institutions. Associated token exchangers exchange bank notes into EPM-token, and keep the exchanged notes at their vaults or their reserve accounts at the central bank to guarantee

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[6]Following the guidance by the Japanese Financial Services Agency, it turned out that this project needs to be carried out as "Cash Remittance" business by a corporate organization, not by a non-profit organization, according to the Japanese commercial laws.

100% Token $\Longleftrightarrow$ Notes convertibility at all times. In this way EPM-token becomes truly M_0-backed token. In return, associated token exchangers receive exchange service fees from EPM-UA.

Step 3. Confirm "Know Your Customers (KYC)" at the associated exchangers for the first time users. EPM-token users are charged "Community Service Fees (CSF)", a kind of transaction fees[7] , which are used to cover operational-costs of EPM-UA, including exchange service fees to the associated exchangers and EPM-token blockchain developers.

Step 4. Carry out a pilot experiment of EPM-token for several months among local communities by inviting local shops, producers, farmers and consumers to help stimulate and revive their economy.

Step 5. Expand the EPM-token region to nation-wide simultaneously, as long as the management capacity of EPM-UA is secured. Maximum amount of EPM-token to be exchanged would be as large as the amount of bank notes in circulation, about 100 trillion yen in Japan as of August 2017, and as large as the amount of base money, about 460 trillion yen in Japan.

The objective of this EPM token project is to serve as a bridge from the current debt money system to EPM system by converting central bank notes $\Longleftrightarrow$ EPM tokens $\Longleftrightarrow$ EPM. Therefore, EPM-UA will fulfill its objective once the current system is fully transitioned to EPM system. The project will then be transferred to the PMA (Public Money Administration) of each nation state.

***** End of Quote ******

3   Modeling EPM-token Experiment

We are now in a position to build a generic model of EPM-token experiment proposed above; more specifically, the model that can handle the above Step 1 through 4. Our model developed in this paper is based on the double-bookkeeping Accounting System Dynamics method [3, 2003]. Let us begin by specifying three players in the experiment; that is, EPM Users Association (EPM-UA), EPM-token Exchanges, and EPM-token Users.

3.1   Three Players of the Experiment

EPM-UA EPM-UA, established as non-profit organization, is the main organizer of this experiment. It organizes a consortium that performs the

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[7]A system dynamics simulation model of EPM-token project will be developed and utilized to figure out optimal fees that cover all of its running costs. As the users and transactions of EPM-token increase, optimal CSF are surely reduced such that benefits are paid back to communities.

EPM-token experiment, consisting of local financial institutions as EPM-token Exchanges, and retailers, shops, corporations, consumers, local government, etc as EPM-token Users. Its revenues come from two sources: Consortium Participation Fees and Community Service Fees (CSF).

EPM-token Exchanges EPM-token Exchanges have to be registered as financial institutions (or newly licensed non-financial organizations) that can legally handle "cash remittance" businesses. They issue wallets of EPM-token in exchange for cash in circulation with one-to-one exchange rate. Their revenues come from two sources: wallet issuance charge and EPM-token transaction fee.

EPM-token Users Any individual and organization can be EPM-token users as long as they agrees to pay wallet issuance charge and transaction fees to EPM-token Exchanges, and CSF to EPM-UA. Several devices are already in use for electronic payments, that is, digital e-card for cash payment, and debit and credit cards for deposits payment. The success of EPM-token experiment depends on whether EPM-UA and EPM-token Exchanges can offer cheaper transaction fees and CSF than existing electronic payment charges, and more efficient and safer theft-free P2P payment system.

3.2 Experiment in Action

The experiment proceeds according to the following four processes.

$\Rightarrow$ EPM-token and cash are convertible any time with one-to-one ratio at the EPM-token Exchanges. Bank deposits cannot be converted to EPM-token[8].

$\Rightarrow$ EPM-token users purchase their EPM-token wallets at the EPM-token Exchanges through KYC (Know Your Customers) identification procedure. EPM-token Exchanges are obliged to hold the converted amount of cash at their vaults or as their special EPM-token reserves at the central bank.

$\Rightarrow$ EPM-token users are requested to pay community service fees (CSF) to the EPM UA and transaction fees to the EPM-token Exchanges every time their payment transactions are made.

$\Rightarrow$ When the experiment is terminated, all EPM-token held by users are immediately converted to cash at their EPM-token Exchanges.

Table 3.2 indicates who should pay several types of fees incurred in this experiment.

Remark on Flexible Fee*. EPM-token Exchanges can freely determine their transaction fees, depending on their business conditions and local business environment. Thus, transaction fee is indicated *flexible* in the table.

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[8]Reserve deposits of local financial institutions at the central bank could be converted as M_0-backed EPM-token so long as M_0 is separately reserved to back the EPM-token.

EPM-token Services	EPM Users Association	EPM-token Exchanges
KYC and Wallet Issuance		Fixed Charge
Conversion to EPM-token		Free
Transaction Fees	Uniform CSF	Flexible Fee*
Conversion to Cash		Free or Optional

Table 2: Classification of Services and Fees

3.3 EPM-token Experiment Model

The model consists of three players: EPM UA, EPM-token Exchanges and EPM-token Users. Their sub-models based on Accounting System Dynamics method are illustrated in the Appendix 1. The ASD models are mainly constructed along with balance sheet of assets, liabilities and net assets. Accordingly, these frameworks are briefly described here.

Figure 8 illustrates the Balance Sheet of EPM-UA. Its assets consists of EPM-token Assets, Cash & Deposits, EPM-token Computer Systems and Deferred Assets. Deferred Assets allows the EPM-UA to defer the payments of several costs and expenditures incurred by the experiment. Loan is the only liability. Its net assets consist of Equity obtained by fund-raising, EPM-token Retained Earnings and ordinary Retained Earnings.

Figure 9 illustrates Income Statement or Profits/Loss statement of EPM-UA. Its revenues come from consortium participation fees and community service fees. Its expenditures mainly consist of operating expenses such as marketing, wages and depreciation.

Figure 10 illustrates the Balance Sheet of a representative EPM-token Exchange. Its assets consists of Cash & Reserves, Cash & Reserves as EPM-token Collateral, and EPM-token Assets. Its liabilities consists of Demand Deposits and EPM-token Outstanding. Its net assets consists of EPM-token Retained Earnings and ordinary Retained Earnings.

Figure 11 illustrates a simplified Balance Sheet of EPM-token Users. Its assets consist of Demand Deposits, Cash and EPM-token Assets. There is no liability and only Net Assets is used to balance its bookkeeping.

Main purpose of the model is, first of all, to find out the appropriate levels of fees summarized in Table 3.2 and Consortium Participation fee such that all participants to the EPM-token experiment can get benefits, and secondly to assure that EPM-token payment system is indeed sustainable.

Model Validation

The EPM-token Experiment Model has successfully passed the built-in tests in Vensim; that is, Check Model and Units Check tests. Moreover, it has also passed Balance Sheet Check for ASD model as demonstrated in Figure 12 in the Appendix 1.

4 Analysis of EPM-token Experiment

Let us now analyze the behaviors of EPM-token experiment. Numerical values of fees used for this simulation are shown in the Table 3. All 130 equations of the model are listed in the Appendix 2.

EPM-token Services	EPM Users Association	EPM-token Exchanges
KYC and Wallet Issuance		500 Yen per Wallet
Conversion to EPM-token		Free
Transaction Fees	Uniform CSF (0.3%)	Transaction Fee (1%)
Conversion to Cash		Free or Optional

Table 3: Numerical Service Fees

Our simulation is performed by considering two different ways of issuing wallets. Left-hand diagram of Figure1 shows how wallets are issued during the experiment. Line 1 shows the S-shaped daily increase in the issuance of wallets, while line 2 shows the fixed issuance of wallets at the beginning of the experiment. Right-hand figure shows how net assets (= EPM-token retained assets + ordinary retained assets) are increased according to two different ways of issuing wallets. In this simulation, the amount of issuing wallets in two different ways are adjusted so that nets assets of EPM-token Exchanges become the same for comparison.
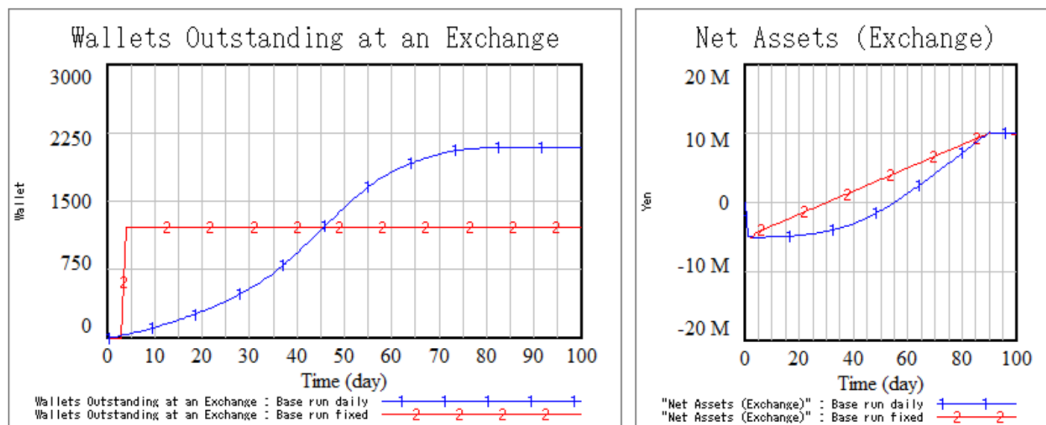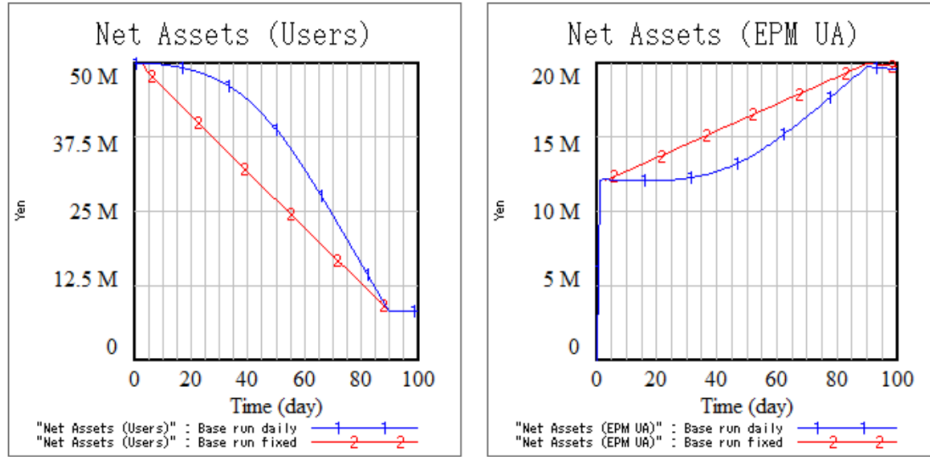

Figure 1: Daily and Fixed Issuance of Wallets

Figure 2: Net Assets of Users and EPM UA

Figure 2 shows similar behaviors of net assets by EPM-token users and EPM-UA. Net assets of users keep decreasing simply because they keep paying wallets issuance charge, community service fees and transaction fees (See Figure 11).
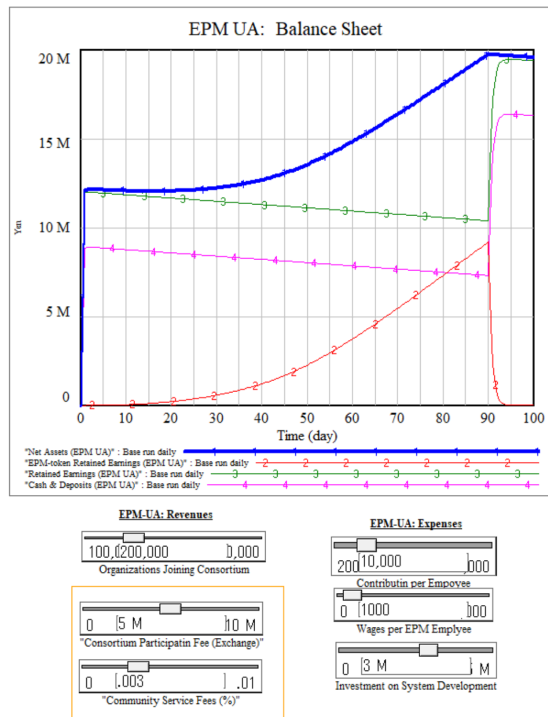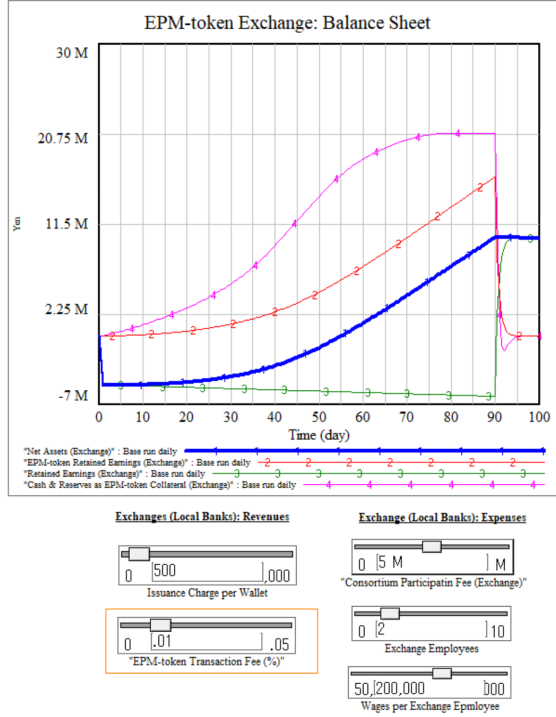

Figure 3: EPM-UA Simulation

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Figure 4: EPM-token Exchange Simulation

Figure 3 and Figure 4 above illustrate our simulation control panels in which net assets of EPM-UA and EPM-token Exchange are managed by the various parameter values including three fees. Lines 1 show how their net assets continue to rise, irrespective of the levels of fees, and remain positive after the termination of the experiment at 90th day. Cash and deposits (lines 4) also end with positive values. Retained earnings (lines 3) also end with positive values. Meanwhile EPM-token retained earnings (lines 2) become zero at the end of the experiment of 90th day.

Figure 5 below shows how EPM-token assets are broken down among three participating players of the experiment. Line 4 indicates the amount of cash and reserves held by all EPM-token Exchanges as collateral of EPM-token. Lines 1, 2 and 3 indicate the EPM-token held by EPM-token users, EPM-UA, and all EPM-token Exchanges, respectively. The sum of these EPM-token is equal to the collateral (line 4), indicating that EPM-token is fully guaranteed for conversion to cash. As a matter of fact, they all becomes zero[9].

It can be easily observed that the composition of EPM-token assets by EPM-UA and EPM-token Exchange increases as CSF and transaction fees are increased, while that of the EPM-token users decreases. In this sense, distribution of the EPM-token assets becomes zero-sum game among the players of the experiment.

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[9]Some miner adjustment errors of computation remain after the termination of 90th day.
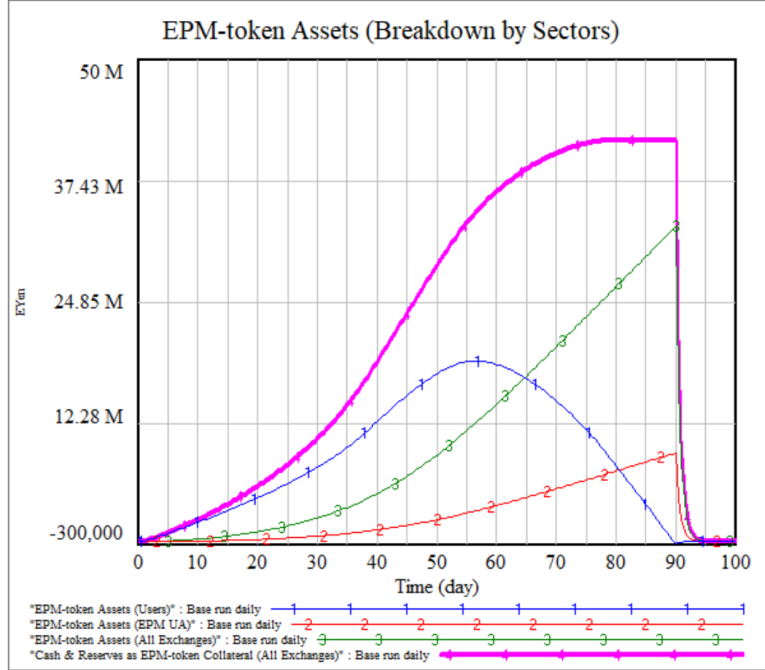
Figure 5: EPM-token Assets Zero-Sum Game (Daily)

Yet, if we consider the whole game of macroeconomic transactions, players of the EPM-token transaction enjoy positive-sum game as a whole against the players of the current digital and credit cards, so long as the fees of EPM-token payment are cheaper than those of current card fees. In this sense, the introduction of EPM-token provides a win-win game to the EPM-token players even under the debt money system.

Let us now consider the case in which the issuance of wallets is fixed at the beginning of the experiment. In this case, EPM-token users may run out of EPM-token during the experiment, so that they are obliged to convert additional cash into EPM-token at some days. Figure 6 below indicates that such conversions took place at the 55th and 76th days. These behaviors are similar to those observed under the inventory management of fixed amount of orders.

Figure 7 illustrates the breakdown of EPM-token assets for this fixed case, which vividly contrasts with the case for daily issuance of wallets in Figure 5.
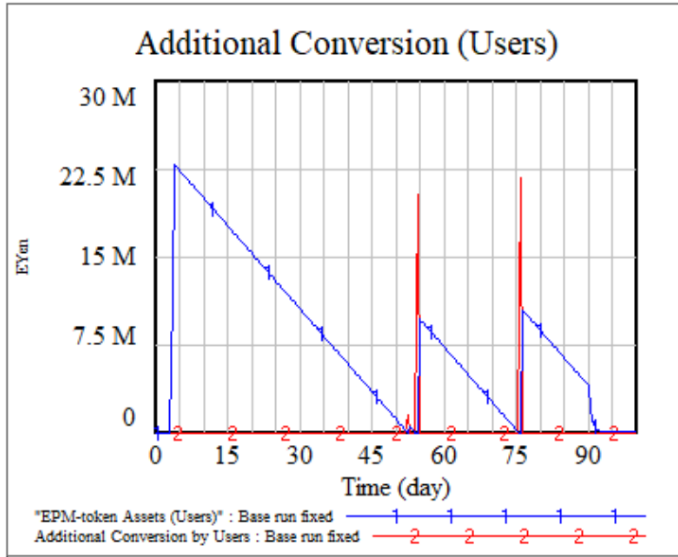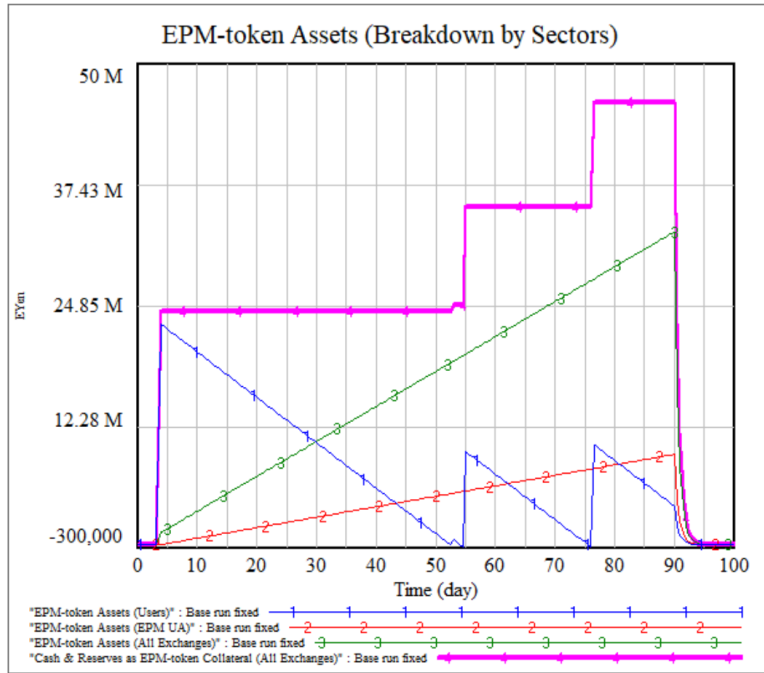
Figure 6: Additional Conversion by Users

Figure 7: EPM-token Assets Zero-Sum Game (Fixed)

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Some Remarks on the Model

Transaction fee Transaction fees determined by the EPM-token Exchanges in the model can be flexibly determined, but assumed to be be fixed during the experiment. However, they do not need to be fixed. As the EPM-token users increase, revenues of the Exchanges also increase. Accordingly, EPM-token Exchanges could freely reduce their transaction fees in a competitive market environment. This feedback loop of adaptable transaction fees is missing in the model, and should be considered in our revised model in the future.

Community Service Fee When EPM-token system under the current debt money system is transformed into the comprehensive EPM system in the future, EPM-UA will also be reorganized as the Public Money Administration (PMA) under the direct management of the Legislative branch of the government. At that time, community service fee (CSF) will be transformed into a nation-wide *Uniform Tax Rate* proposed in [4, 2017]. Hence, our EPM-token model could be a preamble model of the EPM payment system.

Infinite Termination Day of Experiment When termination day of the experiment is prolonged into the future, our EPM-token experiment model becomes a truly strategic business model of EPM-token system. This can be easily done by setting the Closing Date of Experiment from the current 90th day into infinity. This versatility of the model demonstrates its robustness as a generic model of EPM-token system.

5 Merits to introduce EPM-token

We have now successfully examined our simulation results. Our generic model turns out to be robust enough to determine the various service fees that enable to provide positive net assets to all participants. Accordingly, we could say that the EPM-token is worth introducing for attaining more beneficial P2P payment than the current one.

Even so, in the advanced countries where financial services are well provided and cashless payments are getting dominant, there seems to be no strong incentives to convert to the EPM-token payment system. For those skeptical players, here are some persuasive merits for introducing EPM-token system.

1. EPM-token is absolutely secure, simply because it is backed by cash or central bank reserves, that is, by base money M_0. In case of predicted financial crises and bank-runs in the near future, bank may be closed and withdrawal of deposits is prohibited. Under such panicky circumstances, EPM-token absolutely becomes one of the safest financial assets.

2. Shops are obliged to pay charges and commissions whenever they accept payment by credit cards and digital e-cards. If payment fees by EPM-token are cheaper than these charges, retailers and shops become eager to accept EPM-token payment. In addition, those payments are done

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through P2P and payed immediately in cash, compared with the monthly payments by credit card sales.

3. Accordingly, retailers and shops becomes better off even if they make discount sales to their customers by avoiding payments of charges and commissions to the card companies. EPM-token users, on the other hand, can also get benefits from discount sales instead of paying regular prices with credit cards.

4. Local banks and financial institutions who become the EPM-token Exchanges also have better business and investment opportunities through EPM-token transactions, because users of EPM-token are more attracted to become their clients.

5. Moreover, business and economic activities of local communities may get reactivated as the velocity of EPM-token increases and, as a result, total amount of local transactions grows as well. In this sense, EPM-token indeed begins to play a role of local and community currencies in the age of blockchain and distributed ledger technology.

Conclusion

The purpose of this paper is to find out if the introduction of the EPM-token brings about the merits to local communities and economies. More specifically, it is to find out if CSF and transaction fees are set to be competitive enough against the existing electronic card charges, and, as a result, business players such as EPM UA and EPM-token Exchanges as well as EPM-token users become profitable and sustainable.

To answer these questions we have built the EPM-token experiment model based on the Accounting System Dynamics method. The model become successful to be able to answer them positively. In this sense, the EPM-token experiment is shown to be a fist step toward the implementation of Electronic Public Money (EPM) as money of the futures.

We would like to conclude this paper, similar to our previous paper [4, 2017], with a call for the advancement of design configuration of world-wide EPM systems openly and inter-disciplinarily among blockchain developers, cryptography researchers, system engineers, economists as well as policy makers.

> **World-wide EPM System Forum**
> **– Electronic (P2P) Public Money –**

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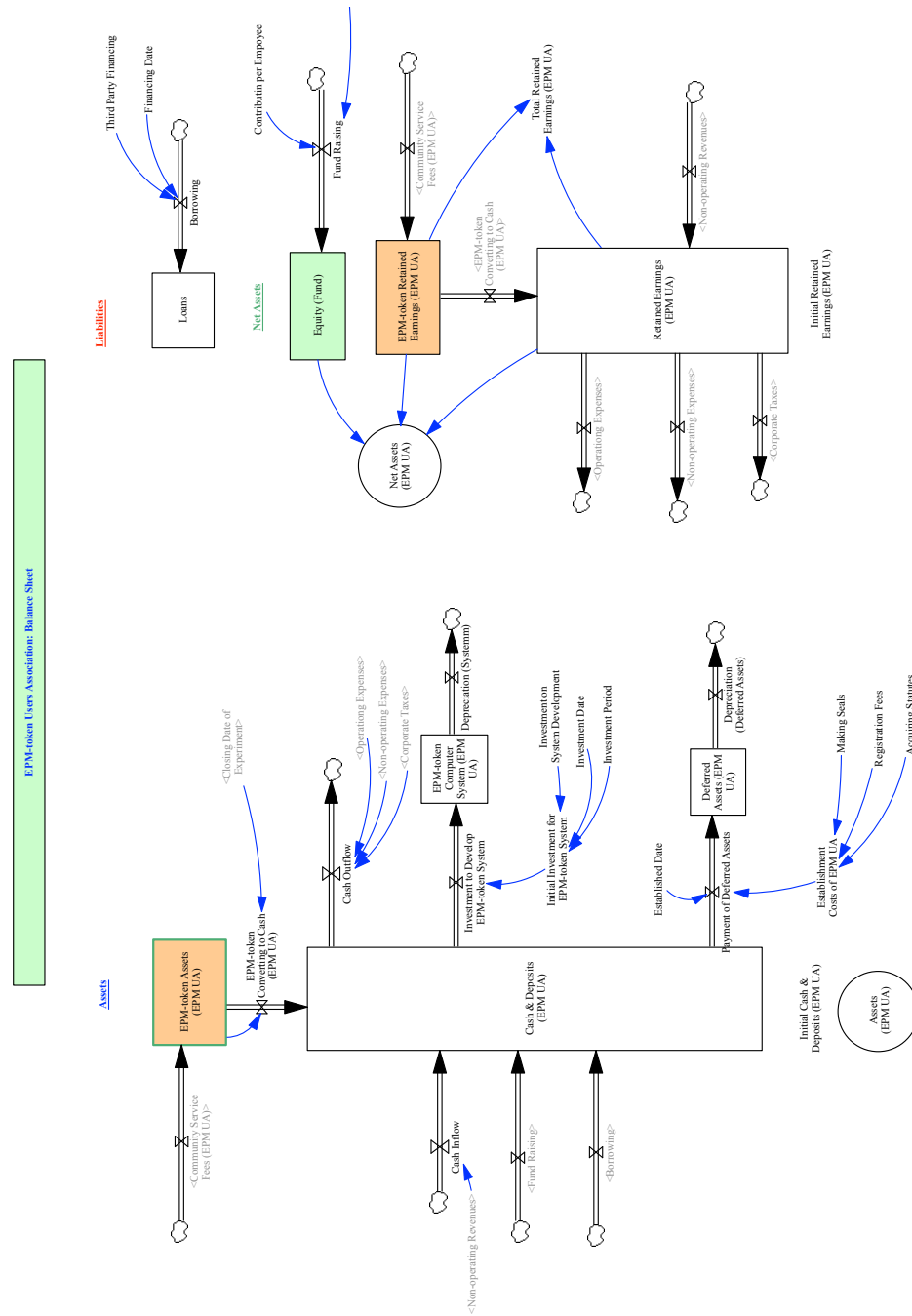
Appendix 1 : EPM-token Experiment Model
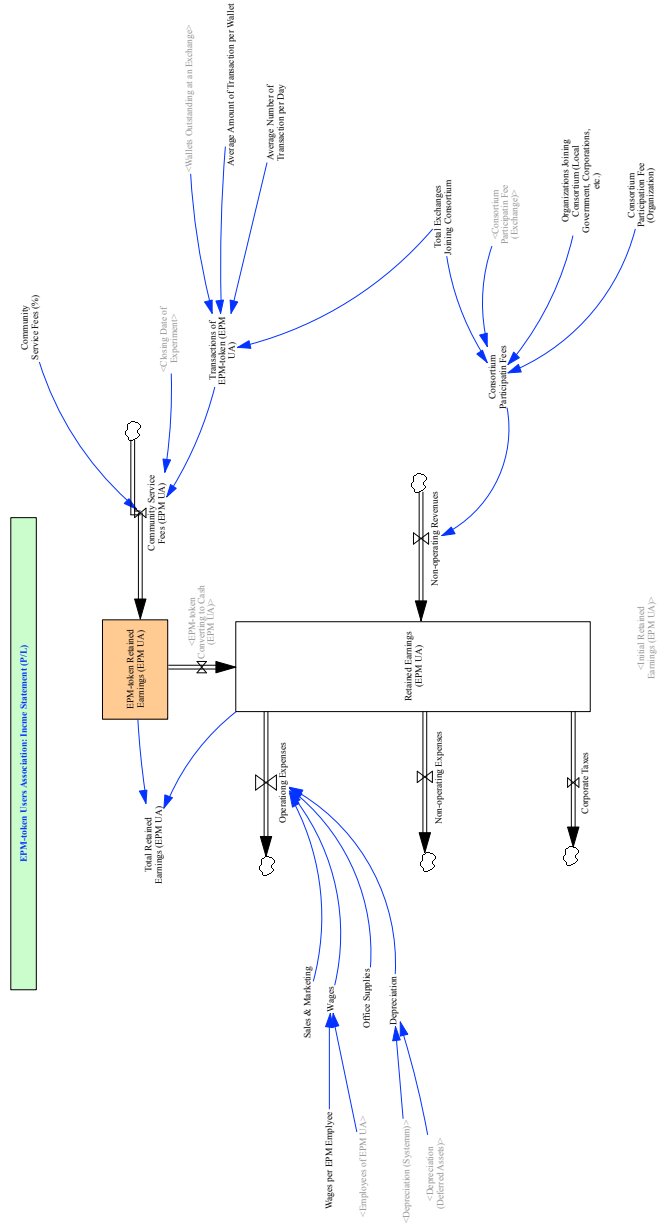

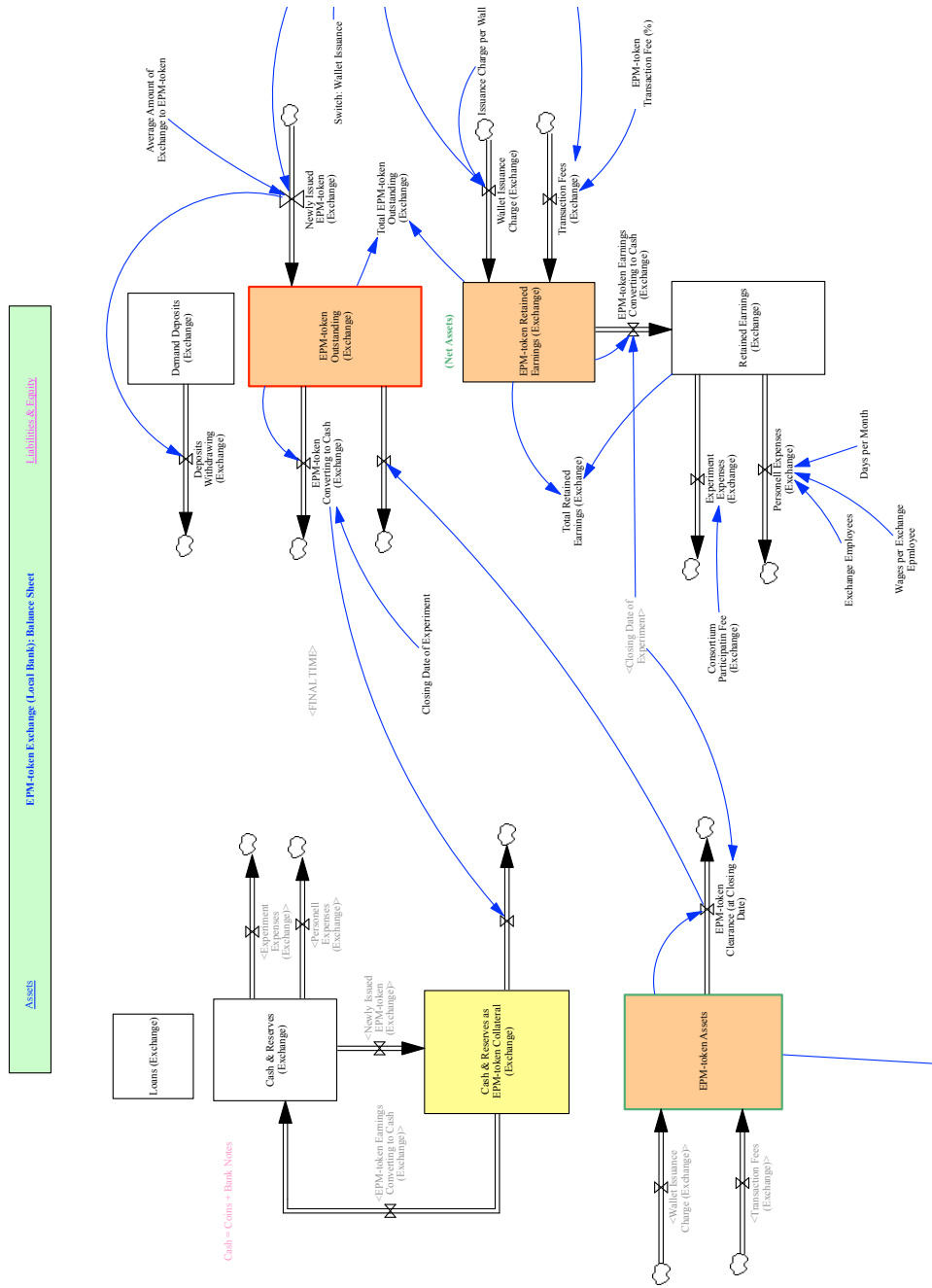Figure 8: EPM-UA Balance Sheet

Figure 9: EPM-UA Income Statement
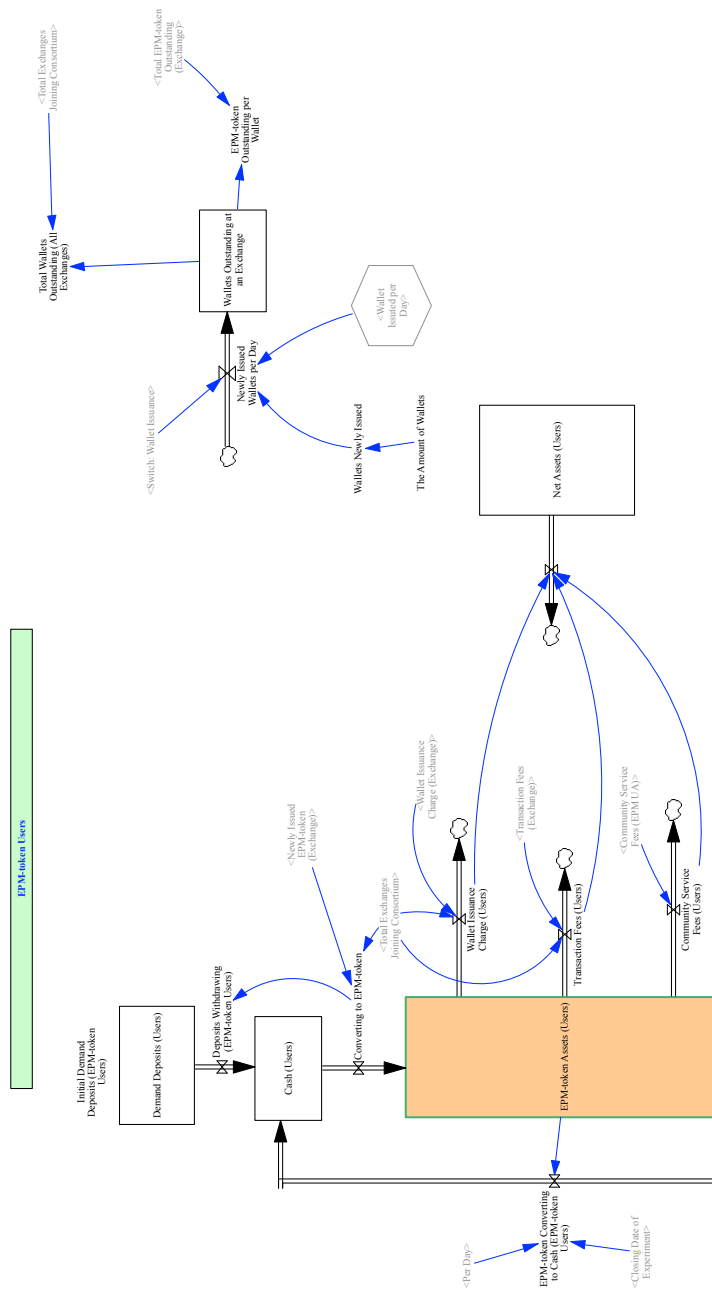
Figure 10: EPM-token Exchange
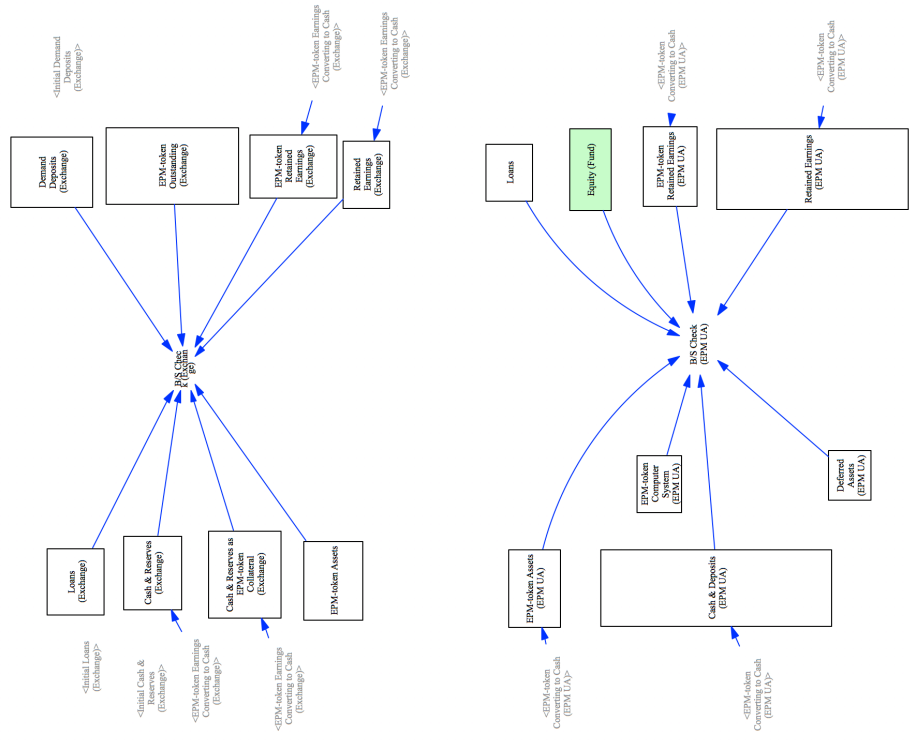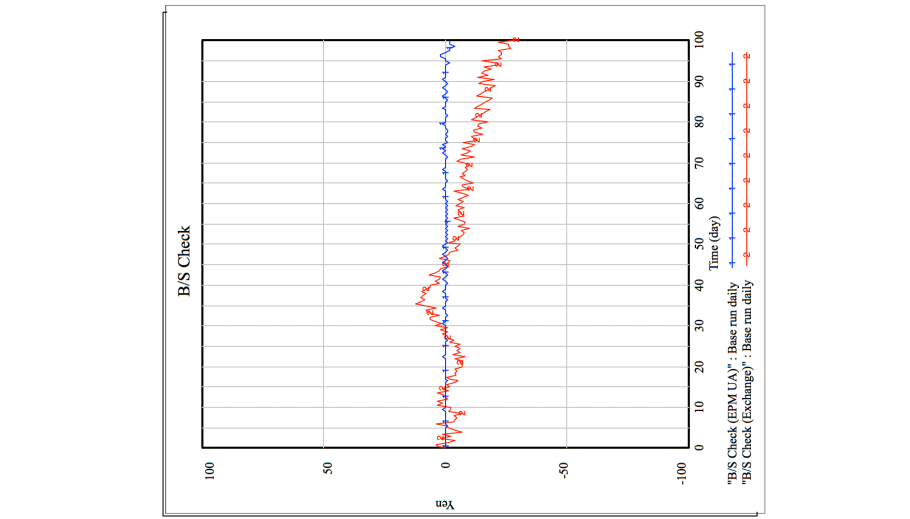
Figure 11: EPM-token Users

Figure 12: Balance Sheets Check

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Appendix 2 : Model Equations

(001) Acquiring Statutes= 50000+40000
Units: Yen/day

(002) "Additional Amount of Exchange to EPM-token"=Additional Conversion by Users *
ZIDZ(Wallets Outstanding at an Exchange, "Total Wallets Outstanding (All Exchanges)")
Units: EYen/day

(003) Additional Conversion by Users=IF THEN ELSE("EPM-token Assets (Users)"<=0,
ABS("EPM-token Assets (Users)")*Per Day*Additional Conversion Scale, 0)
Units: Yen/day

(004) Additional Conversion Scale= 100
Units: Dmnl [10,200,10]

(005) "Assets (EPM UA)"= "Cash & Deposits (EPM UA)"+"EPM-token Computer System (EPM UA)"
                        +"Deferred Assets (EPM UA)"
Units: Yen

(006) "Assets (Exchange)"=
"Cash & Reserves (Exchange)"+"Cash & Reserves as EPM-token Collateral (Exchange)"
+"EPM-token Assets"
Units: Yen

(007) "Average Amount of Exchange to EPM-token"=10000
Units: EYen/Wallet

(008) Average Amount of Transaction per Wallet= 5000
Units: EYen/Wallet/day [0,10000,1000]

(009) Average Number of Transaction per Day= 3
Units: Dmnl [0,10,1]

(010) "B/S Check (EPM UA)"=
"Cash & Deposits (EPM UA)"+"EPM-token Computer System (EPM UA)"+"Deferred Assets (EPM UA)"
      +"EPM-token Assets (EPM UA)"
-Loans-"Equity (Fund)"-"EPM-token Retained Earnings (EPM UA)"-"Retained Earnings (EPM UA)"
Units: Yen

(011) "B/S Check (Exchange)"=
"Loans (Exchange)"+"Cash & Reserves (Exchange)"
+"Cash & Reserves as EPM-token Collateral (Exchange)"
+"EPM-token Assets"
-"Demand Deposits (Exchange)"-"EPM-token Outstanding (Exchange)"
-"EPM-token Retained Earnings (Exchange)"
-"Retained Earnings (Exchange)"
Units: Yen

(012) Bank of Japan Notes Outstanding= INTEG (

"EPM-token Converting to Cash"+Withdrawing Reserves-"Newly Issued EPM-token",
Initial Bank of Japan Notes Outstanding)
Units: Yen

(013) Base Money=Bank of Japan Notes Outstanding
                +"Reserves (Bank of Japan)"+"EPM-token Outstanding"
Units: Yen

(014) Borrowing=Third Party Financing*PULSE(Financing Date, 1)
Units: Yen/day

(015) "Cash & Deposits (EPM UA)"= INTEG (
"EPM-token Converting to Cash (EPM UA)"+Cash Inflow+Fund Raising+Borrowing
-"Investment to Develop EPM-token System"-Cash Outflow-Payment of Deferred Assets,
"Initial Cash & Deposits (EPM UA)")
Units: Yen

(016) "Cash & Reserves (Exchange)"= INTEG (
"EPM-token Earnings Converting to Cash (Exchange)"-"Newly Issued EPM-token (Exchange)"
        -"Personell Expenses (Exchange)"-"Experiment Expenses (Exchange)",
"Initial Cash & Reserves (Exchange)")
Units: Yen

(017) "Cash & Reserves as EPM-token Collateral (All Exchanges)"= INTEG (
"Newly Issued EPM-token (Exchange)"*Total Exchanges Joining Consortium
-"EPM-token Converting to Cash (All Exchanges)", 0)
Units: Yen

(018) "Cash & Reserves as EPM-token Collateral (Exchange)"= INTEG (
"Newly Issued EPM-token (Exchange)"
-"EPM-token Earnings Converting to Cash (Exchange)"
-"EPM-token Converting to Cash (Exchange)", 0)
Units: Yen

(019) "Cash (Users)"= INTEG (
"EPM-token Converting to Cash (EPM-token Users)"
+"Deposits Withdrawing (EPM-token Users)"
-"Converting to EPM-token", 0)
Units: Yen

(020) Cash Inflow= "Non-operating Revenues"
Units: Yen/day

(021) Cash Outflow=
Operationg Expenses+"Non-operating Expenses"+Corporate Taxes
Units: Yen/day

(022) "Cash-Reserves Ratio"= 0.6
Units: Dmnl [0.1,1,0.1]

(023) Closing Date of Experiment= 90
Units: day [60,365,1]

(024) "Community Service Fees (%)"= 0.003
Units: Dmnl [0,0.01,0.001]

(025) "Community Service Fees (EPM UA)"=
IF THEN ELSE(Time >=Closing Date of Experiment, 0,
"Transactions of EPM-token (EPM UA)"*"Community Service Fees (%)")
Units: EYen/day

(026) "Community Service Fees (Users)"= "Community Service Fees (EPM UA)"
Units: EYen/day

(027) "Consortium Participatin Fee (Exchange)"= 5e+06
Units: Yen/day [0,1e+07,100000]

(028) Consortium Participatin Fees=
"Consortium Participatin Fee (Exchange)"*Total Exchanges Joining Consortium
+Organizations Joining Consortium*"Consortium Participation Fee (Organization)"
Units: Yen/day

(029) "Consortium Participation Fee (Organization)"= 10
Units: EYen/day [1,50,1]

(030) Contributin per Empoyee= 10000
Units: Yen/Person

(031) "Converting to EPM-token"=
"Newly Issued EPM-token (Exchange)"*Total Exchanges Joining Consortium
Units: EYen/day

(032) Corporate Taxes= 0
Units: Yen/day

(033) Days per Month= 30
Units: day/Month

(034) "Deferred Assets (EPM UA)"= INTEG (
  Payment of Deferred Assets-"Depreciation (Deferred Assets)", 0)
Units: Yen

(035) "Demand Deposits (Exchange)"= INTEG (
Lending-"Deposits Withdrawing (Exchange)",
"Initial Demand Deposits (Exchange)")
Units: Yen

(036) "Demand Deposits (Users)"= INTEG (
-"Deposits Withdrawing (EPM-token Users)",
"Initial Demand Deposits (EPM-token Users)")

Units: Yen

(037) "Deposits Withdrawing (EPM-token Users)"= "Converting to EPM-token"
Units: Yen/day

(038) "Deposits Withdrawing (Exchange)"= "Newly Issued EPM-token (Exchange)"
Units: Yen/day

(039) Depreciation= "Depreciation (Systemm)"+"Depreciation (Deferred Assets)"
Units: Yen/day

(040) "Depreciation (Deferred Assets)"= 0
Units: Yen/day

(041) "Depreciation (Systemm)"= 0
Units: Yen/day

(042) Employees of EPM UA= INTEG (Employment, 0)
Units: Person

(043) Employment= Employment Lookup(Time)
Units: Person/day

(044) Employment Lookup([(0,0)-(100,10)],(1,9),(2,0),(3,2),(4,0),(100,0))
Units: Person/day

(045) "EPM-token Assets (All Exchanges)"= "EPM-token Assets"
                *Total Exchanges Joining Consortium
Units: EYen

(046) "EPM-token Assets (EPM UA)"= INTEG ("Community Service Fees (EPM UA)"
                  -"EPM-token Converting to Cash (EPM UA)" ,0)
Units: EYen

(047) "EPM-token Assets (Users)"= INTEG (
"Converting to EPM-token"
-"EPM-token Converting to Cash (EPM-token Users)"
-"Wallet Issuance Charge (Users)"
-"Community Service Fees (Users)"
-"Transaction Fees (Users)", 0)
Units: EYen

(048) "EPM-token Assets"= INTEG ("Wallet Issuance Charge (Exchange)"
        +"Transaction Fees (Exchange)" -"EPM-token Clearance (at Closing Date)", 0)
Units: EYen

(049) "EPM-token Clearance (at Closing Date)"=
STEP("EPM-token Assets"*Per Day, Closing Date of Experiment-0.1)
Units: EYen/day

(050) "EPM-token Computer System (EPM UA)"= INTEG (
"Investment to Develop EPM-token System"-"Depreciation (Systemm)", 0)
Units: Yen

(051) "EPM-token Converting to Cash (All Exchanges)"=
"EPM-token Earnings Converting to Cash (Exchange)"*Total Exchanges Joining Consortium
+"EPM-token Converting to Cash (EPM UA)"
+"EPM-token Converting to Cash (EPM-token Users)"
Units: Yen/day

(052) "EPM-token Converting to Cash (EPM UA)"=
STEP("EPM-token Assets (EPM UA)"*Per Day, Closing Date of Experiment-0.1)
Units: EYen/day

(053) "EPM-token Converting to Cash (EPM-token Users)"=
"EPM-token Assets (Users)"*Per Day*PULSE(Closing Date of Experiment, 10)
Units: EYen/day

(054) "EPM-token Converting to Cash (Exchange)"=
STEP("EPM-token Outstanding (Exchange)"*Per Day,Closing Date of Experiment+0.5)
Units: EYen/day

(055) "EPM-token Converting to Cash"= 0
Units: Yen/day

(056) "EPM-token Earnings Converting to Cash (Exchange)"=
STEP("EPM-token Retained Earnings (Exchange)"*Per Day, Closing Date of Experiment -0.1)
Units: Yen/day

(057) "EPM-token Outstanding (Exchange)"= INTEG (
  "Newly Issued EPM-token (Exchange)"-"EPM-token Clearance (at Closing Date)"
      -"EPM-token Converting to Cash (Exchange)", 0)
Units: EYen

(058) "EPM-token Outstanding per Wallet"=
  ZIDZ("Total EPM-token Outstanding (Exchange)", Wallets Outstanding at an Exchange)
Units: EYen/Wallet

(059) "EPM-token Outstanding"= INTEG (
        "Newly Issued EPM-token"-"EPM-token Converting to Cash", 0)
Units: Yen

(060) "EPM-token Retained Earnings (EPM UA)"= INTEG (
  "Community Service Fees (EPM UA)"-"EPM-token Converting to Cash (EPM UA)", 0)
Units: EYen

(061) "EPM-token Retained Earnings (Exchange)"= INTEG (
  "Wallet Issuance Charge (Exchange)"+"Transaction Fees (Exchange)"
  -"EPM-token Earnings Converting to Cash (Exchange)", 0)
Units: EYen

(062) "EPM-token Transaction Fee (%)"=0.01
Units: Dmnl [0,0.1,0.001]

(063) "Equity (Fund)"= INTEG (Fund Raising,0)
Units: Yen

(064) Established Date= 0
Units: day [0,10,1]

(065) Establishment Costs of EPM UA=
                  Making Seals+Acquiring Statutes+Registration Fees
Units: Yen/day

(066) Exchange Employees= 2
Units: Person [0,10,1]

(067) "Experiment Expenses (Exchange)"="Consortium Participatin Fee (Exchange)"
            *PULSE(0, 1)
Units: Yen/day

(068) FINAL TIME = 100
Units: day

(069) Financing Date= 1
Units: day [0,100,1]

(070) Fixed Amount of Wallets= 1180
Units: Wallet/day [0,3000,10]

(071) Fund Raising= Employment*Contributin per Empoyee
Units: Yen/day

(072) Initial Bank of Japan Notes Outstanding= 1e+14
Units: Yen

(073) "Initial Cash & Deposits (EPM UA)"= 0
Units: Yen

(074) "Initial Cash & Reserves (Exchange)"=
"Initial Demand Deposits (Exchange)"*"Cash-Reserves Ratio"
Units: Yen

(075) "Initial Demand Deposits (EPM-token Users)"= 5e+07
Units: Yen [1e+06,8e+07,10000]

(076) "Initial Demand Deposits (Exchange)"=
5e+07
Units: Yen [1e+06,8e+07,100000]

(077) "Initial Investment for EPM-token System"=
   Investment on System Development*PULSE(Investment Date, Investment Period)
Units: Yen/day

(078) "Initial Loans (Exchange)"="Initial Demand Deposits (Exchange)"
            *(1-"Cash-Reserves Ratio")
Units: Yen

(079) "Initial Reserves (Bank of Japan)"= 4e+14
Units: Yen

(080) "Initial Retained Earnings (EPM UA)"= 0
Units: Yen [0,1e+06,10000]

(081) INITIAL TIME = 0
Units: day

(082) Investment Date= 0
Units: day [0,100,1]

(083) Investment on System Development= 3e+06
Units: Yen/day [0,5e+06,100000]

(084) Investment Period=1
Units: day [1,100,1]

(085) "Investment to Develop EPM-token System"=
            "Initial Investment for EPM-token System"
Units: Yen/day

(086) Issuance Charge per Wallet= 500
Units: EYen/Wallet [0,1000,100]

(087) Lending= 0
Units: Yen/day [1e+06,1e+07,10000]

(088) Loans= INTEG (Borrowing, 0)
Units: Yen

(089) "Loans (Exchange)"= INTEG (Lending,"Initial Loans (Exchange)")
Units: Yen

(090) Making Seals= 20000
Units: Yen/day

(091) "Net Assets (EPM UA)"= "Equity (Fund)"+"EPM-token Retained Earnings (EPM UA)"
            +"Retained Earnings (EPM UA)"
Units: Yen

(092) "Net Assets (Exchange)"=

"EPM-token Retained Earnings (Exchange)"+"Retained Earnings (Exchange)"
Units: Yen

(093) "Net Assets (Users)"= INTEG (-"Wallet Issuance Charge (Users)"
          -"Community Service Fees (Users)" -"Transaction Fees (Users)",
     "Initial Demand Deposits (EPM-token Users)")
Units: Yen

(094) "Newly Issued EPM-token (Exchange)"=
  IF THEN ELSE(Time >=Closing Date of Experiment, 0,
  "Average Amount of Exchange to EPM-token"*Newly Issued Wallets per Day
  +"Additional Amount of Exchange to EPM-token")
Units: EYen/day

(095) "Newly Issued EPM-token"= "Newly Issued EPM-token (Exchange)"
               *Total Exchanges Joining Consortium
Units: EYen/day

(096) Newly Issued Wallets per Day=IF THEN ELSE("Switch: Wallet Issuance"=0,
                 Wallet Daily Issuance Table(Time),Wallets Newly Issued)
Units: Wallet/day [0,1,1]

(097) "Non-operating Expenses"= 0
Units: Yen/day

(098) "Non-operating Revenues"=Consortium Participation Fees*PULSE(0, 1)
Units: Yen/day

(099) Office Supplies=0
Units: Yen/day

(100) Operationg Expenses= "Sales & Marketing"+Wages+Office Supplies+Depreciation
Units: Yen/day

(101) Organizations Joining Consortium= 200000
Units: Dmnl [100000,500000,100000]

(102) Payment of Deferred Assets=
  Establishment Costs of EPM UA*PULSE(Established Date, 1)
Units: Yen/day

(103) Per Day= 1
Units: 1/day

(104) "Personell Expenses (Exchange)"=
  Exchange Employees*Wages per Exchange Epmloyee/Days per Month
Units: Yen/day

(105) Registration Fees= 150000
Units: Yen/day

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(106) "Reserves (Bank of Japan)"= INTEG (-Withdrawing Reserves,
  "Initial Reserves (Bank of Japan)")
Units: Yen

(107) "Retained Earnings (EPM UA)"= INTEG ("EPM-token Converting to Cash (EPM UA)"
        +"Non-operating Revenues"-"Non-operating Expenses"
        -Corporate Taxes-Operationg Expenses,  "Initial Retained Earnings (EPM UA)")
Units: EYen

(108) "Retained Earnings (Exchange)"= INTEG (
  "EPM-token Earnings Converting to Cash (Exchange)"
  -"Personell Expenses (Exchange)"-"Experiment Expenses (Exchange)",0)
Units: Yen

(109) "Sales & Marketing"= 500
Units: Yen/day [0,2000,100]

(110) SAVEPER  = TIME STEP
Units: day [0,?]

(111) "Switch: Wallet Issuance"= 0
Units: Dmnl [0,1,1]

(112) "The Amount of EPM-token Transaction per Day"=
   Wallets Outstanding at an Exchange
   *Average Amount of Transaction per Wallet
   *Average Number of Transaction per Day
Units: EYen/day [0,1000,50]

(113) Third Party Financing= 0
Units: Yen/day [0,3e+06,10000]

(114) TIME STEP  = 0.5
Units: day [0,?]

(115) "Total EPM-token Outstanding (Exchange)"=
   "EPM-token Outstanding (Exchange)"+"EPM-token Retained Earnings (Exchange)"
Units: EYen

(116) Total Exchanges Joining Consortium= 2
Units: Dmnl [0,10,1]

(117) "Total Retained Earnings (EPM UA)"=
   "EPM-token Retained Earnings (EPM UA)"+"Retained Earnings (EPM UA)"
Units: Yen

(118) "Total Wallets Outstanding (All Exchanges)"=
  Wallets Outstanding at an Exchange*Total Exchanges Joining Consortium
Units: Wallet
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(119) "Transaction Fees (Exchange)"=
    IF THEN ELSE(Time >=Closing Date of Experiment,0,
    "The Amount of EPM-token Transaction per Day"*"EPM-token Transaction Fee (%)")
Units: EYen/day

(120) "Transaction Fees (Users)"=
    "Transaction Fees (Exchange)"*Total Exchanges Joining Consortium
Units: EYen/day

(121) "Transactions of EPM-token (EPM UA)"=
    Wallets Outstanding at an Exchange*Average Amount of Transaction per Wallet
        *Average Number of Transaction per Day*Total Exchanges Joining Consortium
Units: EYen/day

(122) Wages= Employees of EPM UA*Wages per EPM Emplyee
Units: Yen/day

(123) Wages per EPM Employee= 1000
Units: Yen/day/Person [0,20000,1000]

(124) Wages per Exchange Employee= 200000
Units: Yen/Person/Month [50000,300000,1000]

(125) Wallet Daily Issuance Table([(0,0)-(100,60)],(0,0),(1,10),(10,15),(20,20),
            (30,30),(40,50),(50,50),(60,24),(80,0),(100,0))
Units: Wallet/day

(126) "Wallet Issuance Charge (Exchange)"=
    IF THEN ELSE( Time >=Closing Date of Experiment, 0,
    Newly Issued Wallets per Day*Issuance Charge per Wallet)
Units: EYen/day

(127) "Wallet Issuance Charge (Users)"=
    "Wallet Issuance Charge (Exchange)"*Total Exchanges Joining Consortium
Units: EYen/day

(128) Wallets Newly Issued= Fixed Amount of Wallets*PULSE(3, 1)
Units: Wallet/day [10,1000,10]

(129) Wallets Outstanding at an Exchange= INTEG (Newly Issued Wallets per Day, 0)
Units: Wallet

(130) Withdrawing Reserves= 0
Units: Yen/day
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