Fundamentals of the ASD Model as an Alternative to SMM

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1. Stock-flow Approach of System Dynamics

Our Criticism of SMM (Standard Macroeconomic Model) (Mahmud, Yamaguchi & Yulek, 2017) cannot be effective unless we can provide its alternative model. Most of SMM could be said to have originated from the general equilibrium model, so-called Arrow-Debreu model (Arrow and Debreu, 1954), and "Theory of Value" by Debreu (1959). Since the days of publication, they have dominated the way economists concoct economic theories until today. Luckily I had a chance, as a graduate student at the Univ. of California, Berkeley, to learn the general equilibrium theory from Prof. Debreu in person during late 1970's and early 80's. Through such graduate studies I began to recognize that Debreu's Theory of Value is built on several fictions to accomplish its rigorous mathematical formulation; that is, (1) timeless and static, (2) classless such as workers and shareholders, and (3) moneyless[1], which had led me to conclude that "*these fictions present logical inconsistencies, and accordingly they cannot be acceptable* (Yamaguchi, p.48, 1988)".

Dynamic Stochastic General Equilibrium (DSGE) family of models that overwhelmingly constitutes SMM today is one of the attempts, though unsuccessful, to overcome such logical inconsistencies arising from these fictions. Without being satisfied by such attempts, I have gradually lost my interest in economic research.

It was when I visited the Sloan School of Management, MIT, that my interest in economic modeling was reactivated. During my visits in 1999 and 2000, I attended seminars by Prof. Jay Forrester, founder of System Dynamics (Forrester, 1961), and audited Prof. John Sterman's MBA class on System Dynamics (Sterman, 2000). Gradually I have comprehended that system dynamics modeling could indeed overcome logical inconsistencies of today's SMM. To do so, however, it has to be integrated, I have recognized later in my research, with double-entry bookkeeping principle of accounting system.

Let us start by introducing some fundamentals of System Dynamics. It is designed to capture dynamic behaviors of state variables (so called in differential equations) in terms of stock-flow relation. In Figure 1, a state variable is represented in a stock box labeled Commodity (which has a commodity unit), while the level of stock can only be changed by

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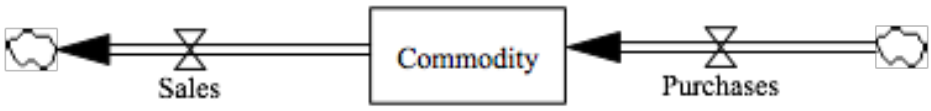
[1] See Yamaguchi (pp.41-48, 1988) for detailed seven critiques of Prof. Debreu's "Theory of Value".

the amount of flows such as Sales and Purchases (which have a time unit such as unit/ month). The reader is referred to Chapter 1 (System Dynamics) of Yamaguchi (2013) for more comprehensive presentation of system dynamics modeling.

Commodity can be interpreted as inventory. In this simple dynamics modeling, equilibrium is attained when "Purchases = Sales", so that net change in commodity inventory becomes zero. If Sales are not equal to Purchases, inventory increases or decreases. In either case, we can easily model both states of equilibrium and off-equilibrium in this stock-flow presentation.

Figure 1. Stock-flow relation of Dynamics



On the other hand, in textbook macroeconomic models in which Sales are interpreted as GDP and Purchases as consisting of C + I + G, equilibrium can only be formalized as equation such that

$$GDP = C + I + G \quad \text{(equilibrium equation)} \tag{1}$$

Furthermore, off-equilibrium state could only be described as identity such that

$$GDP \equiv C + I^* + G \quad \text{(off-equilibrium identity)} \tag{2}$$

where I* includes Inventory Investment. Hence, under the analytical framework of SMM modeling, off-quilibrium state is hard to be modeled as equation, compared with the stock-flow modeling approach. This is the reason why SMM has to be constrained to the *equilibrium analysis*. The reader is referred to Chapter 2 (Demand and Supply) of Yamaguchi (2013) for further discussions.

2. Co-flows of Money and Commodity

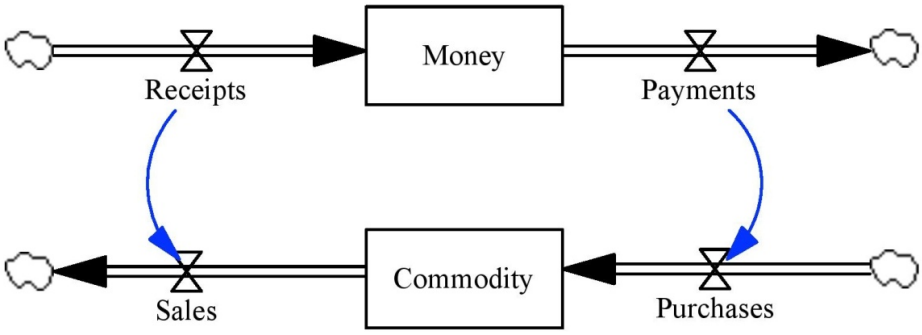
Even kids are fully aware that they cannot buy commodity without money; that is, all economic transactions have to be performed with money that plays a role as a medium of exchanges. In Figure 2 below, Money is represented as another stock (whose unit is dollar), while Receipts and Payments are illustrated as flows (whose units are dollar/month). To introduce money as a stock-flow relation, at least the following three pieces of information on money have to be identified; that is, money as stock, a unit to measure its amount, and volumes of its flows as a medium of exchange for goods and services.

From these modeling requirements, three essential functions of money, as explained in

standard textbooks, are derived:

- Unit of account (unit of money stock has to be determined before modeling);
- Medium of exchange (flow amount of money stock has to be determined in relation to co-flow commodity);
- Store of value (money has to be modeled as the amount of stock).

Figure 2. Co-flows of Commodity and Money



The co-flow relation of money and commodity is the prerequisite of economic modeling of any transaction. Commodity cannot be traded without payment of money! If sufficient amount of money does not exist or payments by debt obligation are not accepted, transactions cannot be performed at all. The reader may easily confirm how monetary constraint affects behaviors of business cycle in a monetary Goodwin model in Chapter 4 (Macroeconomic System Overview) of Yamaguchi (2013). This monetary constraint has been entirely overlooked by economic dynamics researchers of Goodwin Growth Cycle Model (Goodwin, 1967). This one example exemplifies how money is needed to claim that an economic model is rational.

In general equilibrium framework of SMM, an auctioneer of the economy is assumed to quote prices p until equilibrium is attained such that Purchases (p*) = Sales (p*). What Arrow-Debreu model has demonstrated is the existence proof of such equilibrium prices p* in all markets, except money. Once such equilibrium prices p* are attained, all economic agents are allowed to trade at the equilibrium prices *without money*! Hence, money has been considered as a *veil* of real economy. It is now clear that such *moneless* SMM is logically inconsistent as a real economic model.

3. Accounting System Dynamics

Under the co-flow transactions of money and commodity, buyers have to give up their money assets to increase their commodity assets, while sellers have to give up commodity

assets to increase their money assets. In short, commodity transactions with money are always booked as an increase and decrease of assets simultaneously. According to the double-entry bookkeeping rule of accounting, commodity transactions with money as illustrated in Figure 2 can be described as in Table 1.

In this way System Dynamics (SD) approach is integrated with double-entry principles of accounting system. This integrated modeling method is called Accounting System Dynamics (ASD) by Yamaguchi (2003).

Table 1 Journal Entries of Transactions with Money

Buyers		Sellers	
Debit (Assets)	Credit (Assets)	Debit (Assets)	Credit (Assets)
Commodity (+)	Money (-)	Money (+)	Commodity (-)

4. Creation of Debt Money out of Nothing

As discussed above, the root cause of the failures of the SMM (whether neoclassical, Keynesian or monetarist) lies in the failure of properly incorporating roles of money and finance in their models. ASD economic models try to fix this failure with the introduction of money. What is money, then? According to Table 2 (Yamaguchi & Yamaguchi, 2017), money is first of all classified into two categories; public money and debt money.

Table 2: Classification of Money: Public Money vs Debt Money

	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)

Public money has historically been issued by the public sector such as government (legislative or executive branch) and sovereign powers such as king, queen and emperors *at interest-free*. Public money issuers can only obtain seigniorage once at a time of money

issuance. On the other hand, debt money is issued by private banks *at interest*. It consists of legal tender and functional-money. Debt money issued by (private) central banks is called base money which is legal tender, while debt money issued by private banks mainly consists of bank deposits which function as money; that is, functional-money.

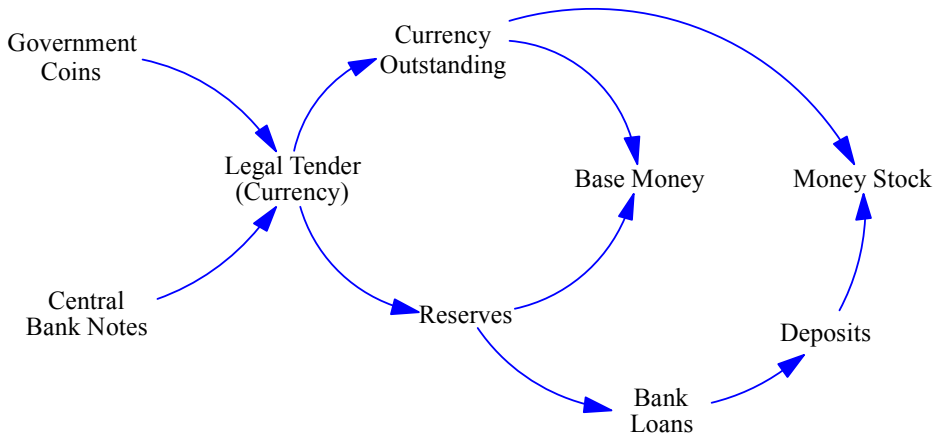
What is legal tender, then? Zarlenga quotes Aristotle's (384-322 BC) articulation on money as follows:

> "It has the name *nomisma* - because *it exists not by nature, but by law (nomos)* and it is in our power to change it and make it useless." (Zarlenga, 2012; emphasis added by the authors)

Following Aristotle, it is plausible to define money as *legal tender* in the sense that people cannot refuse to accept it in exchange for commodity. In other words, money always co-flows as *legal tender* along with commodity inseparably as illustrated in Figure 2.

In order to define money as legal tender, there must be specific laws that stipulate the legal issuance of money. In Japan, for example, the Currency Unit and Money Issuance Act (revised in 1987) and the Bank of Japan Act (revised in 1997) enable both the government and the Bank of Japan to issue coins and banknotes, respectively. Consequently, in Japan, *currency*, consisting of government *coins* and Bank of Japan *notes*, is specifically defined by law as legal tender, such that it cannot be refused as a means of payment; that is why it is alternatively called *fiat money*. Figure 3 illustrates the state of currency (coins and banknotes) as legal tender.

Figure 3 Base Money as Legal Tender

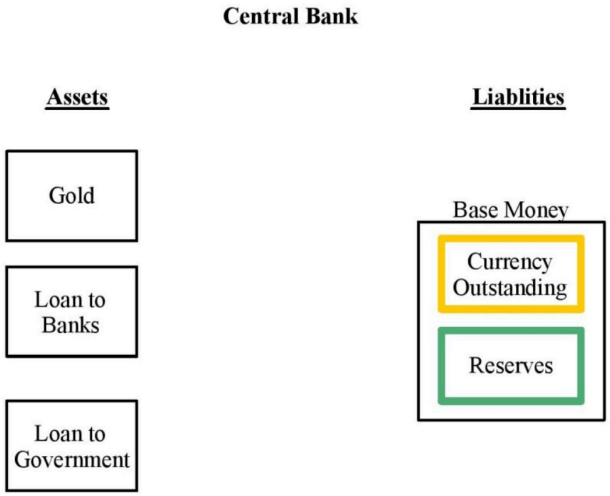


Under the current debt money system, once currency is put into circulation as legal tender, it begins to split into two parts: currency outstanding and reserves with the central bank. The sum of these parts is called *base money*. Hence, base money is by definition legal tender.

Base Money = Currency Outstanding + Reserves (3)

Although central banks are legally allowed to issue base money, it can issue base money only when someone comes to borrow at interest. Those who come to borrow from the central bank are mainly commercial banks and government. Base money is issued against various lending facilities or asset purchases using the double-entry accounting rule. Base money is thus booked as liabilities on the balance sheet of the central bank, and backed by various types of assets, such as gold, discount loans to commercial banks and loans to the government (securities) as illustrated in Figure 4.

Figure 4 Issuance of Base Money Backed by Various Types of Assets



On the other hand, under the debt money system, banks can create deposits *out of nothing* by merely granting loans, collectively, to the non-banking economic sectors. Deposits thus created are used for transaction payments as if they are money as illustrated in Figure 5.

Using double-entry accounting principle, this transaction is booked as in Table 3. Hence, all transactions are booked within the account of assets. Does this mean that deposits, created by banks, become legal tender, similar to money, such that no one can refuse to accept? According to Masaaki Shirakawa, former governor of the Bank of Japan, the answer is negative.

> "Contrary to the central bank notes, creditors can refuse to accept bank deposits as the payments of debt obligations because of credit risks associated with bankruptcies of debtors' banks. However, in normal times, bank deposits *function as money* because of creditors' confidence that bank deposits can be converted to central bank notes." (Shirakawa, 2008; emphasis added by the authors)

Figure 5 Deposits as Functional-Money

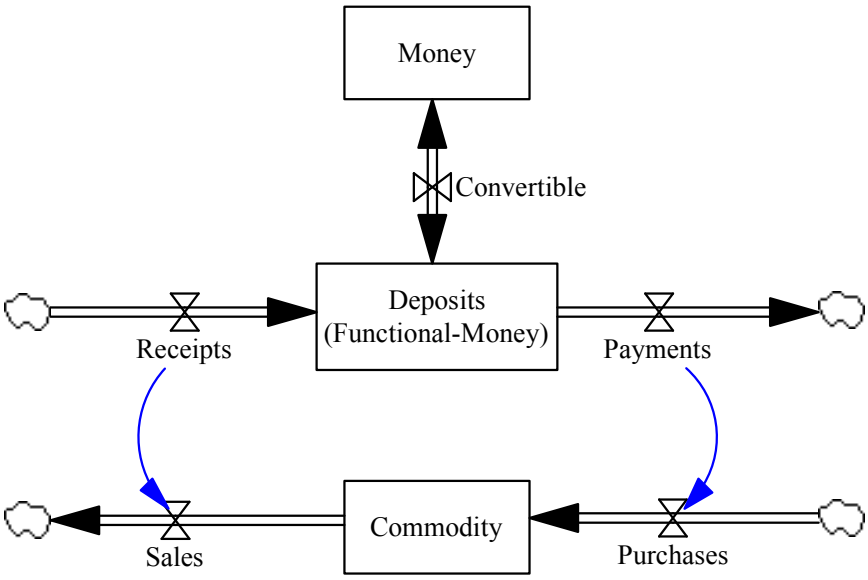


Table 3 Journal Entries of Transaction with Deposits

Buyers		Sellers	
Debit (Assets)	Credit (Assets)	Debit (Assets)	Credit (Assets)
Commodity (+)	Deposits (-)	Deposits (+)	Commodity (-)

What is meant here is that deposits are accepted for commodity transactions in Figure 5 only when their convertibility to money is presumed by their recipients. In this sense, they are not legal tender. Henceforth, we may regard deposits as f*unctional-money,* technically different from legal tender. Based on the assumption that deposits function as money, standard textbooks define another concept of monetary aggregate in addition to *money* as

$$\text{Money Stock} = \text{Currency in Circulation} + \text{Deposits} \tag{4}$$

Money stock thus defined is the total amount of money available in the economy as a medium of exchange for transactions and economic activities.

5. Heads and Tails of Debt Money Creation

Concerning the creation of debt money *out of nothing*, economists have been divided into three groups for a century (Werner, 2015): that is, intermediation of loanable funds (ILF),

fractional reserve banking (FRB) and financing through money creation (FMC). ILF generally forms the basis of theoretical models, where banks are mere intermediaries, just a neutral channel between savers and borrowers, and cannot create any new credit money individually or collectively. In the FRB, although banks are still portrayed as financial intermediaries, money stock can only be expanded by the banking sector as a whole; no individual bank can create "money out of nothing." The FMC view, on the other hand, considers that individual banks create new credit money endogenously.

Yamaguchi & Yamaguchi (2016) re-examined these three groups by applying a simple ASD model and successfully re-classified them into two groups of Flow and Stock approaches.

Flow Approach[2]. This approach is further broken down in two sub-approaches. Examples of *the financial intermediation theory* of banking include some well-kmown economists. They are: Keynes(1936); Gurley and Show (1955); Tobin (1963, 1969); Sealey and Lindley (1977); Balernsperger (1980); Mises(1980); Diamond and Dybvin (1983); Diamond (1984, 1991, 1997); Bernanke and Blinder(1988); Eatwell, Milgate and Newman (1989); Gorton and Pennacchi (1990); Bencivenga and Smith (1991); Bernanke and Gertler (1995); Rajan (1998); Myers and Rajan (1998); Allen and Gale (2004); Allen an Santomero (2001); Diamond and Rajan (2001); Kashyap, Rajan and Stein (2002); Mattews and Thompson (2005); Casu and Girardone (2006); Dewatripont et a. (2010); Gertler and Kiyotaki (2011); Stein (2014); Carney(2014) and Krugman (2015).

Examples of *the fractional reserve theory* of those who argue that banking system creates money through the process of 'multiple-deposit creation' are: Hayek (1929); Samuelson (1948); Gurley and Show (1955); Warren Simith (1955); Gulbertson (1958); Aschheim (1959); Solomon (1959); Paul Smith (1966); Guttentag and Lindsay (1968); Stiglitz(1997).

Stock Approach. Examples of *the credit creation theory* are: Macleod (1856); Wicksell (1989); Withers (1909, 1916); Schumpeter (1912); Cassel (1918); Hahn (1920); Hawtrey (1919); Howe (1915); Gustav Cassel (1923); Macmillan Committee (1931); Fisher (1935); Rochon and Rossi (2003); Werner (2005); Bank of England (2014); Jakob and Kumhof (2015).

It is interesting to observe from these lists of economists that the stock approach disappeared entirely since Irving Fisher (1935) till quite recently as if it has been *a taboo subject* (Adair Turner, p.31, 2013). Yamaguchi & Yamaguchi (2016) have shown that both flow and stock approaches are identical as if they are heads and tails of the same coin, bringing century-long confusions among economists concerning debt money creation to an end. This also indicates the robustness of the ASD modeling method. The reader is further referred to Chapter 5 (Money and Its Creation) of Yamaguchi (2013) for detailed discussions.

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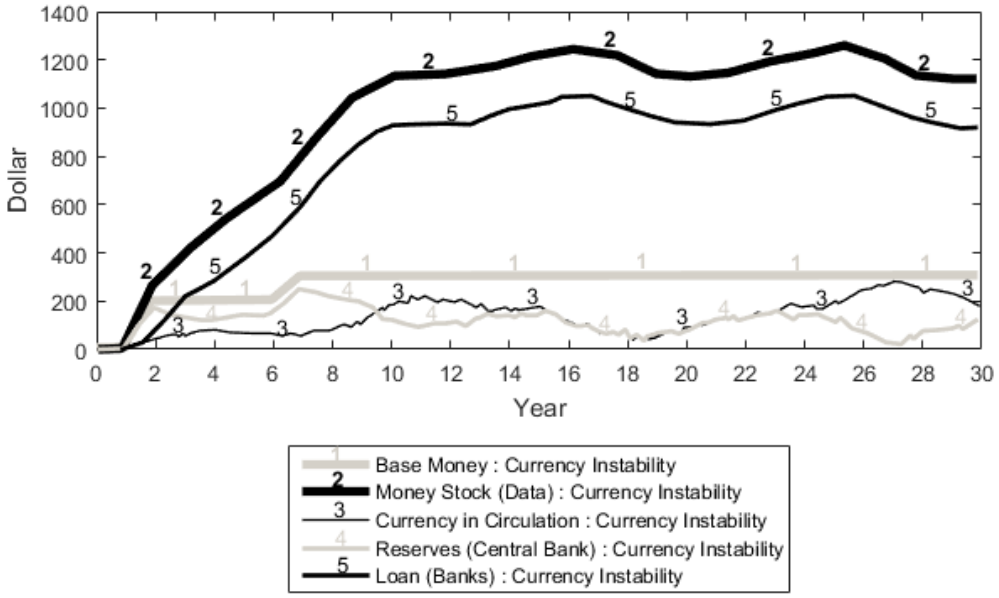
[2] References of these economists quoted here under Flow and Stock approaches are not listed in the references of this paper. Please refer to the original paper of Werner (2015) for detailed references.

6. System Design Failures of Debt Money

Once ASD modeling method is established, it has not been a hard work to construct generic macroeconomic models**,** consisting of five sectors of the economy such as central bank, commercial banks, consumers, producers and government (and foreign sector), as alternative macroeconomic models to SMM, Chapters 7-11 of Yamaguchi (2013). Throughout these model constructions it is demonstrated that the current debt money system is poorly designed such that monetary instability is inescapable, causing booms and busts, economic recessions and unemployment, income inequalities, etc. This is mainly because *money stock* as defined above is endogenously created and destroyed, so that central banks cannot control its amount, contrary to the standard Keynesian view that it can be controlled by central banks through monetary policies such as open market operations.

To demonstrate monetary instability, we have built a simple stock approach model of debt money creation that is equivalent to the above FMC theory of money creation, and obtained the simulation results as in Figure 6 (Yamaguchi & Yamaguchi, 2016).

Figure 6 Stable Base Money and Money Stock Instability



In the figure, base money (line 1) is kept stable, though its composite part of currency in circulation (or outstanding) (line 3) fluctuates cyclically. This stable base money, however, surprisingly yields cyclical fluctuations of money stock (line 2) as well as bank loans (line 5).

The foremost conclusion of this simulation result is evident. Under the debt money system, even stable base money (stable monetary policy) creates unstable money stock. In other words, central banks cannot *wholly* control the amount of money stock. This explains why the quantitative easing (QE) policies recently introduced in Japan, USA and EU

countries have all failed. These policy failures are not caused by misconducts of policy-makers, but by the debt money system itself due to its design failures.

Another example of system design failures is the accumulated national debts of these countries. It is now obvious that debt crises cannot be solved within the current debt money system that has caused them. Hence, we need a new system design of macroeconomy.

7. Public Money System

If airplane crashes occur repeatedly, engineers will try to figure out whether these are caused by human errors or system design failures. When crashes are identified as the fault of system design errors, engineers will be forced to draw new designs for the planes. Thanks to their repeated efforts at re-design, we have now acquired the safest airplane system in human history. In a similar fashion, monetary instabilities discussed above have been identified as system design failures of fractional reserve banking. Faced with the ongoing financial crises and accumulating government debts triggered by the instability of the current debt money system, economists are now, like engineers of airplanes, obliged to re-design our failing monetary and economic system.

Can they re-design it? Part IV (chapters 12 through 16) of Yamaguchi (2013) is devoted to answer the question with the design of *public money system.* It is based on the monetary reform of the Chicago Plan which was proposed in 1930's to attain monetary and financial stabilities as well as debt liquidation of government.

Accordingly, it is worth reviewing its history briefly. The Great Depression in 1929 was the first major economic disaster caused by the system design failures of the debt money.

Faced with these design failures, eight economists at the University of Chicago[3] proposed an alternative system design called "The Chicago Plan for Banking Reform" in 1933. The plan was, then, vehemently carried on by Irving Fisher of Yale University (Fisher, 1935), and a group of five economists[4] under the name "A Program for Monetary reform (Douglas, P. H., *et al.,* 1939)". Their alternative system design was to introduce a required reserve ratio of 100 % for demand deposits. Their monetary reform movement has been further carried on by Zarlenga,

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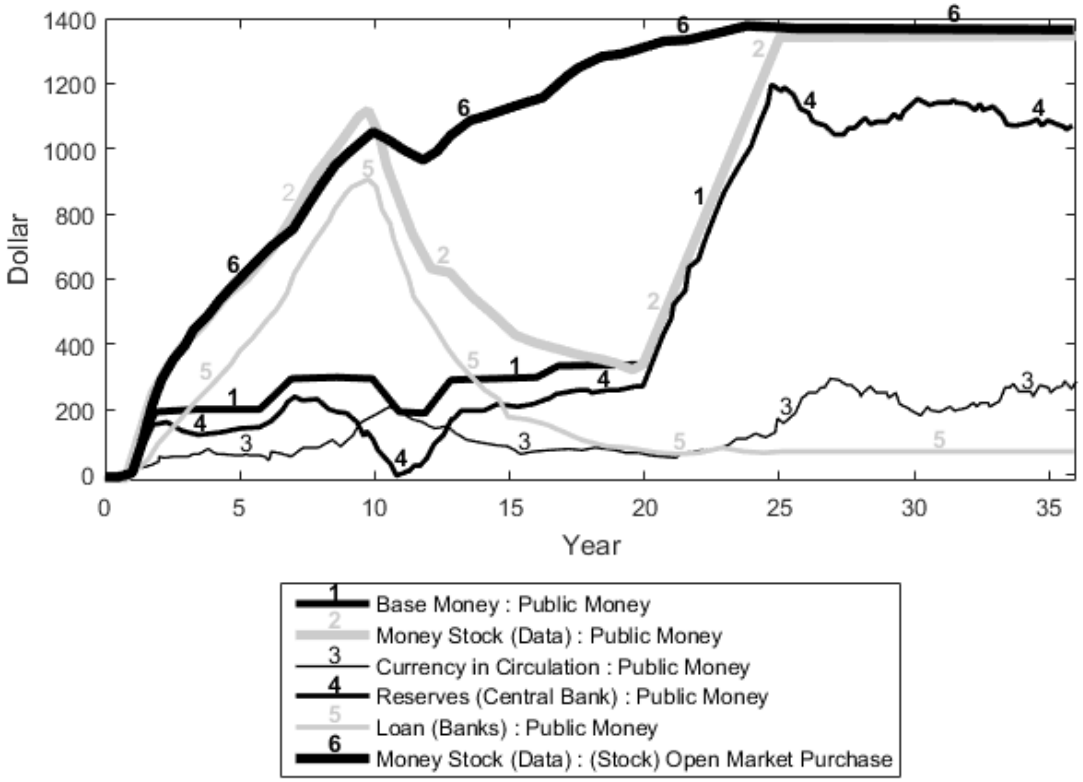
[3] They were: G.V. Cox, Aaron Director, Paul Douglas, A.G. Hart, F.H. Knight, L.W. Mints, Henry Schulz, and H.C. Simons. Their proposal was handed over, through Henry A. Wallace, Secretary of Agriculture, to the President Franklin D. Roosevelt on March 16, 1933. Unfortunately it failed to be implemented. Instead, less restrictive Banking Act of 1933 to bankers, known as Glass-Steagal Act was legalized on June 16, 1933 (Phillips, 1995). The Act was, alas, repealed in 1999 by the president Bill Clinton.

[4] They are Paul H. Douglas, University of Chicago; Frank D. Graham, Princeton University; Earl J. Hamilton, Duke University; Willford I. King, New York University; and Charles R. Whittlesey, Princeton University.

S. (2002) and to our public money system with the ADS macroeconomic models by Yamaguchi (2013).

Figure 7 100 % reserve requirement rule introduced at t=10 and
Public Money Put into Circulation at t=18 for 5 years



Fundamentals of the public money system in a nutshell are the following;

(1) Public money administration under legislative branch of government issues public money,

(2) Required reserve ratio of 100% is attained among all banks, and

(3) Public money is put into circulation constantly to sustain economic growth and welfare.

The simulation results of our ASD model under the public money system are illustrated in Figure 7. Whenever a 100 % reserve ratio is applied to an unstable monetary behaviors of the above Figure 6 at t=10, they get, all of sudden, transformed into the stable ones. More specifically, instability of the money stock under a fractional (not 100%) reserve ratio (line 2) is perfectly subdued by the introduction of the 100 % reserve ratio, so that base money (line 1) becomes identical to money stock (line 2). Theoretically, money stock is shown to become equal to base money under 100% reserve ratio. That is to say, functional-money disappears completely from the circulation and money stock becomes equal to legal tender (that is, base money). Accordingly, monetary stability is completely restored and money stock never gets

affected by loanable behaviors of banks.

Furthermore, to increase the amount of public money in circulation to recover the original level, it is assumed that $200 of public money is newly issued at t=18 for 5 years (lines 1 and 2). In this way, the original level of money stock (line 6) is restored in Figure 7. If more money stock is needed for sustaining economic growth and welfare, public money will be further put into circulation.

8. Banks as Genuine Intermediaries

Under the public money system, banks can no longer create money by making loans at interest. Banks are obliged to make loans with the existing money at hand and share their investment risks with borrowers. To be more specific, banks under the public money system become genuine intermediaries in the following sense.

First, banks would be obliged to hold full amount of customers' deposits. In consequence, the non-banking economic sectors can safely use their deposits anytime as legal tender for their transactions and economic activities. On the other hand, depositors have to pay service charges to the banks in exchange for these transaction services, like the present-day ATM service charges. These service charges in turn become a stable source of earned income for banks. In this way, robust and stable banking and financial management will be established.

Second, as by-product, banks no longer need to borrow or lend in the inter-bank money market. The inter-bank interest rate for borrowing or lending excess reserves will no longer be applicable to one another.

Third, loanable funds for banks come from three sources: their own capital, repaid loans, and time deposits. Among these, time deposits will be a main source of loanable funds. Time deposits are nothing but the surplus deposits that are not needed for daily and short-term transactions, so that they are saved to the time deposits account. Accordingly, banks become efficient by offering higher interest rates for saving and lower interest for loans. Bubbles and bursts created by debt money out of nothing can no longer occur, and existing financial markets are constrained to real zero-sum games; that is, losers and winners coexist. This implies that existing financial bonds and securities are no longer attractive to the banks as a whole. And loanable funds tend to be invested in real economy from which positive interest revenues are obtained for banks as a whole, so long as the economy continues to grow.

In this way interest rates are competitively determined in the public money market, according to the available amount of saving and investment in the economy. They are no longer the instruments of monetary policies by central banks. Interest revenues thus obtained through arbitrage or spread of lending and borrowing truly become banks' earned income for their efforts in providing investment banking services. Interest revenues, in this sense, are no longer unearned income out of nothing.

It is true that investment, whether real or financial, has been a risky economic activity throughout history. Accordingly, to avoid investment risks, earned interest income (or losses) by banks from investment must be shared among banks, time deposits savers and borrower-investors under the public money system.

Islamic finance has been based on interest -free banking, and profits generated by means of loans have been shared with all creditors or stakeholders. In consequence, risk-sharing system under the public money system as explained above turns out to be very similar to the one that has been historically practiced as "participatory banking" system under Islamic banking and finace.[5] In Japan, a similar "mutual social financing" system known as Tanomoshi-kou has been practiced since the 12th century. These risk-sharing managerial practices might have evolved into the modern cooperative banking in countries such as Germany, Japan and USA.

In sum, banking and financial practices under the public money system discussed above turn out to be perfectly compatible with Islamic finance and cooperative banking.

9. ASD Macroeconomic Modeling in Action

Currently we are developing ASD macroeconomic model of Japan based on the Flow of Funds by the Bank of Japan and the System of National Accounts (SNA) by the Government (Yamaguchi & Yamaguchi, 2015) as well as in Turkey. These would be the first macroeconomic models, when completed, that combine the flow of fund and Keynesian macroeconomic data. They could also incorporate some features of the SMM as well. It is our hope that these ASD macroeconomic models will be our next standard macroeconomic models not only as alternatives to SMM but as integrated ones with SMM. The reader will be encouraged to construct the ASD model of his or her economy.

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[5] For instance, see the report: Participation Banks 2016 by TKBB (Participation Banks Association of Turkey), established in 2002.

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