The Endogenous Money ASD Model of the Debt Money System (Part II)
– Loanable Funds vs. Endogenous Money –

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Abstract

In Part II we expand the endogenous money IS-LM model presented in Part I into more comprehensive models by incorporating budget equations based on the Accounting System Dynamics (ASD) approach. The first model is called *Loanable Funds ASD* in which money stock is exogenously supplied by the central bank, and banks play a role as intermediaries of existing funds as savings. The second model is called *Endogenous Money ASD* in which a central bank issues base money and private banks finance loans by creating new deposits when government, households and producers borrow money. Our simulations confirm that the first model fails to support the Keynesian view that aggregate demand creates its supply. The second model, on the other hand, is shown to support the view that aggregate demand creates its supply. The endogenous money ASD model successfully reproduces dynamics of the Great Depression as obtained by Part I model, as well as the case of Japan's lost 30 years, which was previously unexplained. As a result of the structural expansion, the second model also produces the money-debt relationship as well as its decomposition observed in the U.S. and Japan where government debts approximate M_1, and total debts held by non-banking private sectors approximate time deposits, respectively. At this stage of research we are convinced that the Keynesian theory grounded on exogenous money is no longer valid under the current *debt money system*. It is applicable and effective only under the *public money system* where money stock is controlled by the monetary authority. The endogenous money must be at the center of macroeconomics. All textbooks that apply standard IS-LM analysis must be rewritten accordingly. The ASD model presented in Part II provides the framework for theoretical and applied case studies.

Keywords: endogenous money, loanable funds, accounting system dynamics, ex ante and ex post incomes, fractional reserve banking, Japan's lost 30 years

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Introduction

We have shown in Part I (Yamaguchi and Yamaguchi, 2022) that the standard short-run IS-LM model, which is arguably the most popular model featuring in standard macroeconomics textbooks including Mankiw (2016), failed to explain the behaviors of the Great Depression due to its flawed assumptions that money is exogenously given and that price level is fixed. As discussed in Part I, the exogenous money assumption is a fatal flaw as a macroeconomic model since it is both empirically and theoretically unfounded (Yamaguchi, 2021; Yamaguchi and Yamaguchi, 2021a). To correct this, we constructed a system dynamics (SD) model of the IS-LM analysis in Part I and found that the extended model, with flexible price and endogenous money newly incorporated, captures the unexplained behaviors of key macroeconomic variables observed in the United States during the Great Depression. Specifically we proposed the alternative *endogenous money spending hypothesis* where it is assumed that the decline in spending (aggregate demand) and contractions in money stock occurs simultaneously. The structural and behavioral assumptions employed in the revised IS-LM model was that money is created endogenously against debts (bank loans) along with economic activities; that is, money stock M^s is a function of transactions T in terms of the quantity equation proposed by Fisher (1920). For this purpose, we took a simple mechanistic approach where money stock is created or destroyed proportionately according to the growth rate of income, and called this alternative model the endogenous money IS-LM model in Part I as summarized in Table 1 below.

	(Main Features)	Exogenous Debt Money (flawed)	Endogenous Debt Money (valid)
Part I	Fixed Price	Case 1 Keynesian IS-LM (SD)	Case 3 Endogenous Money IS-LM (SD)
	Flexible Price	Case 2 Flexible Price IS-LM (SD).	Case 4 Endogenous Money IS-LM (SD)
Part II	Sectoral Budget Equations	Case 5 Loanable Funds (ASD)	Case 6 Endogenous Money (ASD)

Table 1: Classification of SD and ASD Macroeconomic Models (Part I & II)

The model worked well in that it can capture the Great Depression, and seemed to provide a general theory of economic recessions. Yet we have also identified its limitations. Specifically the model cannot explain the case of Japan's decades-long stagnation since the burst of financial bubble in the mid 1990s. The Japan's prolonged recession, often called *the lost 30 years*, is characterized by the stagnation of aggregate demand and ineffectiveness of monetary and fiscal policies, which, according to the conventional IS-LM analysis, would have brought the economy back into a new (comparative static) equilibrium point with a higher level of income either by fiscal or monetary policy alone, or through the combination of the two as the policy mix. The series of deficit spendings by the government and unconventional monetary policy known as the Quantitative Easing (QE) introduced by the Bank of Japan, however, have been largely ineffective contrary to what the conventional IS-LM model would have predicted. As a result of the policy failures, Japan's M_3 continues to grow while the economy remains stagnant. The Japanese government is increasing its debt at an exponential rate and the economy is now facing debt crisis. The revised IS-LM model in Part I failed to capture this peculiar case of policy resistance observed in Japan, which we illustrated as the point "J" in Figure 18 of Part I paper. These observations suggest the endogenous money IS-LM model developed in Part I is simplistic and needs further revision so that it can capture borrowing and lending of money among domestic macroeconomic sectors; that is, incorporating budget equations instead of the simple mechanistic approach employed in Part I. This is the main purpose of Part II.

1 The Flexible Price IS-LM Model Revisited

To make our description of SD-based macroeconomic modeling complete, let us start by briefly revisit the endogenous money IS-LM model with flexible price presented in Part I. The Keynesian short-run IS-LM model under flexible price assumptions is described as follows:

$$
\begin{aligned}
Y &= AD && \text{(Aggregate Demand Equilibrium)} && (1)\\
AD &= C + I + G && \text{(Aggregate Demand)} && (2)\\
C &= C_0 + cY_d && \text{(Consumption Decisions)} && (3)\\
Y_d &= Y - T && \text{(Disposable Income)} && (4)\\
T &= T_0 + tY - T_r && \text{(Tax Revenues)} && (5)\\
I &= \frac{I_0}{r} - \alpha r && \text{(Investment Decisions)} && (6)\\
G &= \bar{G} && \text{(Government Expenditures)} && (7)\\
\frac{M^s}{P}V &= L^d && \text{(Equilibrium of Money)} && (8)\\
L^d &= aY - bi && \text{(Demand for Money)} && (9)\\
r &= i - \pi^e && \text{(Fisher Equation)} && (10)
\end{aligned}
$$

The model consists of 10 equations with 10 unknowns;

$$Y, AD, C, I, G, Y_d, T, r, i, L^d$$

with 14 exogenously determined parameters;

$$C_0, c, T_0, t, T_r, I_0, \bar{G}, M^s, P, V, \alpha, a, b, \pi^e.$$

L^d stands for liquidity demand based on the liquidity preference theory, and π^e denotes expected inflation rate based on the Fisher Equation. In this IS-LM model, all variables are expressed with real units, except money stock M^s which has nominal unit. Investment is here assumed to be determined by (*ex ante*) real interest rate r in equation (6), while demand for money is determined by nominal interest rate i in equation (9). Real interest rate r is determined by the expected inflation rate π^e in the Fisher equation (10). Capital accumulation ($\frac{dK}{dt}$) is excluded from this IS-LM model so that capital depreciation (δK) is also removed from the equation (4).[1]

2 Loanable Funds Model with Budgets

The Keynesian flexible price IS-LM model presented above is not complete in the sense that it lacks the analysis of budget equations, *i.e.*, the borrowing and lending of money, and debts.

[1] When capital accumulation is considered, which will be incorporated in our next paper (Part III) of this series, this Keynesian model needs to be revised as follows (where δ denotes a depreciation rate):

$$
\begin{aligned}
Y_d &= Y - T - \delta K\\
\frac{dK}{dt} &= I - \delta K
\end{aligned}
$$

As a result, in our extended IS-LM model in Part I, endogenous money is incorporated in a mechanistic way along with the growth rate of income. Consequently, the model is shown to have a limitation as pointed out above. For instance, it failed to present endogenous money creation by the government spending and debt accumulation simultaneously as its consequence.

With these analytical limitations in mind, we now start with the construction of a complete IS-LM model with budget equations of macroeconomic sectors. Yet, at this stage of the current paper, we hold the mainstream Keynesian assumption again that money is exogenously given, and that banks only play a role as pure financial intermediaries of existing funds between savers and borrowers. That is to say, savings (time deposits) are considered as the source of loanable funds for banks to make loans. Let us call this model *Loanable Funds Model*, and examine its workings analytically in this section first. Then, we will construct the *Endogenous Money Model* by applying the Accounting System Dynamics (ASD) method in the next section.[2]

Budget Equation of Households

Let us begin with the budget equation of households. Their money income consists of distributed incomes of wages and profits (as dividends) $(W + \Pi)$ paid by producers in nominal unit, and borrowings from banks (ΔD_H) for housing investments. With these income revenues, households spend on consumption, pay taxes to the government, and purchase houses (I_H). The remaining income after these expenditures are saved with banks as savings (S). Hence, their budget equation becomes as follows:

$$PC + PT + PI_H + S = W + \Pi + \Delta D_H \quad \text{(Households Budget)} \tag{11}$$

$$W + \Pi = PY \quad \text{(Distributed Income)} \tag{12}$$

$$PI_H = \Delta D_H \quad \text{(Housing Budgets)} \tag{13}$$

$$I_H = \bar{I}_H \quad \text{(Housing Investment)} \tag{14}$$

where housing investment is assumed to be made by the given amount of $\bar{I}_H$ for simplicity, and paid with the borrowings from banks.

Budget Equation of Producers

Producers' income comes from the sales of outputs (Y), which is assumed to be fully distributed among workers as wages (W) and their owners (shareholders) as profits (dividends) (Π). In other words, producers retain no earnings. Accordingly they are obliged to raise funds to make new investment (I_P). For simplicity it is assumed that they borrow all of the funds for their investment from banks (ΔD_P). Hence, their budget equation becomes as follows:

$$W + \Pi + PI_P = PY + \Delta D_P \quad \text{(Producers Budget)} \tag{15}$$

$$I_H + I_P = I \quad \text{(Total Private Investment)} \tag{16}$$

where total investment in the economy consists of housing investment and corporate investment made by producers.

[2] In this sense Part II is following the same analytical steps as employed in Part I; that is, building exogenous and endogenous money IS-LM models (with budget equations in Part II) and compare the workings of the two models. Part I examined four cases in total: fixed price & exogenous money (case 1), flexible price & exogenous money (case 2), fixed price & endogenous money (case 3), and flexible price & endogenous money (case 4).

Budget Equation of the Government

Government's revenues consist of taxes (T) and borrowings by issuing bonds (ΔD_G) in case government expenditures (G) exceeds tax revenues. For simplicity, we assume that government borrows directly from banks, instead of issuing and selling bonds to the banks. Hence, the budget equation of the government becomes as follows:

$$PG \quad = \quad PT + \Delta D_G \qquad \text{(Government Budget)} \tag{17}$$

Budget Equation of Banks

Banks accept savings deposits from households, and make loans out of the savings deposits received from households (called loanable funds ΔLF). In this sense, banks here are assumed to merely act as a *pure* financial intermediaries as the mainstream economics often assumes. Hence, their budget equation becomes as follows:

$$\Delta LF \quad = \quad S \qquad \text{(Banks Budget)} \tag{18}$$

A Complete Loanable Funds Model

Now the construction of loanable funds IS-LM model with budget equations is complete. In addition to the flexible price IS-LM model consisting of 10 equations (1) through (10), 8 equations (11) through (18) have now been added. Accordingly, 8 additional unknown variables that correspond to these 8 equations are identified as follows:

$$S, I_H, W + \Pi, I_P, \Delta D_H, \Delta D_P, \Delta D_G, \Delta LF \ ^{3}$$

with one additional exogenous parameter: $\bar{I}_H$

More comprehensively, Keynesian loanable funds model presented here consists of 18 equations in total; (1) through (10) and (11) through (18), with 18 unknown variables and 15 parameters (consisting of the previous 14 parameters and the additional parameter $\bar{I}_H$). Money stock M^s is here assumed to be exogenously determined and price level is fixed by default as well. Hence, the loanable funds model does not change the overall analytical framework of the flexible price IS-LM model presented in Part I by itself.

Loanable Funds Equilibrium

To examine the workings of this loanable funds model, let us now obtain the so-called Walras Law, which is calculated from the budget equations (11) through (18) as follows:

$$P(C + I + G - Y) + \Delta LF - (\Delta D_H + \Delta D_P + \Delta D_G) \equiv 0 \quad \text{(Walras Law)} \tag{19}$$

This Walras law holds true under any situations, and that is why it is presented as identity ($\equiv$). Since the Keynesian aggregate demand equilibrium of real economic sector is assumed as the equation (1), the equilibrium of the following *loanable funds* is simultaneously attained:

$$\Delta D_H + \Delta D_P + \Delta D_G = \Delta LF \qquad \text{(Loanable Funds Equilibrium)} \tag{20}$$

[3] Distributed income of wages and profits ($W + \Pi$) is to be determined by producers' output (PY) and treated as an unknown variable.

This indicates that banks must make loans to households, producers and the government out of their loanable funds deposited or "saved" by the households. Since the total amount of money stock M^s is given by the central bank as a exogenous parameter under the loanable funds model, banks' lending behavior is always constrained by the available amount of the loanable funds. In other words, banks are simply financial intermediaries that collect excess funds from savers (households) and redistribute to borrowers, that is, households, producers, and the government. Hence, there is no extra room for deposit (credit) creation under this loanable funds model. This has been the doctrine of exogenous money theory that has dominated the Keynesian macroeconomics for over 80 years as discussed in Part I.

From the Walras law, if the equilibrium of the loanable funds (20) is assumed first, the aggregate demand equilibrium in equation (1) is also simultaneously attained. Which assumption of the equilibrium should be made as the appropriate model of loanable funds, then? Aggregate demand equilibrium or loanable funds equilibrium?

Since households, producers and government cannot start their economic activities without enough funds at hand, their borrowings have to come first. This means the equation of the loanable funds (20) must be met first. Then, the aggregate demand equilibrium is simultaneously attained to be equal to GDP. In this way, from the macroeconomic point of view, it would be more appropriate to assume the loanable funds equilibrium in the model first such that

$$(\Delta D_H + \Delta D_P + \Delta D_G = \Delta LF) \Longrightarrow (C + I + G = Y) \tag{21}$$

Hence, the loanable funds model must be formally presented by replacing the aggregate demand equilibrium (1) in the Keynesian short-run IS-LM model with the loanable funds equilibrium (20). That is, the loanable funds model now consists of 18 equations, from (2) through (10), (11) through (18) and (20), with the same 18 unknowns and 15 parameters.

Savings in the loanable funds model are fully utilized as follows:

$$S \Rightarrow \Delta LF \Rightarrow PI_H + PI_P + \Delta D_G = PI + \Delta D_G \tag{22}$$

That is, savings made by households become the sources of investment by households and producers, and government debts.

Model Anatomy with *Ex Ante* and *Ex Post* Incomes

At its analytical framework, the loanable funds model developed here is the same as the Keynesian IS-LM model presented in Part I. We have already shown in Part I that the conventional IS-LM model, even under the flexible price assumption (which we called the extended analysis in part I), failed to explain economic behaviors such as the Great Depression and Japan's lost 30 years, and discussed the reason why. The standard IS-LM analysis incorrectly assumed the exogenous money under the current debt money system. Can we similarly argue that the loanable funds model is flawed, then?

Let us examine the validity of the model by introducing the concepts of *ex ante* and *ex post* discussed by Keen (2014). The term *ex ante* is used here as a previous period in which income is distributed as wages and profits such as last month, last quarter or last year, while *ex post* as its next period such as this month, this quarter or this year.[4] Keynesian theory asserts that *ex post* aggregate demand determines *ex post* income. Yet, the loanable funds model leads us to the opposite result; that is, *ex ante* income determines *ex post* aggregate demand.

[4]To avoid confusion, it should be noted here that the terms *ex ante* and *ex post* here are used in a different way as we did in Part I to distinguish the *ex ante* and *ex post* real interest rates.

To examine this reasoning, let us now interpret aggregate demand $AD = I + C + G$ as *ex post* demand, and income Y as *ex ante* income $\underline{\text{Y}}$ in the model. This makes sense because *ex ante* income realized by producers is assumed to be distributed as wages and profits. For the economy to grow, then, we need to assume that

$$C + I + G > \underline{\text{Y}} \qquad (Ex\ post\ AD\ >\ Ex\ ante\ \underline{\text{Y}}) \tag{23}$$

From the Walras law (19), we have

$$C + I + G > \underline{\text{Y}} \iff \Delta\underline{\text{LF}} < \Delta D_H + \Delta D_P + \Delta D_G \tag{24}$$

where $\Delta\underline{\text{LF}}$ implies *ex ante* loanable funds saved by households as deposits with banks. This is because loanable funds of banks are constrained by the *ex ante* savings from their own budget constraint (18). Hence, *ex ante* loanable funds equilibrium (20) must be applied all the time under the exogenous debt money. Accordingly, from the Walras law we must have

$$C + I + G = \underline{\text{Y}} \qquad (Ex\ post\ AD\ =\ Ex\ ante\ \underline{\text{Y}}). \tag{25}$$

In this way, loanable funds model is destined such that *ex post* aggregate demand (or income) is always determined or constrained by the *ex ante* income.

In order for the *ex post* aggregate demand to determine the *ex post* income Y, as the Keynesian theory asserts under the exogenous debt money, the additional amount of money ΔM^E must be put into circulation *exogenously* such that

$$\Delta M^E = \Delta D_H + \Delta D_P + \Delta D_G - \Delta\underline{\text{LF}} \tag{26}$$

Then, in order for the Walras law to hold, we must have

$$C + I + G = \underline{\text{Y}} + \Delta M^E \iff \Delta\underline{\text{LF}} + \Delta M^E = \Delta D_H + \Delta D_P + \Delta D_G \tag{27}$$

Keen (2014, p.284) attained a similar assertion such that "*ex post* expenditure equal *ex ante* income, plus the velocity of money multiplied by the*ex post* change in debt", which is equal to ΔM^E defined in equation (26).

In order to claim that *ex post* aggregate demand determines *ex post* income, therefore, the loanable funds model must have a built-in mechanism to put ΔM^E into circulation automatically (unless accompanied by a corresponding increase in the velocity of money). Only under such circumstance, we have:

$$C + I + G\ (=\ ex\ post\ \text{AD}) \Longrightarrow\ \underline{\text{Y}} + \Delta M^E = Y\ (=\ ex\ post\ \text{Income}) \tag{28}$$

The loanable funds model, however, lacks this mechanism of additional money injection. This is why the model failed to explain the Great Depression as discussed in Part I. That is, the flawed assumption of exogenous money discussed in Part I is the same as that of the loanable funds discussed here. This failure can only be fixed when the flawed assumption of loanable funds model is replaced with the endogenous debt money, as we discussed similarly in Part I. We will now address this in the next section.

Remarks: It should be noted that the loanable funds model itself is not flawed under certain conditions. For instance, the 100% reserve banking system advocated by the Chicago school economists and Irving Fisher and the public money system proposed by (Yamaguchi, 2013, Part V), are the examples of macroeconomic systems where money stock is exogenously adjusted by the monetary authority. Under such systems, the balance between *ex post* and *ex ante* incomes are constantly adjusted through monetary policy to sustain a stable economic growth under

price stability.[5] Hence, aggregate demand can be said to determine *ex post* income even by the loanable funds model under the public money system. Application of the loanable funds model is claimed to be flawed only under the present *debt money* system, not under the exogenous *public money* system.

3 Endogenous Money Model with Budgets

The loanable funds model presented above is destined to fail, in a similar way as the conventional IS-LM model did in Part I, to explain the Great Depression and Japan's lost 30 years, as well as to depict properly the effects of Keynesian fiscal and monetary policies due to the flawed assumption that money stock is exogenously given. Now we are in a position to formally present a paradigm shift of IS-LM model with endogenous debt money. Our target is to change the *exogenous* money stock into the *endogenous* money stock with budget equations.

Endogenous Budget of Banks

So far, banks are assumed to act as intermediaries by accepting savings deposits from households and making loans out of those savings (called loanable funds ΔLF). In the world of fractional reserve banking system, their loanable funds are not constrained by savings as banks can create new deposits to finance loans. Deposits thus created are the increment of money stock (ΔM^s), because they are used for payments as *functional money*.[6] Let us continue to use the same terminology of the loanable funds (ΔLF), to describe the sources of making loans by banks. Then, budget equation of the banks (18) is now replaced with the following:

$$\Delta LF \quad = \quad \Delta M^s \qquad \text{(Endogenous Deposit Creation)} \tag{29}$$

In other words, the total amount of deposit creation constitutes, at a macro-level, the over-arching budget constraint on the domestic sector's loan demands (excluding any incoming cross-border bank loans denominated in foreign currencies).

Consequently money stock M^s is now endogenously obtained by the following:

$$M^s = \int \Delta M^s dt \qquad \text{(Endogenous Money Stock)} \tag{30}$$

We have now added two more unknowns to the loanable funds IS-LM model: ΔM^s and M^s for one additional equation (30). Hence, we need one more equation to complete the model. For this purpose, we bring back the aggregate demand equilibrium (1), which has been removed in the loanable funds IS-LM as a redundant equation from the Walras law. Under the endogenous debt money system, it is no longer redundant because the revised Walras law now becomes

$$P(C + I + G - Y) + \Delta LF - (\Delta D_H + \Delta D_F + \Delta D_G) + S - \Delta M^s \equiv 0 \text{ (WalrasLaw)} \tag{31}$$

Due to the additional equation of savings and increment of money stock ($S - \Delta M^s$), the aggregate demand equilibrium (1) and loanable funds equilibrium (20) can now coexist. Under

[5] For the separation of powers, Yamaguchi (2012, 2014, 2015) proposes that public money policy should be implemented by the Public Money Administration (PMA), established as an independent committee under the direct supervision of the legislature such as the Congress in U.S., the parliament in UK, and the Diet in Japan. This governance mechanism ensures the PMA is isolated from daily political pressures by other branches of government in fulfilling the price stability objective as the sole issuer of interest-free currency. See Yamaguchi (2010, 2011, 2013) further for ASD-based simulation studies on the topic.

[6] See Yamaguchi (2013, Chapters 5, 6 and 7) further for the definition of public money, debt money and functional money, and Yamaguchi and Yamaguchi (2021b) for their classification in the Japanese economy.

the loanable funds model, this additional equation of savings and money stock was missing. As a result, either the aggregate demand equilibrium or loanable funds equilibrium had to be made redundant.

Endogenous Money Model

The further revised IS-LM model is now complete, in which money stock M^s is made to be endogenously created. Let us call this revised model *Endogenous Money Model with Budgets*, which is hereafter called *endogenous money* model in comparison with the *loanable funds* model. The endogenous money model consists of the following 20 equations; (1) through (10), (11) through (17), (20), (29) and (30) with 20 unknowns:

$$Y, AD, C, I, G, Y_d, T, r, i, L^d, S, I_H, W + \Pi, I_P, \Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, \Delta M^s, M^s$$

and 14 exogenously determined parameters:

$$C_0,\ c,\ T_0,\ t,\ T_r,\ I_0,\ \bar{G},\ P,\ V,\ \alpha,\ a,\ b,\ \pi^e,\ \bar{I}_H.$$

Model Feature 1: Money Stock = Total Debts

We know, both theoretically and empirically, that total money stock is approximated by the total debts from banks held by non-banking private sectors (*i.e.* households and producers) and the government.[7] Let us denote these debts by D_H, D_P, D_G, respectively. Then, these debts (stocks) can be obtained by integrating their flow amounts of $\Delta D_H, \Delta D_P, \Delta D_G$ such that

$$D_H = \int \Delta D_H dt \qquad \text{(Debts of Households)} \tag{32}$$

$$D_P = \int \Delta D_P dt \qquad \text{(Debts of Producers)} \tag{33}$$

$$D_G = \int \Delta D_G dt \qquad \text{(Debts of Government)} \tag{34}$$

Thus, from the equations (20), (29) and (30), we obtain the following:

$$M^s = \int \Delta LF = \int (\Delta D_H + \Delta D_P + \Delta D_G) dt = D_H + D_P + D_G \tag{35}$$

Accordingly, we have shown that money stock M^s is to be endogenously determined, and equals to the total debts held by households, producers and government under the endogenous money model.[8] In the case of discrete formula, equations (32) $\sim$ (34) can be replaced with

$$D_{H_t} = D_{H_{t-1}} + \Delta D_{H_t} \tag{36}$$

$$D_{F_t} = D_{F_{t-1}} + \Delta D_{F_t} \tag{37}$$

$$D_{G_t} = D_{G_{t-1}} + \Delta D_{G_t} \tag{38}$$

[7] Yamaguchi and Yamaguchi (2021a,b) first observed the money-debt relationship in the case of Japanese Yen (JPY) during a period between 1980-2019. Following the JPY case, Yamaguchi (2021) examined the money-debt relationship in the United States Dollar (USD) and found that total debts from banks approximate M_2 between 1945-2020. As a reference Yamaguchi (2021, p.16, figure 9) reports that the correlation coefficient between total debts and M_2 of the U.S. is 0.998 during 1945-2020 and 0.996 during 1980-2020. The money-debt relationship in the USD case was more precisely observed than it did in the JPY case where the correlation coefficient between total debts and M_3 is 0.987 during 1980-2019. Furthermore, the correlation coefficient between total debts and nominal GDP of the U.S. was 0.987 during 1945-2020 and 0.978 during 1980-2020.

[8] Public money such as coins issued by the government only constitutes 0.3% of M_3 in Japan, and negligible in terms of the circulating amount. Thus they are omitted from this endogenous money model.

where initial stock amounts are given as follows:

$$D_{H_{t-1}} = \bar{D}_H,\ D_{F_{t-1}} = \bar{D}_F,\ D_{G_{t-1}} = \bar{D}_G.$$

This is a more formal statement of the paradigm shift discussed in Part I; *LM* curve is no longer independent of *IS* curve. Both *IS* and *LM* curves are closely linked with one another and must move jointly. Flow amounts of money stock such as $\Delta D_H, \Delta D_P, \Delta D_G$ have to be borrowed from banks. Hence, we now need to consider their budget equations more precisely.

Model Feature 2: Increased Money Stock Ends up with Savings

Let us continue to examine the endogenous money model in more detail. At the equilibrium, we have, from the revised Walras law (31):

$$S = \Delta M^s \qquad \text{(Savings as Monetary Increase)} \tag{39}$$

That is, savings are equal to the increased amount of money stock. How should we interpret this relation? When aggregate demand determines (*ex post*) GDP as the Keynesian theory presumes, loanable funds by banks must be first made available to meet the demand for the total flow amounts of debts, which in turn increase money stock ΔM^s. In this way the loanable funds are indeed created endogenously by banks as follows:

$$\Delta D_H + \Delta D_P + \Delta D_G \Rightarrow \Delta LF \Rightarrow \Delta M^s \tag{40}$$

On the other hand, at the equilibrium, aggregate demand determines (*ex post*) GDP such that

$$C + I_H + I_P + G \Rightarrow Y \tag{41}$$

Accordingly, from the Walras law (31) we must have:

$$\Delta M^s \Rightarrow S \tag{42}$$

What does this mean? In the loanable funds and endogenous money models, we have assumed that households receive all distributed income of wages and profits ($W + \Pi$). Hence, savings S are defined in equation (11) as the balance between income and expenditure by households and include all kinds of savings made by them. Specifically, those savings are first made as demand deposits, which are then transferred further into time deposits as a leakage from circulation or withdrawn back to demand deposits as re-flows into the monetary circulation as Figure 1 below (next page) illustrates.[9]

Yamaguchi and Yamaguchi (2021b) analyzed the composition of the money-debt relationship in Japan and found that time deposits are approximated by total debts held by non-banking private sectors (such as households and producers), while M_1 is approximated by the government debts in Japan. The similar relationships were observed in the U.S. by Yamaguchi (2021) (the case in Japan is shown in Figure 21 below). From equations (40) and (42), we could say that debts by households and producers $\Delta D_H + \Delta D_P$ end up with time deposits, and debts

[9] Adopted from Yamaguchi (2021, figure 1). Under the current fractional reserve system, national governments issue coins indicated by the green box. Government coins are issued and circulated as interest-free stable currencies (*public money*). The rest is all *debt money*. Central banks issue reserve deposits shown at the bottom left corner through the direct lending facility and purchases of financial assets in open market operations. Total money stock are defined as M_2 in most economies. Some central banks, however, define M_3, such as in Japan, to differentiate time deposits held by different depository institutions (banks, postal savings, etc.)

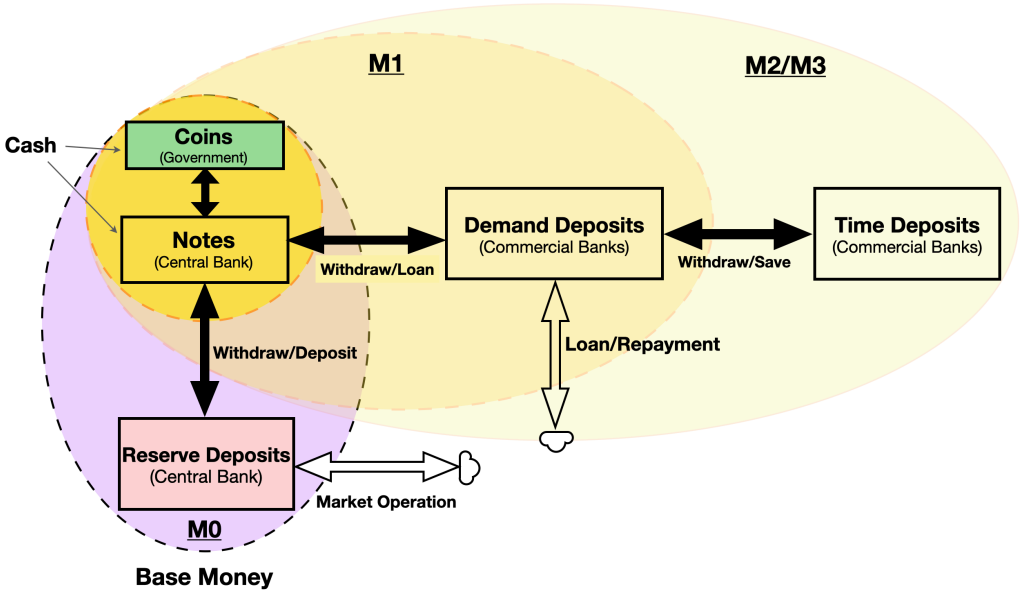

Figure 1: Components of Monetary Aggregates (M_{0-3}) under the Debt Money Systems

incurred by the government ΔD_G end up with demand deposits (which amounts to 86.5% of Japan's M_1 as of the end of 2018) as follows:

$$\Delta M^s \Rightarrow S \Rightarrow \begin{cases} \Delta D_H + \Delta D_P \Rightarrow \text{Time Deposits} \\ \Delta D_G \qquad\quad \Rightarrow \text{Demand Deposits} \end{cases} \tag{43}$$

This implies that deposit money newly created by banks under the debt money system ends up with savings, which are further broken down into demand (checkable) and time (savings) deposits. In the loanable funds model, savings become the source of loans (and investment). In the endogenous money model, savings become the final leakages of endogenously created money from circulation, which will accumulate as demand and time deposits. This provides a theoretical foundation of our empirical findings in JPY and USD cases as Figure 1 illustrates.

Summary: Against the mainstream macroeconomic theory, which claims that savings determines investment, we have observed completely opposite macroeconomic behaviors; debts determines investment, which then ends up as savings. When aggregate demand (AD) exceeds *ex ante* income $\underline{\text{Y}}$, two different macroeconomic behaviors take place under the two different assumptions of loanable funds (exogenous money) and endogenous *debt money* systems:

$$AD > \underline{\text{Y}} \quad \Rightarrow \quad \Delta LF = \underline{\text{S}} \quad \Rightarrow AD = \underline{\text{Y}} \qquad \text{(Loanable Funds)} \tag{44}$$

$$\Rightarrow \quad \Delta LF = \Delta M^s \Rightarrow AD = Y \Rightarrow S \quad \text{(Endogenous Money)} \tag{45}$$

where $\underline{\text{S}}$ implies *ex ante* savings, and Y and S imply *ex post* income and savings, respectively.

As discussed in equation (25), (*ex post*) aggregate demand is always constrained by *ex ante* income under the loanable funds. In other words it ends up with the Say's law ("supply creates its own demand"). Ironically, the loanable funds model, which falsely assumes exogenous money, has played a role of supporting the Say's law even though the Keynes's *General Theory* originally intended to departure from or oppose to it as the 'classical' economics. In the endogenous money

model, on the other hand, it holds as a truism that (*ex post*) aggregate demand determines *ex post* income as claimed by the Keynesian theory: that is, "demand creates its own supply (production)". Thus, the Keynesian theory must be presented under the endogenous money model, which reveals the following features:

- Debt money are endogenously created and destroyed against loans so that central bank has no direct control over the money stock (negation of "exogenous money").
- Investment is not constrained by the loanable funds, but followed by the *ex post* savings (negation of "banks as financial intermediaries").

Our paradigm shift in Part I is now completed in mathematical models with budget equations.

4 ASD Model of Loanable Funds and Endogenous Money

For the dynamic analysis of budget equations, the Accounting System Dynamics (ASD) method by Yamaguchi (2003) turns out to be effective for describing various inter-sector transactions including lending and borrowing of money and debts. To confirm the paradigm shift in macroeconomic theory furthermore, we need to construct the loanable funds and endogenous money ASD model for comparative simulation analysis. Once the integrated model that covers both loanable funds and endogenous money is built, we can easily switch between the two modes of simulation within the single ASD model just like the endogenous money IS-LM model allowed us to do so in Part I. In this way the Keynesian controversies, such as described above, can be comparatively analyzed to find out which of the model assumption, *i.e.*, loanable funds or endogenous money, is better suited for macroeconomic analysis under the current debt money system.

4.1 GDP, Aggregate Demand and Income at Factor Cost

To construct the integrated ASD model, the above equilibrium loanable funds and endogenous money models need to be changed into disequilibrium dynamic adjustment model as done for the short-run IS-LM model. Macroeconomic textbooks often discuss and assume the equivalence of macroeconomic aggregates such as production (GDP), distribution (Income at Factor Cost) and expenditure (Aggregate Demand). The national income accounting identity can only be observed by simultaneously making special assumptions on the production-distribution-expenditure sides, and only holds at the equilibrium. They do not hold at off-equilibrium. Accordingly, to construct the dynamic ASD model with budget equations, we need to redefine these macroeconomic aggregates more rigorously. As done in the SD model of the Keynesian IS-LM model in Part I, equation (1) for the dynamic ASD model needs to be rewritten at the off-equilibrium as follows:

$$Y = AD + Y_{unsold} \tag{46}$$

which indicates that real production (GDP) consists of the amount of real aggregate demand (AD) and unsold products (Y_{unsold}).

With the introduction of budgets by producers, we need to apply accounting rules to evaluate them properly on the balance sheet. Specifically, Cost of Goods Sold (CGS) needs to be evaluated by unit cost of inventory that is different from market sales price P as follows:

$$\text{Unit Cost of Inventory } (P_{uc}) = \text{Price } (P) - \text{Gross Margin} \tag{47}$$

Hence, there are two different ways to evaluate Unsold Products such that

$$\begin{aligned} Y_{unsold} \text{ (at } P) &= P * Y_{unsold} \quad (48) \\ Y_{unsold} \text{ (at } P_{uc}) &= P_{uc} * Y_{unsold} \quad (49) \end{aligned}$$

That is, Unsold Products evaluated at current Price becomes different from Unsold Products evaluated at Unit Cost. The general rule for non-monetary asset is to record them at their cost. Producers thus need to evaluate inventory at unit cost on their balance sheets. Hence, we have

$$Y_{unsold} \text{ (at } P) > Y_{unsold} \text{ (at } P_{uc}) \text{ (for Gross Margin} > 0) \quad (50)$$

On the other hand, production (GDP) defined as the total value-added amount of all macroeconomic sectors is generally evaluated and estimated at the market price P such that

$$\begin{aligned} \text{Production (GDP)} &= P * Y \\ &= P * (AD + Y_{unsold}) \\ &= \text{Aggregate Demand} + Y_{unsold} \text{ (at } P) \quad (51) \end{aligned}$$

where Aggregate Demand is the amount of real aggregate demand transacted at market prices ($= P * AD$) as Consumption (by households), Investment (by producers and households) and Government Expenditure in our current version of the model (see Transactions in Section 4.2).

Similar to the evaluation of inventory at unit cost, production (real) may also be evaluated at unit cost basis such that

$$\text{Production (Unit Cost Basis)} = \text{Aggregate Demand} + Y_{unsold} \text{ (at } P_{uc}) \quad (52)$$

Therefore, for positive Gross Margin > 0 and Unsold Products > 0, by definition, we must have

$$\text{Production (GDP)} > \text{Production (Unit Cost Basis)} > \text{Aggregate Demand} \quad (53)$$

In the Loanable Funds model with budgets (Section 2) as well as the Endogenous Money model with budgets (Section 3), we have assumed that producer's sales revenues are fully distributed to households as wages (W) and profits (Π) as dividends in equation (15). Similarly, let us assume here that producers pay wages for the production (Y), which are called Wages (Y), while labor costs incurred for sales are called Wages (Cost). Then, income distribution to households as workers and shareholders becomes the following:

$$\begin{aligned} \text{Income at Factor Cost} &= \text{Wages } (Y) + \text{Dividends} \\ &> \text{Wages (Cost)} + \text{Dividends} \\ &= \text{Aggregate Demand - Depreciation (Cost)} \quad (54) \end{aligned}$$

since producer's revenues from Aggregate Demand are distributed at factor cost such that

$$\begin{aligned} \text{Aggregate Demand} &= \text{Cost of Goods Sold} + \text{Profits} \\ &= \text{Wages (Cost)} + \text{Depreciation (Cost)} + \text{Dividends} \quad (55) \end{aligned}$$

and "Dividends = Profits" is assumed for simplicity, *i.e.*, producers retain no earnings.

Now we have introduced four macroeconomic aggregates: Production (GDP), Production (Unit Cost Basis), Income at Factor Cost, and Aggregate Demand. Distinguishing these aggregates is essential to construct off-equilibrium dynamic adjustment process of the integrated ASD model of Loanable Funds and Endogenous Money. As we will discuss in Section 4.3, any model lacking these four aggregates is disqualified as a dynamic macroeconomic model.

4.2 Transactions of Macroeconomic Sectors

Producers

Let us begin with transactions of producers as illustrated in Figure 2. First of all, the model has only one stock of Inventory, which means the model does not distinguish semifinished ("work in process") goods from finished goods. Therefore, inventories in the model corresponds to those of investment (production) goods and final consumption goods (intermediate goods such as raw materials and energy are out of the scope of analysis). In the macroeconomic system, producers always face two important managerial decisions: production for this year and investment for the futures. Hence, their behaviors are briefly summarized as follows.

- Producers make production decisions as the sum of the forecasting amount of the next year's aggregate demand and adjustment of the current level of inventory against the desired inventory (I^*). This is the same production adjustment process assumed in the *IS* sub-model of the Keynesian IS-LM model in Part I. Investment decision is assumed to be made by the standard macroeconomic investment function as equation (6).

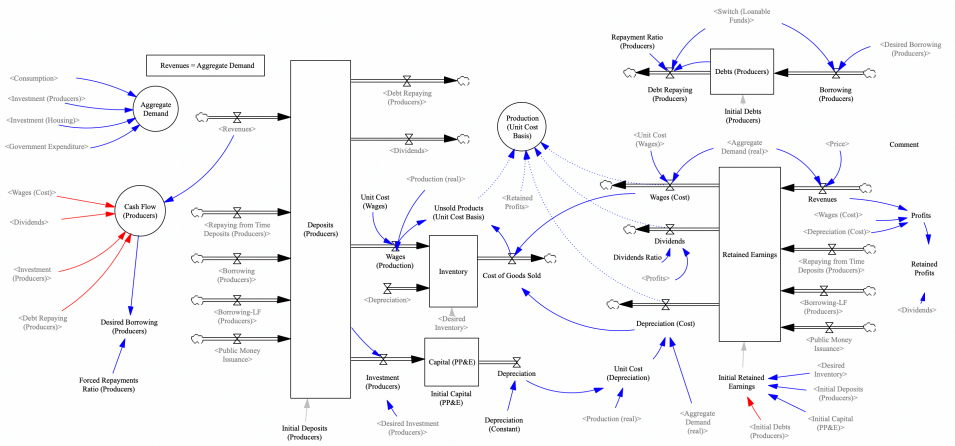

Figure 2: Transactions and Balance Sheet of Producers

- Producers pay wages for the production, Wages (Y). Upon sales, they recognize the costs of goods sold. The remaining becomes profits before tax, from which dividends can be distributed to their shareholders (various taxes on producers are not incorporated yet). The remaining profits are booked as retained earnings (which is assumed to be zero here).

- Producers are constantly in a state of cash flow deficits (Yamaguchi, 2013, Chapter 4). To make new investment, therefore, they have to raise funds. Under the loanable funds, they can borrow savings in the economy (time deposits of households) from banks. In the endogenous money, on the other hand, banks create "deposits" out of nothing and lend them to producers. Interest payments to banks are not considered here for simplicity.

Households

Households as consumers have to make two decisions: firstly, how much to consume and how much to save, and secondly, how much to borrow for housing investment. Consumption decision

is assumed to be made according to the standard consumption function as equation (3). Some of the transactions by households are summarized as follows.

- Households receive income at factor cost as wages and dividends from producers.
- Out of the income as a whole, they pay income taxes, and the remaining amount becomes their disposable income. Interest payments between banks are not considered here.
- Households spend on consumption out of disposable income[10] and the remaining is saved.
- Households borrow funds needed to purchase houses from banks (housing investments).

As explained in the loanable funds model, we have assumed that households receive all income at factor cost of wages and profits (didivends) $(W + \Pi)$. Hence, savings S are defined in equation (11) as the balance between income and expenditure of households and include all kinds of savings made by the households sector. Those savings are first made as demand deposits, which are then converted into time deposits as a leakage from monetary circulation, or withdrawn back to demand deposits. Currently, the model is set up so that households mechanistically convert time deposits to demand deposits based on the parameter called "desired deposit ratio". In the future, it is possible to allow the interest rate, for instance, to determine how much of the demand deposits are channeled into time deposits as savings. Figure 3 illustrates transactions of households as a balance sheet.

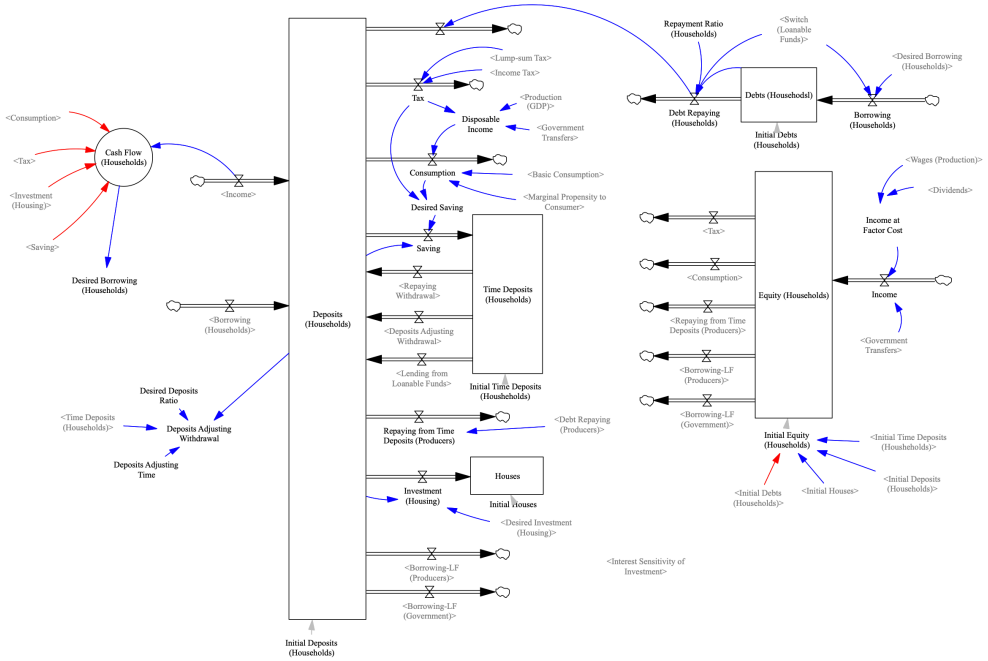

Figure 3: Transactions and Balance Sheet of Households

[10]To avoid the calculation errors as simultaneous equations, Production (GDP) is used instead of Income at Factor Cost for the calculation of disposable income, on which consumption decisions are made. This happens to support "permanent income hypothesis" by Milton Friedman, because consumption is indirectly based on the production (GDP), not the income at factor cost of this year.

Government

Government faces decisions such as how much taxes to levy as its revenues and how much to spend as expenditures. Tax revenues are assumed to be collected according to the standard formula in equation (5), while expenditures are determined by the revenue-dependent tax and primary balance ratio. Primary balance ratio is assumed to be "1" by default so that the government budget is in equilibrium at the beginning. Some of the transactions by the government are summarized as follows.

- Government receives income taxes from households as tax revenues.
- Government spending consists of government expenditures and transfers.
- Government expenditures are assumed to be endogenously determined by tax revenue-dependent expenditures.
- If spending exceeds tax revenues as assumed here, government has to utilize time deposits through banks as intermediaries in the case of loanable funds, or borrow directly from the central bank for simplicity in the case of endogenous money. Payments involving government are done through banks for simplicity.

Figure 4 illustrates transactions of government as a balance sheet.

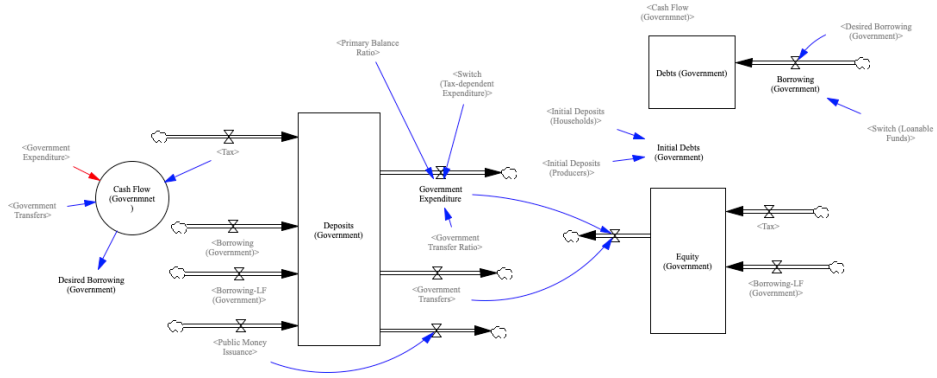

Figure 4: Transactions and Balance Sheet of Government

Banks

Under the loanable funds model, banks are assumed to act as intermediaries of time deposits from depositors (as savers) to borrowers who make investment (producers and households). Under the endogenous money model, banks are assumed to play a passive role; that is, they only make loans for the amount asked by producers and households. Furthermore, they do not purchase government bonds, which are assumed to be directly purchased by the central bank here for simplicity. They are also assumed to make no portfolio decisions among loans and other financial products. Some of the transactions of banks are summarized as follows.

- Banks receive demand deposits from households and producers, and time deposits from households. Interests payments (cost for banks) are neglected for simplicity here.

- In the case of loanable funds, banks make loans out of the savings of time deposits, while under the endogenous money case, they finance loans by creating deposits as much as the desired amount of borrowings asked by producers and households. Interests on these loans and corporate tax on banks are not considered likewise for simplicity.

Figure 5 illustrates transactions and the balance sheet of banks as an aggregate sector.

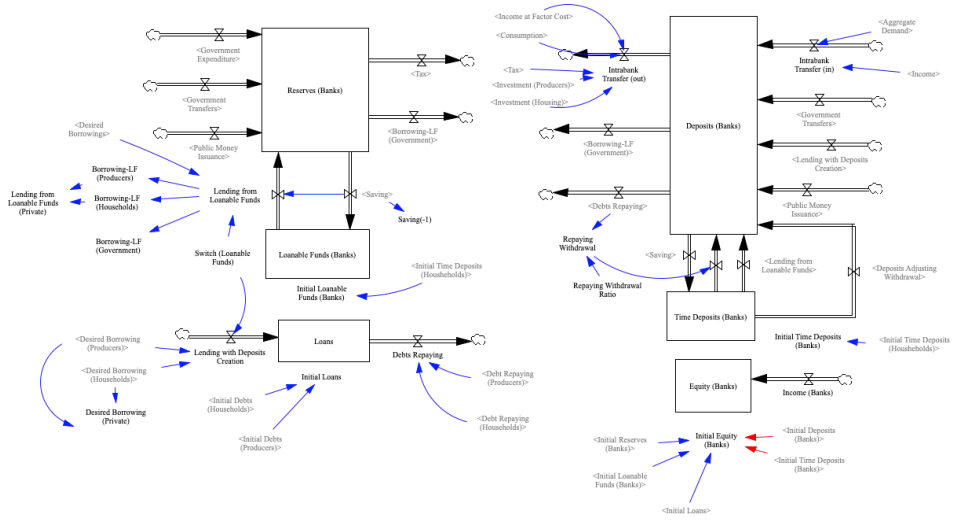

Figure 5: Transactions and Balance Sheet of Banks

Central Bank

The central bank takes deposits from banks and the government. Its primary role is to transfer money (reserves) between banks and government on behalf of the treasury as well as to make loans directly to the government under the endogenous money case. Transactions are made simple enough to avoid complexity and summarized as follows.

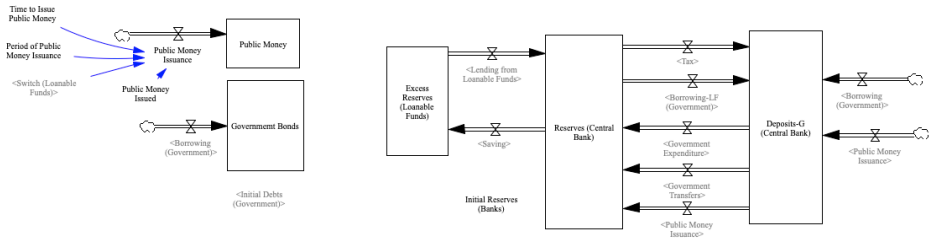

Figure 6: Transactions and Balance Sheet of Central Bank

- In the case of loanable funds, it is assumed that the central bank transfers funds to the government through reserves of the banks, while in the case of endogenous money, the central bank make loans directly to the government for simplicity.

- As explained in "Remarks" at the end of Section 2, the workings of loanable funds model are fundamentally the same as (thus applicable to) that of the public money system where PMA regulates the total supply of money in place of the central bank. Accordingly it is also assumed that central bank issues public money on behalf of the PMA.

Figure 6 illustrates transactions of central bank as a balance sheet.

Revised LM Sub-Model

With the introduction of budget equations, total amount of money stock is now obtained endogenously within the model as follows:

$$\text{Money Stock } (M^s) = M_1 + M_T \text{ (Time Deposits)} \tag{56}$$

where M_1 is the sum of deposits held by producers, households and government as shown at the left middle part of Figure 7. Demand for money are obtained as the sum of outflows from

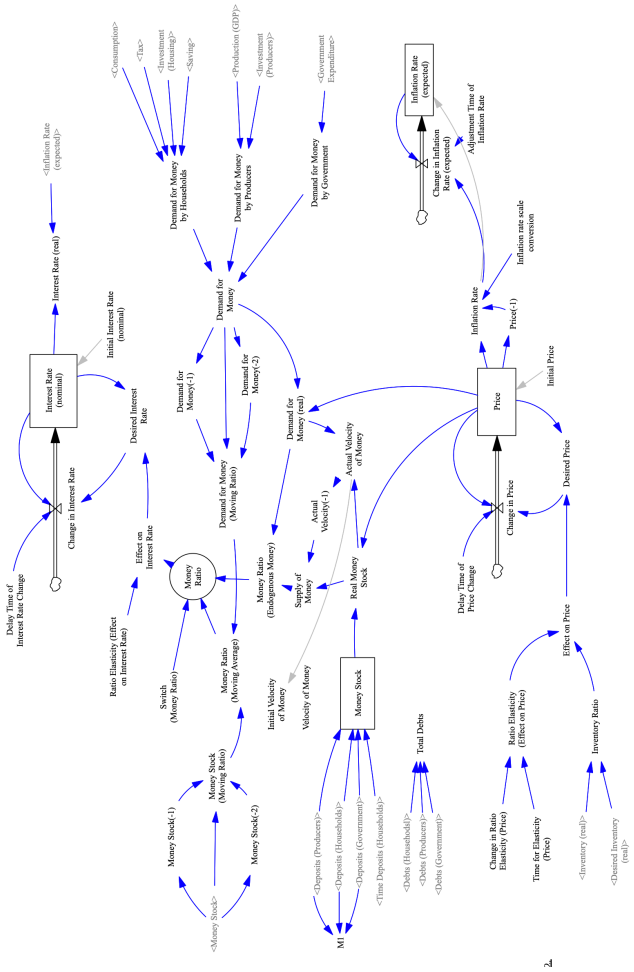

Figure 7: Revised *LM* Sub-model of the ASD Model

Deposits of each sector. We assert that quantity equation ($MV = PT$) must be an identity that holds at any time. This means that the velocity V is only an observed variable that is estimated a posteriori and should not be used as a determinant in macroeconomic analysis. However, in the traditional IS-LM model V is used in the definition of the supply of money.

Since M^s can be obtained within the model, there is no need to rely on V and we can redefine interest rate dynamics in equation (16) in Part I on the basis of endogenous variables. Specifically, Money Ratio in the previous formation of the LM sub-model (Part I) is now modified in the ASD model here as a moving average ratio of real money stock and demand for money. Figure 7 presents this newly revised version of Money Ratio (Moving Average). It becomes the revised LM sub-model of the integrated ASD model.

4.3 Validations of the ASD Macroeconomic Model

We have now completed our ASD macroeconomic model that integrates mathematical models of loanable funds and endogenous money, and examined the following four tests as the minimum requirements that must be met for any macroeconomic model to be a reliable one.

(1) Validation as SD Model: Model and Units Check

First validation test that must be cleared is built-in model test performed by the SD simulation software such as Vensim's "Check Model" and "Units Check". Our model have passed these tests. We have pointed out in Section 3.3 of Part I that the extended IS-LM model with expected inflation rate presented by Mankiw (2016, Chapter 12) failed this unit check.

(2) Validation as ASD Model: Balance Sheets and Flow-of-Funds Checks

Accounting system requires that balance sheets of all sectors must be in balance. This test is called balance sheets (B/S) check. Furthermore, the flow-of-funds framework requires that all assets and liabilities (equity) of all transaction items in the model must be in balance across all macroeconomic sectors involved. This test is called the flow of funds (F/F) check. A left

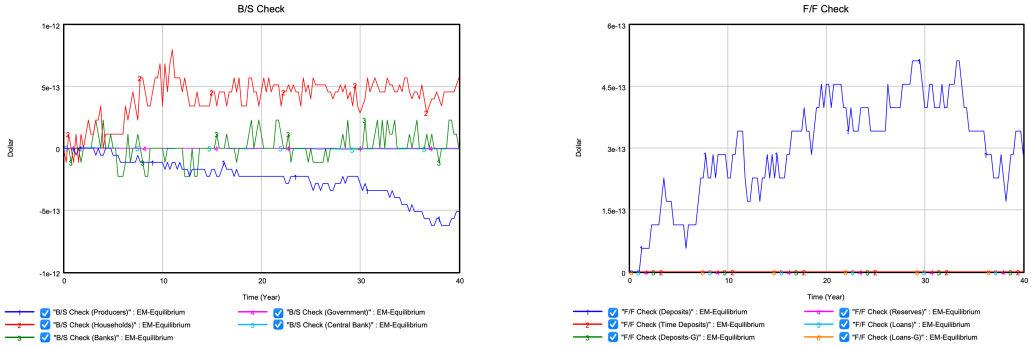

Figure 8: Validation (2) – Balance Sheets (B/S) and Flow of Funds (F/F) Checks

diagram of Figure 8 shows that the balance of each sector's balance sheets are almost zero under the Endogenous Money (EM) model, indicating that the model passes the B/S check for all macroeconomic sectors. Similarly the right diagram indicates that the Flow of Funds are all in balance (almost zero) among transaction items such as deposits, time deposits, reserves, and loans. B/S and F/F checks on Loanable Funds (LF) model are also confirmed.

(3) Validation as Macroeconomic Model: Debt Money Check

We have mathematically shown in the equation (35) that money stock is equal to total debts under the current debt money systems. As mentioned in footnote 7, we have found the following macroeconomic relationships hold in Japan and the U.S.:

1. Money Stock (M_2) = Total Debts
   (corresponding to line 1 = line 2 in both diagrams of the Figure 9)
2. Time Deposits (M_T) $\simeq$ Private Debts (by Producers and Households)
   (corresponding to line 3 $\simeq$ line 4 in both diagrams of the Figure 9)
3. M_1 (= Currency + Demand Deposits) $\simeq$ Government Debts
   (corresponding to line 5 $\simeq$ line 6 in both diagrams of the Figure 9)

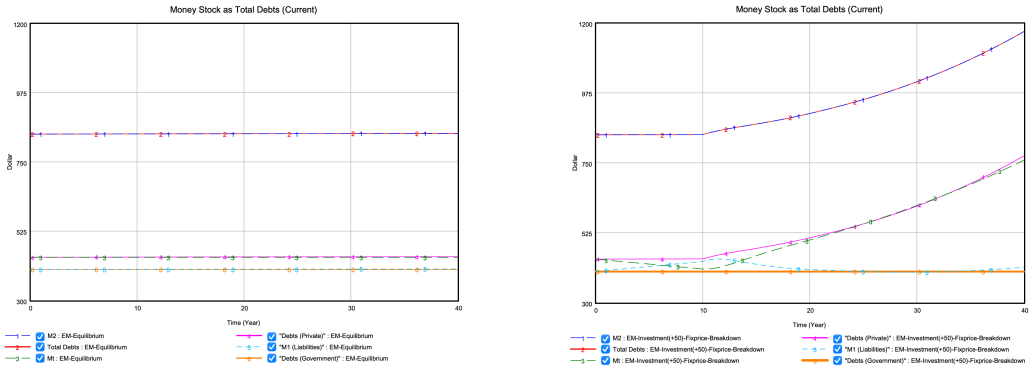

Figure 9: Validation (3) – Debt Money Check: Money Stock $\simeq$ Total Debts

Our empirical findings (Yamaguchi and Yamaguchi, 2021a; Yamaguchi, 2021) and mathematical analysis presented above in equation (43) suggest that the second and third relations could be similarly observed in other currency areas. Depending on the specific case under study, the second and third breakdown relationships may be tested additionally.

Our empirical findings indicate that at least the first relation must hold in any economy operating under the debt money system. Hence, we have introduced this additional validation test as *Debt Money* check. The left diagram of Figure 9 shows all three relationships hold at the equilibrium under our Endogenous Money model. The right diagram shows that the first relation similarly holds (line 1 = line 2) under a different scenario where Investment is increased by \$50 at t=10 (also see the following test below). Moreover, the second and third relations are also shown to hold under the parameter value of Repaying Withdrawal Ratio = 0.4. Changes in this parameter value only affect the amount between demand and time deposits, but do not affect other behaviors of the model at all. These relations are shown to hold similarly under the Loanable Funds model.

(4) Production, Income at Factor Cost and Expenditure: Non-Equivalence Checks

Our fourth validation test compares the four macroeconomic aggregates introduced in Part II such as Production (GDP), Production (Unit Cost Basis), Aggregate Demand (Expenditure) and Income at Factor Cost (Distributed Income). They are in general not equivalent. Only at the equilibrium in which Unsold Products = 0, as illustrated in the left diagram of Figure

10, we observe the following equivalence (numbers within parentheses indicate simulation line numbers in the figure):

$$\begin{aligned} \text{Production (GDP) (1)} &= \text{Production (Unit Cost Basis) (2)} \\ &= \text{Aggregate Demand (3)} \\ &= \text{Income at Factor Cost (4) + Depreciation (Cost) (6)} \\ &\geq \text{Income at Factor Cost (4)} \qquad (57) \\ &\quad \text{(for Depreciation (Cost)} \geq 0) \end{aligned}$$

Only when depreciation (cost) is zero, equivalence relations holds: that is, GDP = Income at Factor Cost = Aggregate Demand (Expenditure). These relations are called "three-sided equivalence" or "equivalent principle of three aspects" in standard textbooks. To be precise, for these equivalence relation to hold, there must be another strong assumptions that all value-added products are distributed during each period (which is the assumption made in our model) such that producers fully distribute profits and thus retain no earnings. Furthermore, "operating surplus" in distribution side must necessarily includes the value-added of inventory whose sales have not yet been realized in national income accounting.

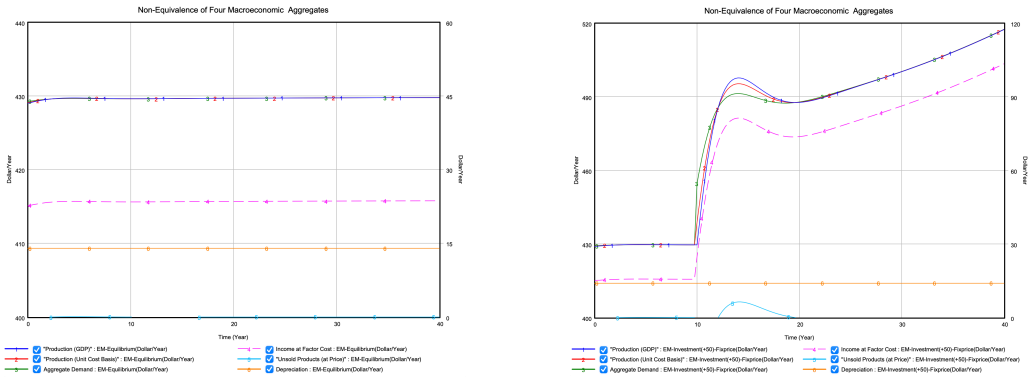

Figure 10: Validation (4) – Non-equivalence of Four Macroeconomic Aggregates

A right diagram is a simulation in which investment is increased by \$50 at t=10. Around t=14, when Unsold Products (at Price) is positive, the following relations are observed:

$$\begin{aligned} \text{Production (GDP) (1)} &> \text{Production (Unit Cost Basis) (2)} \\ &> \text{Aggregate Demand (3)} \\ &> \text{Income at Factor Cost (4)} \qquad (58) \end{aligned}$$

These relations indicate that macroeconomic models that presume only the equivalence of production=income at factor cost (distribution)=aggregate demand (expenditure) as in equation (57) are too simplistic and must be refuted as defect models from our viewpoint of ASD approach to dynamic off-equilibrium analysis. The national income identity can be observed only under the special conditions of equilibrium.

5 Analysis of the ASD Model: Loanable Funds vs Endogenous Money

Our integrated ASD model of loanable funds and endogenous money is now completed. Let us hereafter call the loanable funds model simply the LF model, and the endogenous money model the EM model. To run the model in LF mode, we simply set the value of "Switch (Loanable Funds)" in the integrated ASD model to 1. Its default value is set to be 0, under which the model runs in the EM mode as was also the case for the Part I model.

For the comparative behavior analysis of EM and LF models under fixed price, we run two simulations: (1) the equilibrium case and (2) outside shock caused by investment increase in \$50 at t=10. Table 2 summarizes legend names indicated in Figures 11 and 12 below, and case numbers (5 and 6) correspond to the classification of Part II models summarized in Table 1. The model assumes a growing economy by default. Specifically, it assumes that Producer's

Endogenous Money ASD (Case 6)	Loanable Funds ASD (Case 5)
Line 1: EM-Equilibrium	Line 3: LF-Equilibrium
Line 2: EM-Investment(+50)-Fixprice	Line 4: LF-Investment(+50)-Fixprice

Table 2: Simulations under Loanable Funds (LF) vs Endogenous Money (EM) models

Investment increases exponentially over time. Except for the left hand diagram in Figure 11, line 1 in blue and line 2 in red show behaviors of the EM model, while line 3 in green and line 4 in pink are those of the LF model in the Figures below.

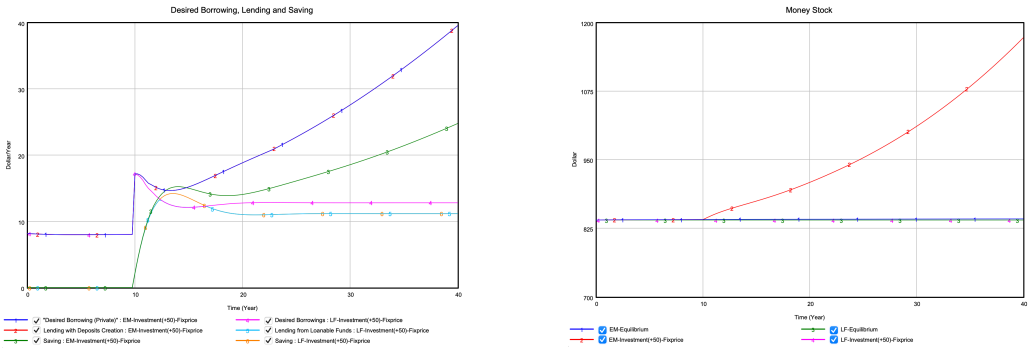

Figure 11: Loanable Funds vs Endogenous Money: How Money are Created?

Left hand diagram of Figure 11 shows desired amount of producers to borrow funds under the EM model (line 1) and LF model (line 4). When investment increases, producers need to raise funds. It is interesting to observe how the outside shock of investment increase affects macroeconomic behaviors differently due to different lending behavior of banks under EM and LF models. In the EM model, Desired Borrowing (line 1) is shown to be always met with Lending with Deposits Creation (line 2) without being constrained by the amount of Saving (line 3). Money is indeed endogenously created to meet the desired investment as indicated by equation (29). In the EM model, saving takes place only after these money is created by banks as indicated by equation (42).

In the LF model, on the other hand, Desired Borrowing (line 4) failed to be met, because Lending from Loanable Funds (line 5) is shown to be constrained at maximum by the available

amount of Saving (line 6): that is,

$$\text{Lending from Loanable Funds (5)} = \text{Min (Desired Borrowing (4), Saving (6))} \tag{59}$$

This lending behavior confirms our mathematical analysis in Section 2. That is, in the LF model, savings become the only sources of investment as analyzed by equations (18) and (22).

The right diagram of Figure 11 compares behaviors of money stock under the two models. At equilibrium under fixed price assumption, money stocks in EM model (line 1) and LF model (line 3) do not change. When investment increases, money is created by banks for lending under EM model, and money stock keeps increasing (line 2). Meanwhile, in the LF model money stock (line 4) does not increase because lending comes from saving.

Let us next observe how interest and production (GDP) are affected by the investment increase. Left diagram of Figure 12 shows that, after the investment increase at t=10, nominal interest rate (line 2) first jumps but then continues to decrease due to the increase in money stock under EM model. Meanwhile, interest rate in the LF model (line 4) jumps but eventually converges to a constant level under constant amount of money stock. Right diagram indicates how these different behaviors of interest rate affect production (GDP). Production (GDP) (line 2) continues to grow under the EM model due to the endogenous creation of money, followed by the decrease in interest rate, while it get stagnated at constant level under the LF model (line 4) due to the exogenously fixed amount of money, followed by the constant interest rate.

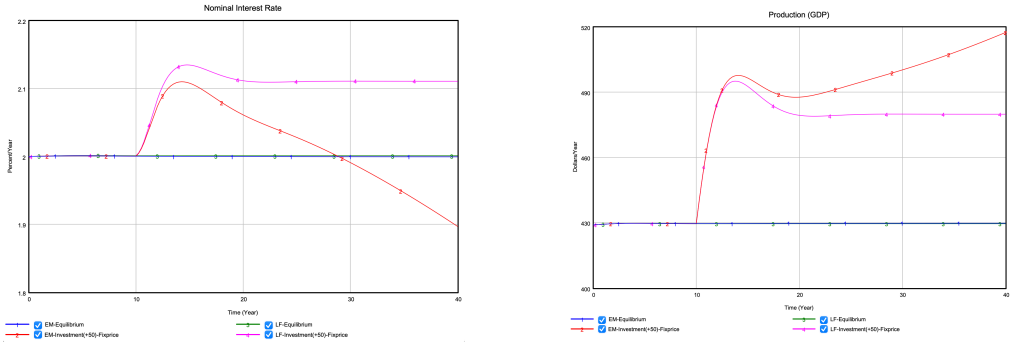

Figure 12: Loanable Funds vs Endogenous Money: Interest and Production (GDP)

Let us now compare the above different behaviors of EM and LF models in terms of phase diagram as done in Part I. Figure 13 illustrates behaviors of production (GDP) and nominal interest rate as IS-LM phase diagram. By drawing imaginary IS and LM curves, equilibrium points under EM and LF models are illustrated at the intersection points of IS and LM curves. LM model is basically the same as the Keynesian IS-LM model in Part I. Therefore, when investment increases by \$50 at t=10, new equilibrium point moves along with the same LM curve (line 2) since money stock does not change.

On the other hand, as discussed in Part I, under Endogenous Money, joint shift of *IS* and *LM* curves must take place to capture new endogenous money dynamic equilibrium (line 1). It is illustrated in the diagram as if both *IS* and *LM* curves move jointly to capture new equilibrium point. In other words, it's impossible to capture this dynamic macroeconomic behavior in terms of comparative static method of IS-LM curves. We need paradigm shift for the analysis of endogenous money macroeconomic behaviors.

Having analyzed the behaviors of both LF and EM models, we have to decide which model is appropriate for macroeconomic analysis under the debt money system. In the EM model, interest rate is shown to decrease and production (GDP) is shown to grow as illustrated by

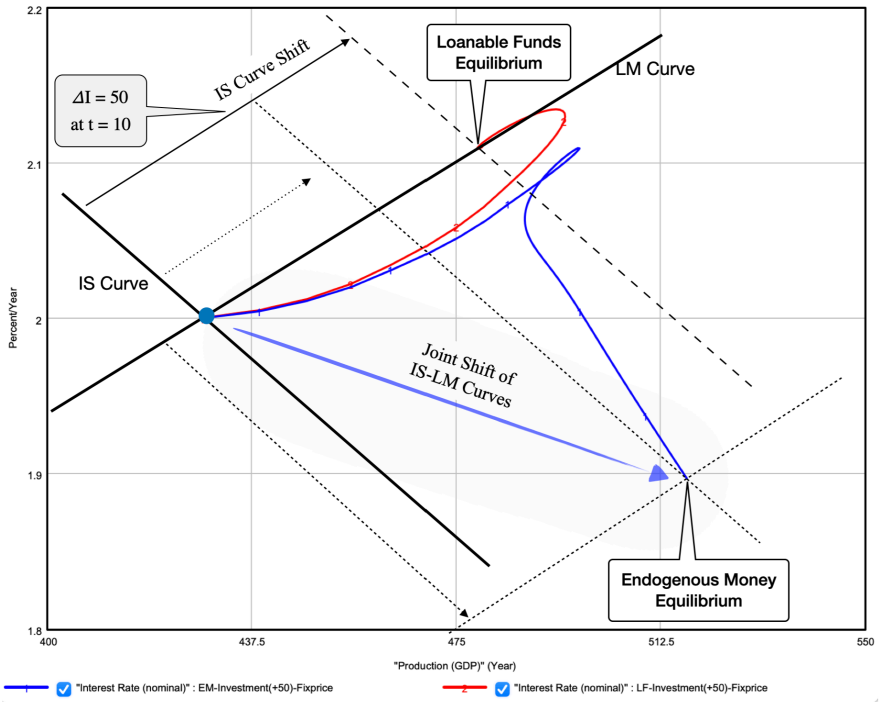

Figure 13: Loanable Funds vs Endogenous Money: Joint Shift of IS-LM Curves

lines 2 in Figure 12. On the other hand, in the LF model money stock does not increase and production (GDP) is constrained to grow. This is a fatal flaw as a macroeconomic model.

We have rejected the exogenous money IS-LM model in Part I, because it failed to produce the contraction of money stock during the Great Depression. Loanable funds ASD model here shares the same flaw as the one in the exogenous money IS-LM model in Part I. Consequently, the LF model has to be similarly rejected here as a model for the macroeconomic analysis of the debt money system in which money is endogenously created and destructed. There is no built-in mechanism of endogenously creating money in the LF model. As discussed in Part I, central bank can only control the amount of base money M_0, but cannot control the amount of M_1 and M_2, or M_3 by its monetary policy. This is a serious design failure of constructing macroeconomic model for the debt money system. Therefore, Keynesian view that money stock is exogenously determined and savings (time deposits) become the sources of loanable funds for investment can no longer be supported, This is the reason why we argued in Part I that there is a need for a paradigm shift in macroeconomics toward the endogenous money ASD model.

Public Money as Loanable Funds

Our rejection of the Keynesian loanable funds model as the one for the analysis of debt money system does not mean that it is of no use as a macroeconomic model. We are just claiming that it is not relevant as a macroeconomic model of the debt money system. Convinced by the visions of monetary reform and 100% money by Irving Fisher, as discussed in Part I, we have developed public money system (Yamaguchi, 2013, Part V: Public Money System) and Yamaguchi and Yamaguchi (2016). In this new macroeconomic system money is constantly

put into circulation and withdrawn by the Public Money Administration, and banks only play a role as intermediaries of public money. Accordingly, the Keynesian loanable funds model we have developed so far indeed fits into the economic system of the public money.

In this sense, the LF model could be a candidate for the macroeconomic model of the public money system, but not the one for the debt money system. As a hypothetical situation, let us assume that the Public Money Administration (previous central bank under the debt money system) has injected public money of $11 at t=10 for 30 years; that is, $330 in total. That is, money stock (bold line 5 in blue sky) in Figure 14 is shown to increase from $840 to $1,170 for 30 years. Voila! This amount of money under the public money system is issued at interest-free and without causing government debts! Due to this continued injection of public money, production (GDP) (bold line 5) in the right diagram now increases, out of the constant level of production (line 4 in pink) under the LF model, as much as the production level (line 2 in red) under the debt money system. This is the essence of the public money system

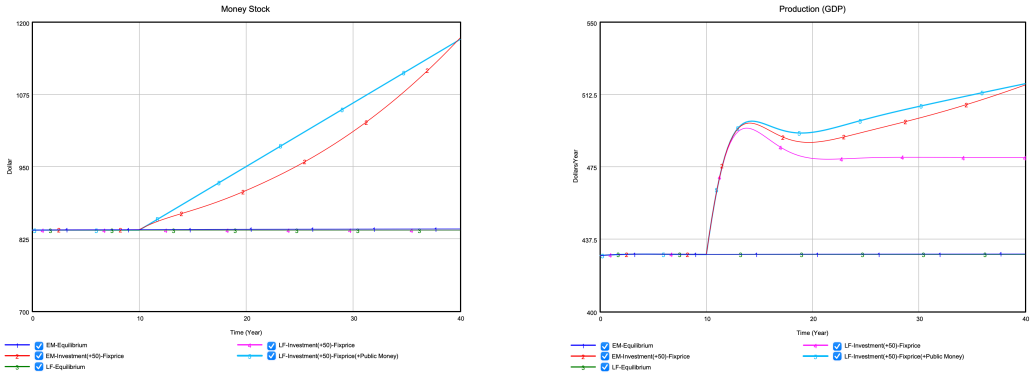

Figure 14: Public Money as Loanable Funds

In this way, it turned out that the loanable funds ASD model could serve as a macroeconomic model only under the public money system; it cannot work effectively as a macroeconomic model of the current debt money system in which money is endogenously determined.

6 The Great Depression Case Revisited

In Part I, we has successfully reproduced behaviors of the Great Depression by introducing the *endogenous money spending hypothesis*. Let us now examine if the ASD model developed here can similarly reproduce the Great Depression environment. We have run simulations under EM and LF models for the cases of fixprice and flexprice for detailed comparison. This time instead of PULSE function applied in Part I, we have used STEP function built in the ASD model. The simulation for the Great Depression is run for 20 years starting from 1925 through 1945.[11] Parameter values used for the simulation are summarized in the following Table 3. Simulation results thus obtained for the Great Depression are shown in Figure 15 through 16. Table 4 lists corresponding names of diagram legends throughout simulation results.

Flexprice behaviors of the EM model (bold lines 3 in green) are what we want to examine as the behaviors of the Great Depression. They turned out to reproduce similar model behaviors successfully as in Part I, and qualitatively capture the behaviors of the Great depression Data

[11] Technically speaking, initial time=0 in the ASD model is specified as t = 1925.

Great Depression (Fixprice)	(1) Repayment Ratio (Households) = 0.04 ($\leftarrow$ 0.018) (2) $\Delta C_0 = \Delta I_0 = \Delta \bar{I}_H = -20$ at t=1929, 1930, 1931 (Δ implies a change)
Great Depression (Flexprice)	(3) Change in Ratio Elasticity (Price) = 0.06 ($\leftarrow$ 0)

Table 3: Parameter Values for the Great Depression Simulation

Endogenous Money ASD	Loanable Funds ASD
Line 1: EM-Equilibrium	Line 4: LF-Equilibrium
Line 2: EM-Great Depression-Fixprice	Line 5: LF-Great Depression-Fixprice
LIne 3: EM-Great Depression-Flexprice	Line 6: LF-Great Depression-Flexprice

Table 4: Legend Names for Simulations under The Great Depression Revisited

as illustrated in the Appendix 1 of Part I. Specifically, they capture the behaviors such as the decrease in price, the destabilizing effects of deflation, the fall in nominal interest rate, rise in real interest rate, decrease in money stock and rise in real money balance.

On the contrary, flexprice behaviors of the LF model (dotted line 6 in orange) failed to capture money stock and real money balance (Figure 16), though the other behaviors are successfully captured. Hence it is concluded that LF model has to be rejected as a legitimate macroeconomic model to analyze economic recessions such as the Great Depression, confirming our conclusion in Part I.

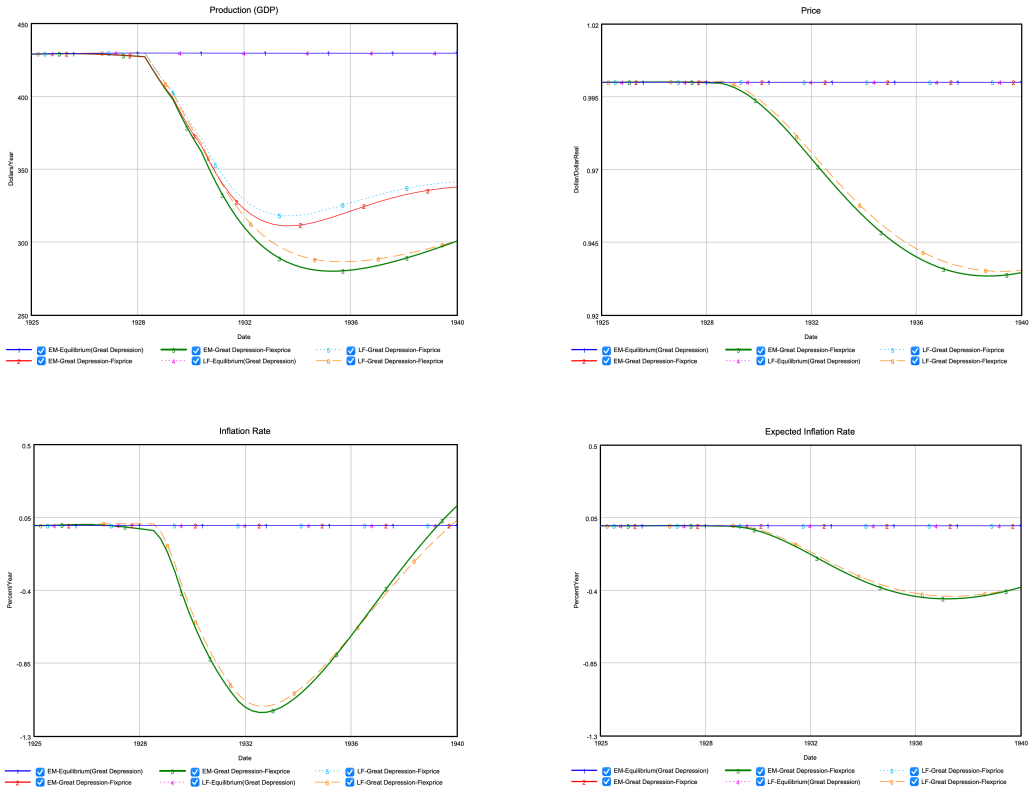

Figure 15: The Great Depression – Production (GDP), Price and Inflation

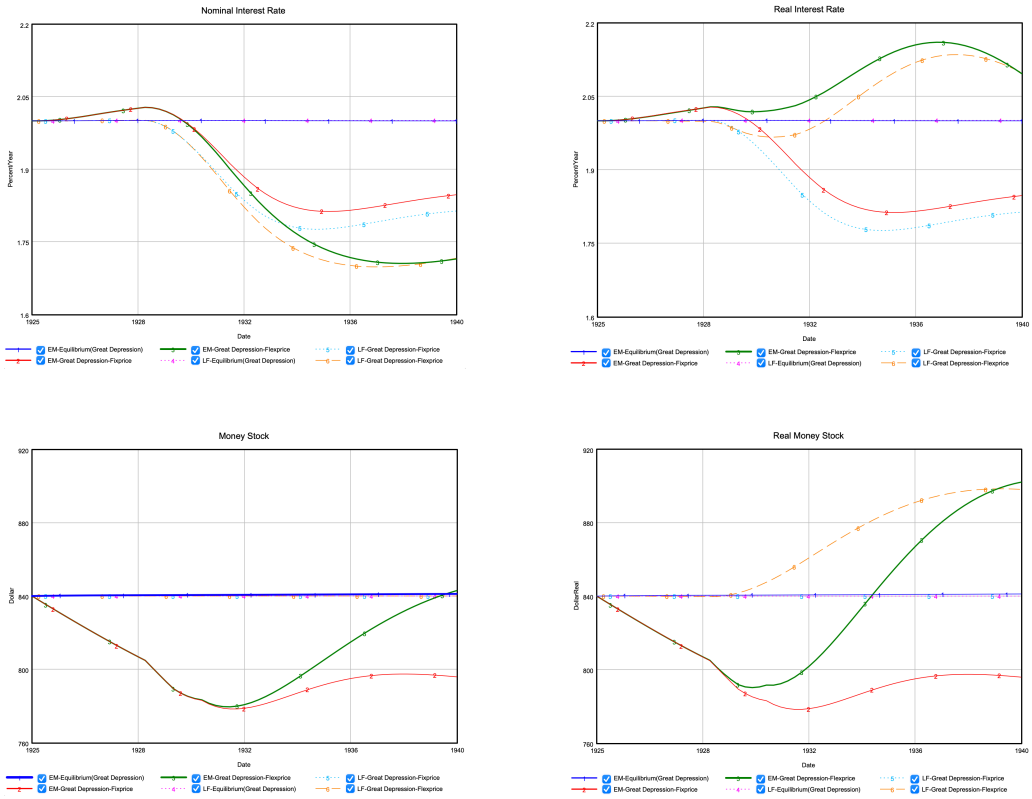

Figure 16: The Great Depression Revisited – Nominal and Real Interest Rates and Money Stocks

Figure 17 is a summary evaluation of the simulation behaviors of EM and LF models for the case of the Great Depression obtained above, which is similarly presented as Figure 15 in Part I: Qualitative Evaluation of Spending, Money, and Endogenous Money Spending Hypotheses. Specifically, behaviors of the EM model here are similar to those of Endogenous Money Spending Hypothesis (Case 4) of the IS-LM model in Part I. When economy is driven into recessions in general, its behaviors need not be constrained by the existing loanable funds anymore, because producers may not demand for further borrowings of funds. Hence, economic behaviors of the LF model become similar to those of the EM model except money stock as already pointed out in Part I.

	M^s	P	$\frac{M^s}{P}$	i	r
The Great Depression (1929-1933)	↓	↓	↑	↓	↑
Endogenous Money ASD Model	↓	↓	↑	↓	↑
Loanable Funds ASD Model	→	↓	↑	↓	↑

Figure 17: Qualitative Evaluation of EM and LF Models

Figure 18 shows comparative IS-LM analysis of production and interest rate in phase diagram. In the left diagram, nominal interest rate is taken on the vertical axis whereas real interest rate is taken on the right diagram. EM model (lines 3 in green) and LF model (line 6 in orange) seem to behave similarly, because under the Great Depression money stock contracts and does not become behavioral constraints as in the case of economic growth analyzed

in the previous section. We should not be misled by these similarities, because as discussed

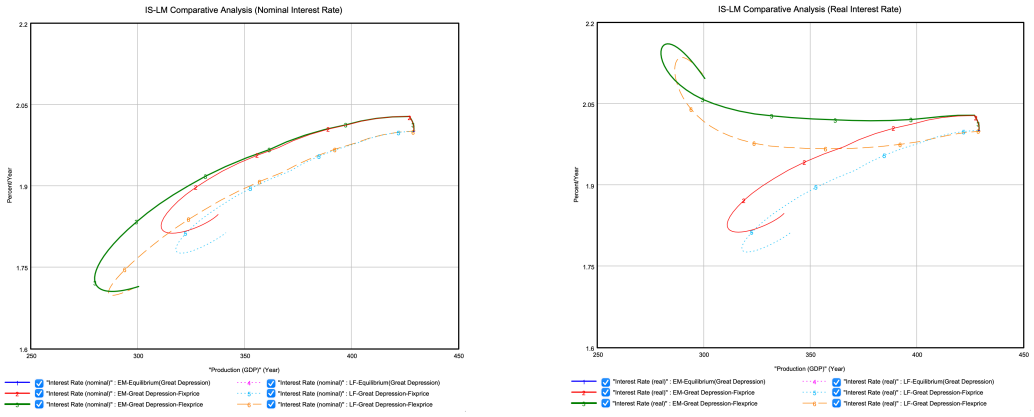

Figure 18: The Great Depression Revisited – IS-LM Phase Diagrams

above the LF model failed to capture the contract of money stock and increase in real money balance during the Great Depression. Accordingly, the production (GDP) in the LF model (line 6) is over-calculated against that of EM model (line 3) in the above left diagram of Production (GDP) in Figure 15. That is to say, recessions and financial instability tend to be under-estimated as long as we use the LF model. This is another reason why the LF model must be rejected as a macroeconomic model of debt money system.

7 Japan's Lost 30 Years as Another Case

7.1 Can the ASD Model Capture Japan's Lost 30 Years?

In order for the endogenous money ASD model developed in this Part II to be claimed as a generic macroeconomic model of debt money system, it has to be able to capture another major economic event in history; that is, Japan's lost 30 years, starting in 1991. Though simulation is run for 40 years from 1980 through 2020,[12] it should be reminded that this is not a quantitative data-fitting against real economic data of the period in Japan. Instead, it is regarded as a exploratory simulation to investigate if our ASD model can capture the observed behaviors of the Japan's lost 30 years qualitatively, using the one-time changes of parameter values as outside shocks. Parameter values used for the simulation are summarized in Table 5.

Equilibrium (Japan) (a growth path as usual as if "Japan as No.1")	(1) Repayment Ratio (Households) = 0 ($\leftarrow$ 0.018) (2) Change in Ratio Elasticity (Price) = 0.06 ($\leftarrow$ 0) (3) Primary Balance Ratio = 1.1 ($\leftarrow$ 1) (4) Initial Deposits (Households) = 50 ($\leftarrow$ 360) (5) Initial Time Deposits (Households) = 550 ($\leftarrow$ 440)
Japan's Great Depression (without gov. spending)	(6) $\Delta C_0 = -20$ at t=1991, $\Delta I_0 = -50$ at t=1991 $\Delta \bar{I}_H = -30$ at t=1991
Japan's Lost 30 Years	(7) $\Delta \bar{G} = 15$ at t=1993 (Fiscal Policy)

Table 5: Parameter Values for the Simulation of Japan's Lost 30 Years

[12] Initial simulation time t=0 in the model is specified as t=1980. Accordingly, simulation time t=11 implies 1991and t=13 implies1992.

Table 6 lists corresponding names of diagram legends throughout simulation results shown in Figures 19 and 20. EM-Equilibrium (Japan) (lines 1 in blue) shows a base run case as a growth path as usual as if the economy continued the high growth as "Japan as No.1" in the 70s and 80s. EM-Japan's Great Depression (lines 2 in red) indicates "what if" behaviors without active fiscal spending policies of the Japanese government during the lost 30 years. In other words, behaviors presented by lines 2 could be interpreted as the prolonged behaviors of the Great Depression spread over 30 years in Japan. Indeed, if they were compressed to those of 10 years, they exhibit similar behaviors of the Great Depression (1929-1939) discussed in Part I and those of the revisited one above. We can observe that behaviors of the Japan's lost 30 years are similar to those of the Great Depression in terms of the underlying behavioral patterns in key macroeconomic variables. Therefore, we may conclude that under the debt money system, economic recessions, whether the Great Depression, the Japan's lost 30 years, or any other recessions in general, could exhibit similar behaviors observed under the endogenous money spending hypothesis.

Endogenous Money ASD	Loanable Funds ASD
Line 1: EM-Equilibrium (Japan)	
Line 2: EM-Japan's Great Depression	(With Fiscal Policy)
Line 3: EM-Japan's Lost 30 Years	Line 4: LF-Japan's Lost 30 Years

Table 6: Legend Names for the Simulations of Japan's Lost 30 Years

EM-Japan's Lost 30 Years (bold lines 3 in green) shows simulation behaviors, under the endogenous money spending hypothesis, when fiscal spending policy is applied. Accordingly, lines 2 and 3 provide comparative behaviors of the Japan's recession cases without or with fiscal policy. For instance, production (GDP) shown in the left diagram of Figure 19 indicates

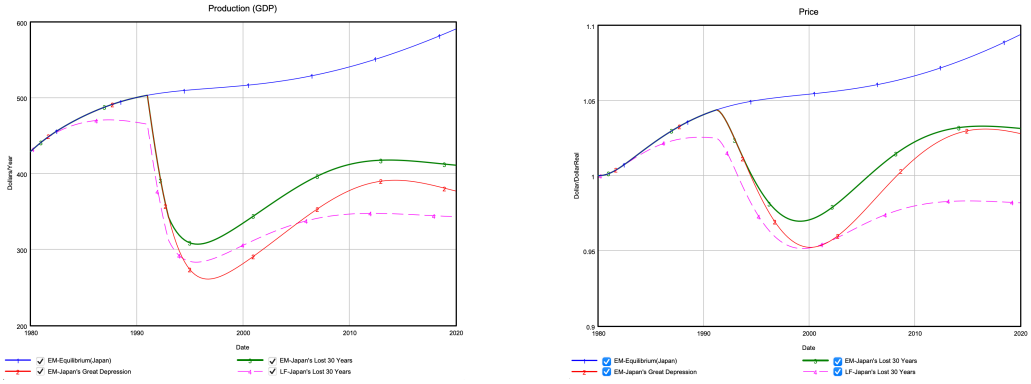

Figure 19: The Great Depression: Production (GDP and Price

that Japan's GDP would have been reduced significantly (line 2), compared with line 3, if the government did not apply the active spending policy. LF-Japan's Lost 30 Years (dotted lines 4 in pink) is additionally included to see how Japan's lost 30 years could have been described under the mainstream LF model. Similarly, right diagram indicates that deflation would have been more severe without fiscal policy (line 2) than the case with spending policy (line 3).

Figure 20 presents another comparative behaviors of Japan's lost 30 years such as inflation rate, expected inflation rate, nominal and real interest rates, and real money stock. These variables produce similar behaviors as those obtained in the above section of the Great Depression case revisited . However, money stock continues to increase in Japan against the observed

decrease during the Great Depression in the U.S. This odd behavior of the increase in money stock is related with a crowding out effect discussed in the following subsection.

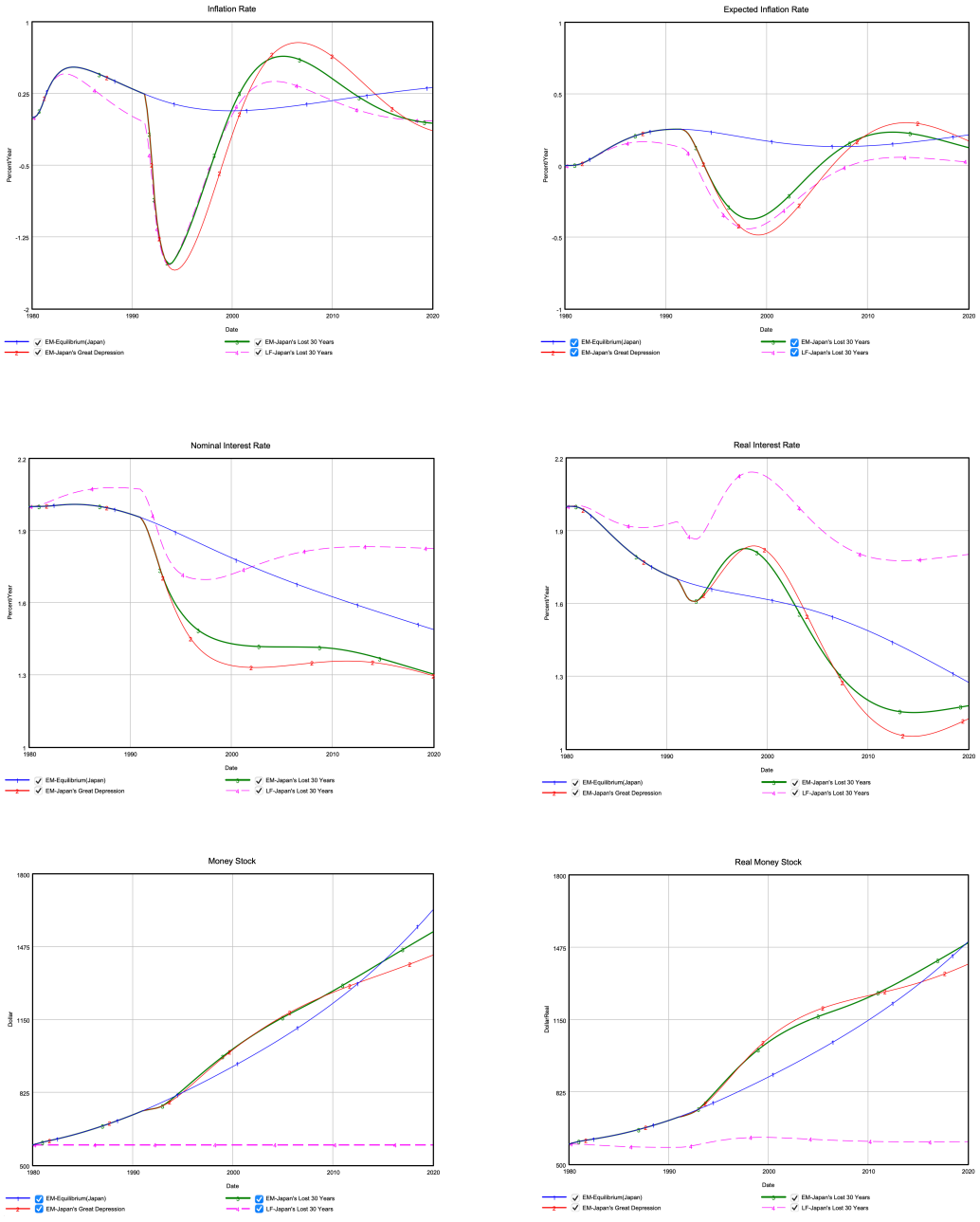

Figure 20: Japan's Lost 30 Years – Inflation, Interest Rates and Money Stocks

7.2 A Mainstream Myth of A Crowding Out Effect

One of the claims made by the mainstream economics was that if Japan continues to accumulate government debts the economy would sooner or later face with the rising interest due to the so-called crowing-out effects, which reduces investment and cancel out the effects of fiscal policy. Yet, such rises in interest rates did not occur. To examine this claim, let us observe the behaviors of nominal interest: line 3 in green under EM model and dotted line 4 in pink under LF model in Figure 20. Indeed, nominal interest of line 4 shows that nominal interest rate is increasing as the government debts continues to increase under fiscal policy during the lost 30 years. That is, crowing-out effect by mainstream economists seem to have been supported by the flawed LF model.

On the contrary, nominal interest rates continued to decline during the lost 30 years in Japan. Line 3 of endogenous money ASD model in the same diagram illustrates this continued decline of nominal interest rate. This declining nominal interest rate has been a puzzle for the mainstream economists whose mindsets are occupied by the loanable funds (exogenous money) model. Our EM model indicates that money stock (bold line 3 in green) of the money stock diagram in Figure 20) continues to increase due to the accumulated debts by the government, which in turn pushes down the nominal interest rate. This is another example that demonstrates how the mainstream theory of loanable funds model is flawed.

Interestingly, real interest rate (dotted line 4 in pink) temporarily rises, then continues to decline, even under the loanable funds model. Mainstream theory of exogenous money failed to show this cyclical behavior of real interest rate as well.

7.3 The Money-Debt Relationships and their Decomposition

Let us continue our analysis, using only the endogenous money ASD model. We have observed three surprising monetary relations in Japan as illustrated in the top left diagram of Figure 21 (Yamaguchi and Yamaguchi, 2021b). Specifically, we have found the following correlations:

- Money Stock (M_3) $\simeq$ Total Debts (corr.coef = 0.987)
  (line 1 $\simeq$ line 2 in the top left diagram of Figure 21)
- Time Deposits (M_T) $\simeq$ Private Debts (by Producers and Households)
  (corr.coef = 0.928) (line 3 $\simeq$ line 4 in the same diagram)
- M_1 (= Currency + Demand Deposits) $\simeq$ Government Debts
  (corr.coef = 0.992) (line 5 $\simeq$ line 6 in the same diagram)

The diagram on top right in Figure 21 shows that our EM model can successfully produce money-debt breakdown relations as observed in Japan. Specifically, money stock (line 1 in blue) is shown to be always equal to total debts (line 2 in red) in the model. This confirms that the equation (35) we presented above holds true in the EM model of the debt money system. Under the present system, money is created only when producers, households and government come to borrow from banks at interest. Bankers receive interests on those loans that are created as borrowers' deposits out of nothing.

Our endogenous money ASD model thus can successfully reproduce these macroeconomic relations of money stock such as M_1, M_T, M_2, M_3 and debts by producers, households, and government. Hence, the EM model would also help analyze and identify system structures underlying the macroeconomic behaviors of debt money by manipulating the model parameter values.

Bottom diagrams are the same as the top ones except that money stocks (lines 1 in blue) in the top are replaced with GDP (lines 1 in blue) in the bottom in order to compare the behaviors

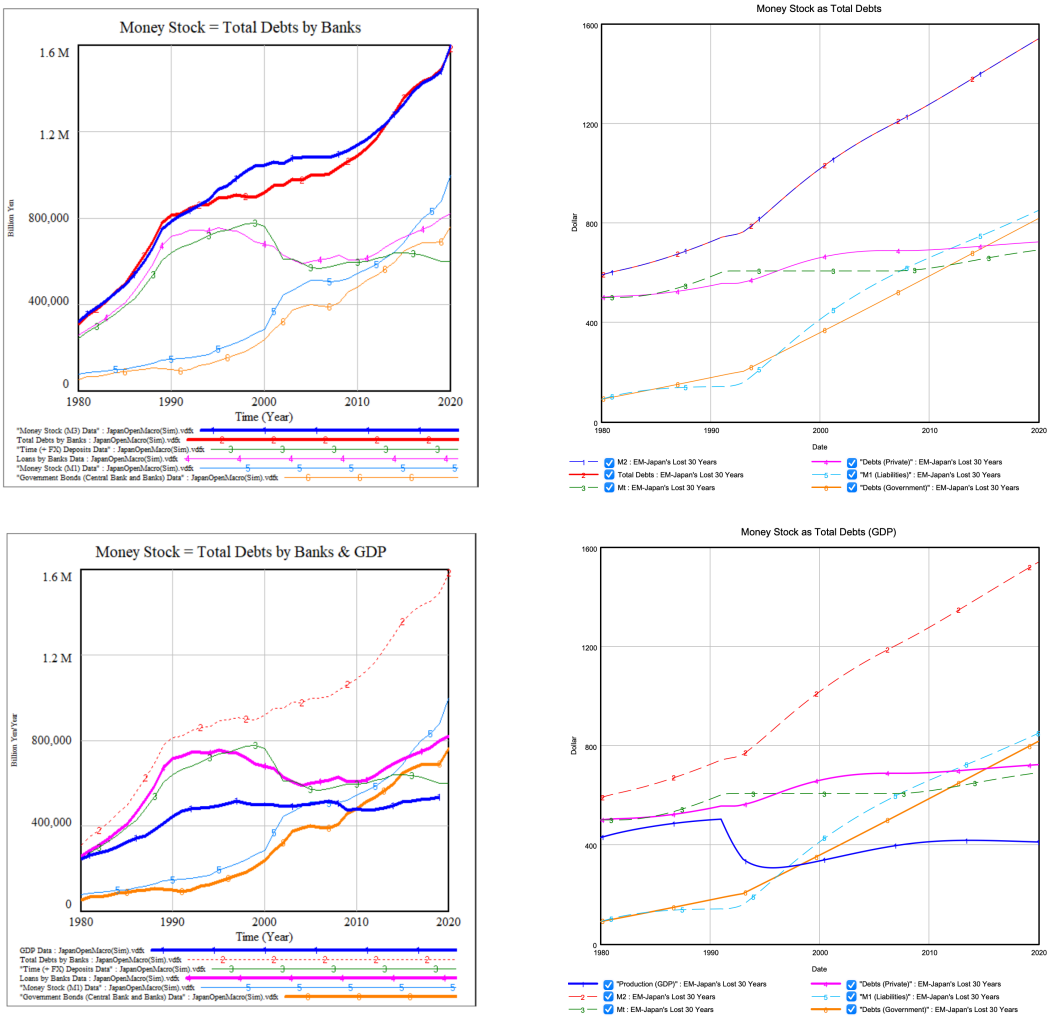

Figure 21: Money-Debt Relationship in Japan and its Decomposition Analyses

of GDP and monetary breakdowns directly. To sum up, the endogenous money ASD model developed in this Part II can be used as a standard macroeconomic model for explaining the paradigm shift in macroeconomics we have emphasized in this paper series.

7.4 Japan's Lost 30 Years as Joint Shifts of IS-LM Curves

For our EM model to be a standard ASD model in macroeconomics, it has to be able to solve the limitation of the short-run IS-LM model discussed in the Introduction. Specifically, we have to be able to produce "point J" indicated in Figure 18 of Part I.

Figure 22 presents the phase diagrams of production (GDP) and nominal interest rate by the behaviors of Japan's lost 30 years produced by the EM model (lines 1, 2 and 3) and LF model (dotted line 4). Line 1 indicates a base run behaviors of Japanese economy as if "Japan as No.1". Line 2 indicates how production (GDP) and nominal interest rate would have been more extremely worsened if no fiscal policy were applied in Japan. Bold line 3 indicates that

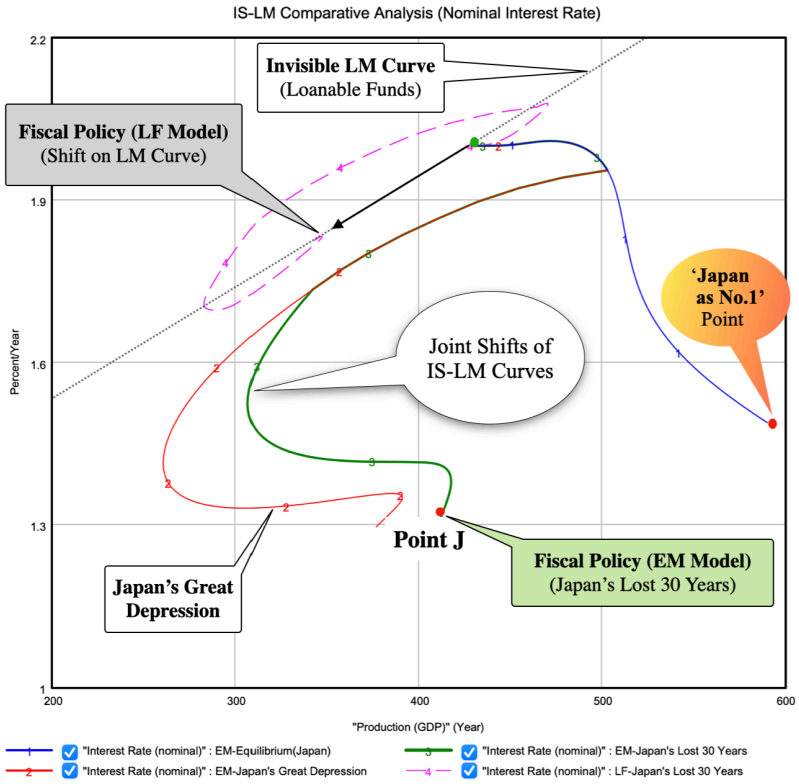

Figure 22: Point J of Japan's Lost 30 Years

production (GDP) continued to decline in the beginning and failed to recover the point of "Japan as No.1" in spite of the aggressive fiscal policy by the Japanese government, while interest rate continued to decline against the mainstream claim of the crowding out effect. These joint shift behaviors ended with "point J", which looks like the point actually observed during the last lost 30 years in Japan. In this way we have successfully captured the behaviors of Japan's lost 30 years in the phase diagram by the endogenous money ASD model developed in this Part II.

On the contrary, if we are obliged to apply macroeconomic model of exogenous money such as the LF model, its economic behaviors are always constrained as if they are moving only along the LM curve which is, though, hidden or made invisible in the phase diagram above. We can easily confirms these behaviors along the invisible LM curve by changing the level of consumption, investment and government spending, whatever amounts we use. In other words, we cannot arrive at the "point J" forever as long as we stick to the old paradigm of loanable funds or exogenous money system.

Our simulation results here seem to demonstrate that macroeconomic behaviors of recessions in general could be similarly produced by the EM model as long as they are running under structurally similar economies of debt money system. By calibrating the model behaviors to actual case studies, the EM model could be used by policy-makers to examine potential impacts of their monetary and fiscal policy on the economy before its implementation. Indeed, we have successfully obtained the endogenous money ASD model of paradigm shift proposed in this

series.

Conclusion

In Part I and II of the series titled "The Endogenous Money IS-LM (and ASD) Model of the Debt Money System", we have attained the following macroeconomic views against the Keynesian view:

1. We first presented the Keynesian short-run IS-LM model in Part I paper as a mathematical model of equations and system dynamics simulation model. The standard IS-LM model with exogenous money and fixed price assumptions, among others, is shown to be flawed in the sense that it cannot explain the typical macroeconomic behaviors such as observed during the Great Depression and the recent case of Japan's lost 30 years.

2. On the other hand, the revised IS-LM model with endogenous money and flexible price is shown to explain the behaviors of the Great Depression successfully under the *endogenous money spending hypothesis*, which integrates the spending hypothesis proposed by Keynes and money hypothesis as originally proposed by Fisher both in the same year of 1935.

3. The explanatory limitation of the conventional IS-LM analysis is due to the above model assumptions. This renders the Keynesian IS-LM model, in which *IS* and *LM* curves are shifted separately for macroeconomic policy analysis, no longer valid as a reliable model of the economy under the fractional reserve banking system where money stock is endogenously determined by total debts by banks.

4. Under the current debt money system, *IS* and *LM* curves must therefore move jointly or simultaneously in the phase diagram of production (GDP) and interest rate. Joint shifts of both *IS* and *LM* curves can occur as wide as the phase diagram allow, making the movement of IS-LM equilibrium point unpredictable.

5. This has led us to identify a methodological problem of the traditional comparative static analysis of shifting either *IS* or *LM* curve separately and observing its impact on the economy, as we have been thoroughly taught by macroeconomic textbooks. It is also no longer applicable to the analysis of recessions. For the analysis of recessions under the current debt money system, both *IS* and *LM* curves must be jointly shifted all the time.

6. Yet, due to our simple mechanistic assumption that endogenous money is artificially implemented according to the growth rate of income, this endogenous money IS-LM model presented in Part I failed to produce the behaviors of Japan's lost 30 years. The mainstream models also failed to provide a systematic explanation.

7. To overcome this limitation, we have expanded the Keynesian short-run IS-LM model in Part II by incorporating the budget equations of macroeconomic sectors as mathematical models of loanable funds and endogenous money first, then, as the Accounting System Dynamics (ASD) macroeconomic models. The ASD model thus constructed was able to integrated both mathematical models.

8. The ASD model constructed on the basis of the exogenous money assumption is called *Loanable Funds ASD* model. It failed to support the Keynesian view that aggregate demand creates its supply (production). At this stage of our research we are convinced the Keynesian view of exogenous money can no longer hold as the macroeconomic theory

of the current debt money system. It could be effective, however, as we have demonstrated in this paper, under the public money system where total money stock is fully controlled.

9. The ASD model constructed on the basis of the *endogenous money spending hypothesis* is called *Endogenous Money ASD* model. It was able to successfully reproduce similar behaviors of the Great Depression as analyzed in Part I, but this time, without relying on the mechanistic assumption of economic growth for the creation of endogenous money and its destruction. Furthermore, the model successfully produced the joint shifts of IS-LM curves to the "point J" as a representative case of the Japan's lost 30 years. In this way, we have shown that the *Endogenous Money ASD* model thus presented in Part II could be more generally applied to the study of major economic recessions in history.

10. Furthermore, the *Endogenous Money ASD* model is shown to produce the money-debt relationships and its decomposition observed in the U.S. and Japan. Accordingly, the inclusion of endogenous money must be a core component of all macroeconomic models under the current debt money system. All textbooks that still apply the traditional IS-LM analysis on the basis of exogenous money must be rewritten immediately. The ASD model presented in Part II serves both as a foundation for the paradigm shift in macroeconomics and a new integrated framework for theoretical and real-world case studies in place of the Keynesian models grounded on loanable funds (exogenous money).

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Appendix: Endogenous Money ASD Model

$$
\begin{aligned}
Y &= AD && \text{(Aggregate Demand Equilibrium)} && (60)\\
AD &= C + I + G && \text{(Aggregate Demand)} && (61)\\
C &= C_0 + cY_d && \text{(Consumption Decisions)} && (62)\\
Y_d &= Y - T && \text{(Disposable Income)} && (63)\\
T &= T_0 + tY - T_r && \text{(Tax Revenues)} && (64)\\
I &= \frac{I_0}{r} - \alpha r && \text{(Investment Decisions)} && (65)\\
G &= \bar{G} && \text{(Government Expenditures)} && (66)\\
\frac{M^s}{P}V &= L^d && \text{(Equilibrium of Money)} && (67)\\
L^d &= aY - bi && \text{(Demand for Money)} && (68)\\
r &= i - \pi^e && \text{(Fisher Equation)} && (69)
\end{aligned}
$$

$$
\begin{aligned}
PC + PT + PI_H + S &= W + \Pi + \Delta D_H && \text{(Households Budgets)} && (70)\\
W + \Pi &= PY && \text{(Distributed Income)} && (71)\\
PI_H &= \Delta D_H && \text{(Housing Budgets)} && (72)\\
I_H &= \bar{I}_H && \text{(Housing Investment)} && (73)\\
W + \Pi + PI_P &= PY + \Delta D_P && \text{(Producers Budgets)} && (74)\\
I_H + I_P &= I && \text{(Private Investment)} && (75)\\
PG &= PT + \Delta D_G && \text{(Government Budget)} && (76)\\
\Delta D_H + \Delta D_P + \Delta D_G &= \Delta LF && \text{(Loanable Funds of Debts)} && (77)
\end{aligned}
$$

$$
\begin{aligned}
(\Delta LF &= S\ ) && \text{(Savings as Loanable Funds by Banks)}\\
\Delta LF &= \Delta M^s && \text{(Endogenous Deposits Creation)} && (78)\\
M^s &= \int \Delta M^s dt && \text{(Endogenous Money Stock)} && (79)
\end{aligned}
$$

The endogenous money short-run IS-LM model consists of the above 20 equations with 20 unknowns:

$$Y, AD, C, I, G, Y_d, T, i, r, L^d, S, I_H, W + \Pi, I_P, \Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, \Delta M^s, M^s$$

and 14 exogenously determined parameters:

$$C_0,\ c,\ T_0,\ t,\ T_r,\ I_0,\ \bar{G},\ P,\ V,\ \alpha,\ a,\ b,\ \pi^e,\ \bar{I}_H.$$