The Long-Run Endogenous Money ASD Model of the Debt Money System (Part III)

– Paradigm Shift in Economics As A Science –

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Abstract

This is the third paper of our ongoing research series on Keynesian macroeconomic models. In Part I, by building the System Dynamics (SD) model of Keynesian short-run IS-LM model, we have refuted the spending and money hypotheses that have been widely accepted in standard textbooks as the causes of the Great Depression. Instead we have shown that the endogenous money spending hypothesis explains the Great Depression. The Part I model, however, failed to explain the peculiar case of Japan's lost 30 years. In Part II, by expanding the IS-LM model with budget equations of domestic macroeconomic sectors based on the Accounting System Dynamics (ASD) method, we have demonstrated that the endogenous money ASD model captures the behaviors of Japan's case as well as the Great Depression. These Keynesian models introduced in Part I and II, however, have so far neglected neoclassical long-run view of macroeconomics with capital accumulation and production function. In Part III, we further expand the Part II model into a *long-run* endogenous money ASD model and demonstrate the model has features of both Neoclassical and Keynesian theories in terms of price adjustment mechanism and income determination. The Part III model has also produced the case of Japan's lost 30 years qualitatively. Accordingly, the *long-run* endogenous money ASD model developed in Part III provides the Neoclassical-Keynesian synthesis that is consistent with the economic reality of the debt money system, and that fully embodies the paradigm shift in economics as a science.

Keywords: Accounting System Dynamics, debt money, endogenous money, loanable funds, long-run ASD model, the Great Depression, Japan's lost 30 years, paradigm shift

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1 Keynesian IS-LM Models (Part I & II) Revisited

Modern macroeconomic theory developed from the *General Theory* by Keynes (1936). His analysis criticized the omnipotence of market mechanism through price adjustments, and analyzed the determination of income from demand side based on the principle of effective demand. Soon after the publication, Hicks (1937) interpreted the Keynes's theory and formulated it into a simple analytical apparatus, which was subsequently refined and popularized by Hansen (1949) as the IS-LM analysis, *aka* the Hicks-Hansen Synthesis. As discussed in Part I in detail, the IS-LM analysis was founded on the premise that money stock is controlled by the monetary authority such as the national government or central bank. Monetary and fiscal policies applied by policy makers have since been deeply influenced by this conventional approach of the Keynesian macroeconomics. As we also discussed in Part I, however, almost all mainstream economic policies failed to recover the Japanese economy from the post-bubble recession since the early 90's, *aka* Japan's lost 30 years. We have asserted in our previous papers (Yamaguchi and Yamaguchi, 2022a,b) that the policy failures were due to the failures of macroeconomic analyses rooted in the IS-LM analysis, and proposed the paradigm shift from the comparative statics to dynamic endogenous money IS-LM analysis. In doing so, we have presented mathematical analyses of the paradigm shift in economics in Part I and II papers, and presented several corresponding system dynamics (SD) models. Since our analyses have become complex, let us begin this Part III by first overviewing the paradigm shift attained thus far. Table 1 below summarizes it according to the corresponding models presented in Part I and II.

1. We began our research in Part I with the Keynesian Short-Run IS-LM Model, which is built on the assumptions of fixed price under exogenous debt money system. Using this standard IS-LM model, Mankiw (2016) rejected the Money Hypothesis and accepted only the Spending Hypothesis as a plausible cause of the Great Depression. Since it is a comparative statics model, we converted it to the dynamic model with SD modeling approach. The Keynesian IS-LM model thus constructed failed to explain the behaviors of the Great Depression under both Spending and Money Hypotheses (Case 1 simulation).

2. Following the Mankiw's extended version of IS-LM model, we have built the corresponding SD model of Flexible Price IS-LM in which price is made flexible under the exogenous debt money assumption. Yet, both Spending and Money Hypotheses failed to explain the behaviors of the Great Depression (Case 2 simulation).

	(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)
Part III	Capital Accumulation	Case 7 Long-run Loanable Funds (ASD)	Case 8 Long-run Endogenous Money (ASD)

Table 1: Classification of SD and ASD Macroeconomic Models

3. Failures of these Keynesian models are caused by the assumption of exogenous money stock. By hypothesizing this way, we have reviewed in-depth the Irving Fisher's Debt-Deflation and Reflation theories (Fisher, 1933, 1945), which has led us to formulate the Endogenous Money Spending Hypothesis in place of Spending and Money Hypotheses.

4. Based on the hypothesis we have built the SD model of Endogenous Money IS-LM. Yet, this model also failed to explain the behaviors of the Great Depression under the fixed price assumption (Case 3 simulation). However, the model was able to explain the behaviors of Depression successfully under the flexible price assumption (Case 4 simulation).

5. Accordingly, the Endogenous Money IS-LM model could be our paradigm shift model, we thought initially, because, under the current debt money system, *IS* and *LM* curves must move jointly or simultaneously in the phase diagram of income and interest rate as discussed in Part I, and this model can demonstrate such dynamic joint behaviors of *IS* and *LM* curves. Hence, the conventional Keynesian IS-LM model, in which *IS* and *LM* curves are shifted separately for macroeconomic policy analysis, is no longer valid as a reliable model of the economy running under the fractional reserve banking system.

6. The Endogenous Money IS-LM model, however, failed to explain the Japan's lost 30 years that is symbolically represented as a "point J" in the IS-LM phase diagram of Figure 18 in the Part I paper. Specifically, we have identified that its explanatory limitation is caused by the mechanistic application of the Endogenous Money Spending Hypothesis such that money stock fluctuates endogenously according to the growth rate of income.

7. To overcome this limitation, in Part II we have further expanded the above IS-LM models by incorporating the budget equations of domestic macroeconomic sectors such as producers, households, government and banks. In Part II paper, we have first presented mathematical model of the Loanable Funds Model with Budgets, and discussed its validity by introducing the concepts of *ex ante* and *ex post*. Next, we have presented mathematical model of the Endogenous Money Model with Budgets, and shown that it can capture the macroeconomic relationships observed under the debt money systems such as "Money Stock = Total Debts" (Yamaguchi and Yamaguchi, 2021a; Yamaguchi, 2021)

8. To examine behaviors of these two models, we have converted them into the ASD (Accounting System Dynamics) models by incorporating transactions of all domestic macroeconomic sectors including the central bank. The two ASD models developed in Part II are called Loanable Funds and Endogenous Money models, respectively. As requirements for a coherent model, they are validated as SD models (unit checks), ASD models (balance sheets and flow of funds checks) and macroeconomic models (debt money checks).

9. The Loanable Funds Model failed to explain the behaviors of the Great Depression (Case 5 simulation). At this stage of research we were convinced the Keynesian view of exogenous money can no longer hold as a valid macroeconomic theory under the present debt money system, as demonstrated by Cases 1, 2, and 5 simulations. On the other hand, the Endogenous Money Model (Case 6) is shown to produce behaviors consistent with data of the Great Depression as the Endogenous Money IS-LM Model (Case 4) in Part I did.

10. In order to claim that the Endogenous Money Model is truly the model of paradigm shift in economics, we have arranged parameter values such that it captures the Japan's lost 30 years ("point J") at least qualitatively. Our simulations produced (i) Japan's lost 30 years as another Great Depression, revealed (ii) the myth of crowing out effect, and successfully reproduced (iii) the debt-money relationships, all of which are discussed in Part II paper. In addition, the model is able to simulate the point J in the phase diagram as a representative case of Japan's prolonged stagnation.

11. In this way, the Endogenous Money Model (Case 6) is shown to explain the two major events that have taken place in modern economic history. Therefore, it could be the genuine macroeconomic model that captures the previously unexplained phenomena observed

under the current debt money systems. All textbooks that still apply the traditional and *flawed* IS-LM analysis must be rewritten based on this integrated framework. These are what we have attained in our macroeconomic modeling analyses so far.

12. Table 1 also features the current research as Part III; that is, Long-run Loanable Funds (ASD) and Endogenous Money (ASD) Models as Case 7 and 8 with capital accumulation and production function. Upon the completion of these models, our series of SD macroeconomic modeling research will be more thoroughly founded.

This finishes our bird's-eye view of Table 1 as the paradigm shift in economics. Let us now begin Part III by discussing the two models; Long-run Loanable Funds and Endogenous Money.

2 Long-run Macroeconomic Models

Our research in Part I started with the Keynesian view of short-run IS-LM model and obtained a view that our Endogenous Money IS-LM model can explain macroeconomic behaviors consistently with data observed during the Great Depression in the 1930s, and the Japan's lost 30 years since 90s in Part II. However, this Keynesian approach has so far entirely neglected neoclassical long-run view of macroeconomics with capital accumulation and production function. Such model structure poses major drawbacks for analyzing price dynamics, and results in omitting key feedback loops characterizing our economies that are path-dependent.

Short Run vs. Long Run

Now is the time to expand our macroeconomic analysis to the long-run model in this Part III paper. What is long-run, then, *vis-à-vis* short-run? From a dynamic flow of time, it is hard to specify how *short* is a short run, and how *long* is a long run. Are we, at this moment, in the short run or in the long run? It depends on when our starting point in time is specified. This moment could be in the short run to apply Keynesian policies. Or it could be already in the long run. Under the traditional IS-LM analysis, we are often told the model is in the short run (e.g. Mankiw 2016). However, there is no hint for policy makers to know which case applies in the real world other than subjectively choosing between short-run and long-run models.

To avoid such ambiguities, let us define *short run* and *long run* according to Table 2 below. Short run is a period of condition in which capital K is fixed, and output is produced only by labor L. That is, aggregate demand AD determines output Y, which determines only the demand for labor L necessary to produce the level of output. The employed labor does not guarantees full employment. In the short run, price P could be fixed or affected by the inventory gap between desired and current inventories (as defined in Part I). On the other hand, long run is defined as a period in which capital accumulation takes place and the economy's potential production capacity changes. In the long run, furthermore, price becomes fully flexible due to the GDP Gap (defined below) and Inventory Gap. This is our definition of short run and long run. In light of this definition, Part I and II are therefore devoted to the analysis of short-run behaviors. In this paper long-run macroeconomic behaviors are analyzed.

Short Run	Long Run
Capital is Fixed $Y = F(\bar{K}, L)$	Capital Accumulates $Y = F(K, L)$
Fixed or Flexible Price due to · Inventory Gap	Flexible Price due to · GDP Gap · Inventory Gap

Table 2: Definition of Short-run vs. Long-run

Long-run Endogenous Money Model

The endogenous money IS-LM model developed in Part II consists of 20 equations, as listed in Appendix 1 of this paper, (22) through (41), and 14 parameters. Let us now bring long-run equations of capital accumulation and price adjustment into the list of this endogenous money IS-LM model. Specifically, three long-run equations shown below are to be brought here such as (2), (3), and (4). With the introduction of capital depreciation, disposal income (25) must be replaced with the equation (1) that further subtracts capital depreciation (δK). Hence our long-run IS-LM model is expanded to include the following:

$$\begin{aligned} Y_d &= Y - T - \delta K && \text{(Disposable Income)} && (1)\\ \frac{dK}{dt} &= I - \delta K && \text{(Net Capital Accumulation)} && (2)\\ Y_{full} &= F(K, L) && \text{(Production Function)} && (3)\\ \frac{dP}{dt} &= \Psi(Y - Y_{full}) && \text{(Flexible Price)} && (4) \end{aligned}$$

Our long-run IS-LM model is complete now. Three equations are newly added to the previous endogenous money IS-LM model with three unknowns: K, Y_{full}[1] and P (P is now moved from a parameter to a model variable) with one replacement equation (1), and two additional parameters δ (capital depreciation rate) and L (labor force). Let us call this expanded model "Long-run Endogenous Money Model", or simply "Long-run Model" with the implicit assumption that money is endogenously determined in the model unless specified otherwise.

The long-run endogenous money model is compactly summarized in Appendix 2. It consists of the 23 equations; (42) through (64). The above four equations (1) through (4) are renumbered as (45), (52), (53), and (54). It has corresponding 23 unknowns such as

$$Y, AD, C, I, G, Y_d, T, i, r, L^d, S, I_H, W + \Pi, I_P,$$

$$\Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, \Delta M^s, M^s, K, Y_{full}, P$$

and 15 exogenously determined parameters:

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

Long-run Loanable Funds Model

In Part II we presented the loanable funds model (case 5) first, then it was expanded to the endogenous money model. In this Part III we have presented the endogenous money model first to indicate that it must be indeed the standard Keynesian macroeconomic model as proved in Part II. That is, loanable funds model turned out to be flawed under the debt money system.

Now the long-run loanable funds model in Part III (case 7) can be shown to be derived from the endogenous money model. Since banks cannot create money endogenously under the loanable funds assumption, their budgets are constrained by the following budget equation:

$$\Delta LF = S \qquad \text{(Savings as Loanable Funds by Banks)} \qquad (5)$$

This replaces endogenous deposit creation (63) and endogenous money stock (64); that is, ΔM^s and M^s are no longer unknowns. Yet, we still have 22 remaining equations; (42) through (62) and (5).

[1]Note that these two variables have real units here.

From Walras law as discussed in Part II, either aggregate demand equilibrium (42) or the equilibrium of loanable funds (62) must be redundant. As we discussed there, households, producers and government cannot start their economic activities without enough funds at hand, so their borrowings have to come first. Hence, the equation (62) must remain effective, and the equation (42) is made redundant as we did in Part II model.

With these considerations in mind, the long-run loanable funds model consists of 21 equations; (43) through (62) and (5) as presented in Appendix 2. It has corresponding 21 unknowns such as

$$Y, AD, C, I, G, Y_d, T, i, r, L^d, S, I_H, W + \Pi, I_P,$$
$$\Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, K, Y_{full}, P$$

and 15 exogenously determined parameters:

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

3 Long-run ASD Model of Endogenous Money and Loanable Funds

Production Function

Once the Long-run Endogenous Money Model (case 8) is constructed, its loanable funds model can be easily turned on by setting Switch (Loanable Funds) = 1 (as in Part II). The model runs under the endogenous money model when it is set to 0. Hence, in this section we only focus on the construction of the long-run endogenous money model. Now let us transform the long-run endogenous money and loanable funds models presented above mathematically into the ASD (Accounting System Dynamics) model. Transactions among macroeconomic sectors are the same as in Part II. So we only discuss the modeling of the long-run related equations.

First, we simply specify the production function in equation (3) as follows:

$$Y_{full} = e^{\kappa t}\frac{1}{\theta}K \tag{6}$$

where κ is an annual rate of technological progress, and θ is a capital-output ratio. Furthermore, for simplicity, labor force L is not considered in this model.[2] With the introduction of production function, real production Y or GDP has to be defined to be realized by the minimum amount of Y_{full} or Y^D such that

$$Y = \text{Min}(Y_{full},\ Y^D) \tag{7}$$

where Y^D is the desired real production used from Part I models.

Let us define the difference between Y_{full} and Y^D as "GDP Gap". Then, by definition, full capacity equilibrium $Y_{full} = Y$ is attained only when the GDP Gap becomes zero:

$$\text{GDP Gap} \equiv Y_{full} - Y = 0 \text{ (Full Capacity Equilibrium)}^3 \tag{8}$$

[2]Labor is yet important factor of production. Here we simply assume that output is determined only by the existing capital, and labor input is flexibly adjusted within each institutional unit of production required to attain this output level, as if our economy is a market-based system consisting of self-managed businesses (producers), not the capitalist economy with labor market. Lifetime employment system that was once dominant in the Japanese (business) management is a good example of such economic system that has proven its high productivity and technological growth. See Yamaguchi (2022) further for population dynamics and labor market.

[3]Note that when $Y^D > Y_{full}$, our economy is running beyond full capacity. Yet, GDP Gap becomes zero according to our definition, and this state of excess demand is regarded as an equilibrium state. When price is flexible in the long run, this excess demand over capacity surely causes price to increase.

For the unified analysis of disequilibria, let us introduce ratios of GDP Gap and Inventory Gap as follows:

$$\text{GDP Gap ratio} = \frac{Y_{full} - Y}{Y_{full}} \tag{9}$$

$$\text{Inventory Gap ratio} = \frac{I^*_{nv} - I_{nv}}{I^*_{nv}} \tag{10}$$

The long-run production process in our ASD macroeconomic model is shown in Figure 1.

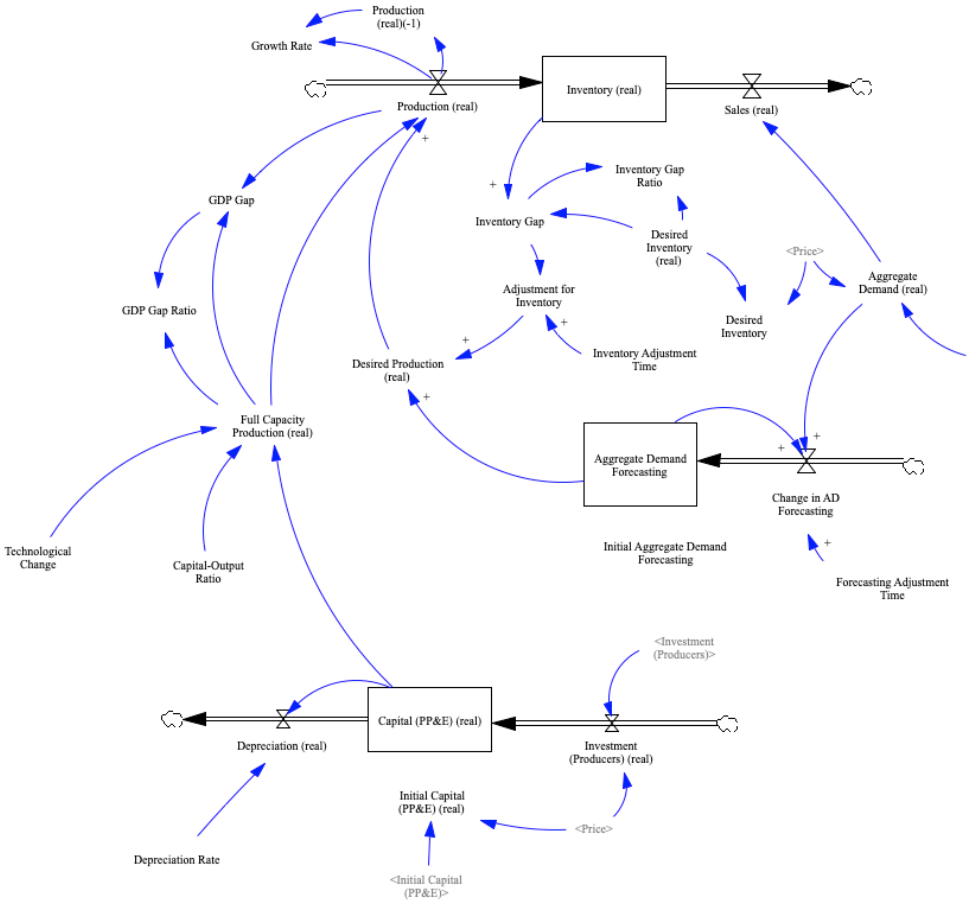

Figure 1: Capital Accumulation, Full Capacity Production and Aggregate Demand

Price Adjustment Mechanism

To attain long-run equilibrium, price is made flexible by introducing equation (4). To reflect the GDP gap, Y in the equation must be further replaced with the desired production Y^D such that

$$\frac{dP}{dt} = \Psi(Y^D - Y_{full}). \tag{11}$$

In the short-run ASD model price adjustment is defined to reflect the behaviors of inventory gap. Here we have assumed that price must be made flexible in the long run with the combination of discrepancies between Y^D and Y_{full} (GDP gap), and inventory I_{nv} and its desired inventory I^*_{nv} (Inventory gap). That is, our new price adjustment mechanism must now be described as

$$\frac{dP}{dt} = \Psi(Y^D - Y_{full},\ I^*_{nv} - I_{nv}). \tag{12}$$

Let us specify this price equation as follows:

$$\frac{dP}{dt} = \frac{P^* - P}{\text{Adjustment Time}} \tag{13}$$

in which the desired price P^* is calculated as

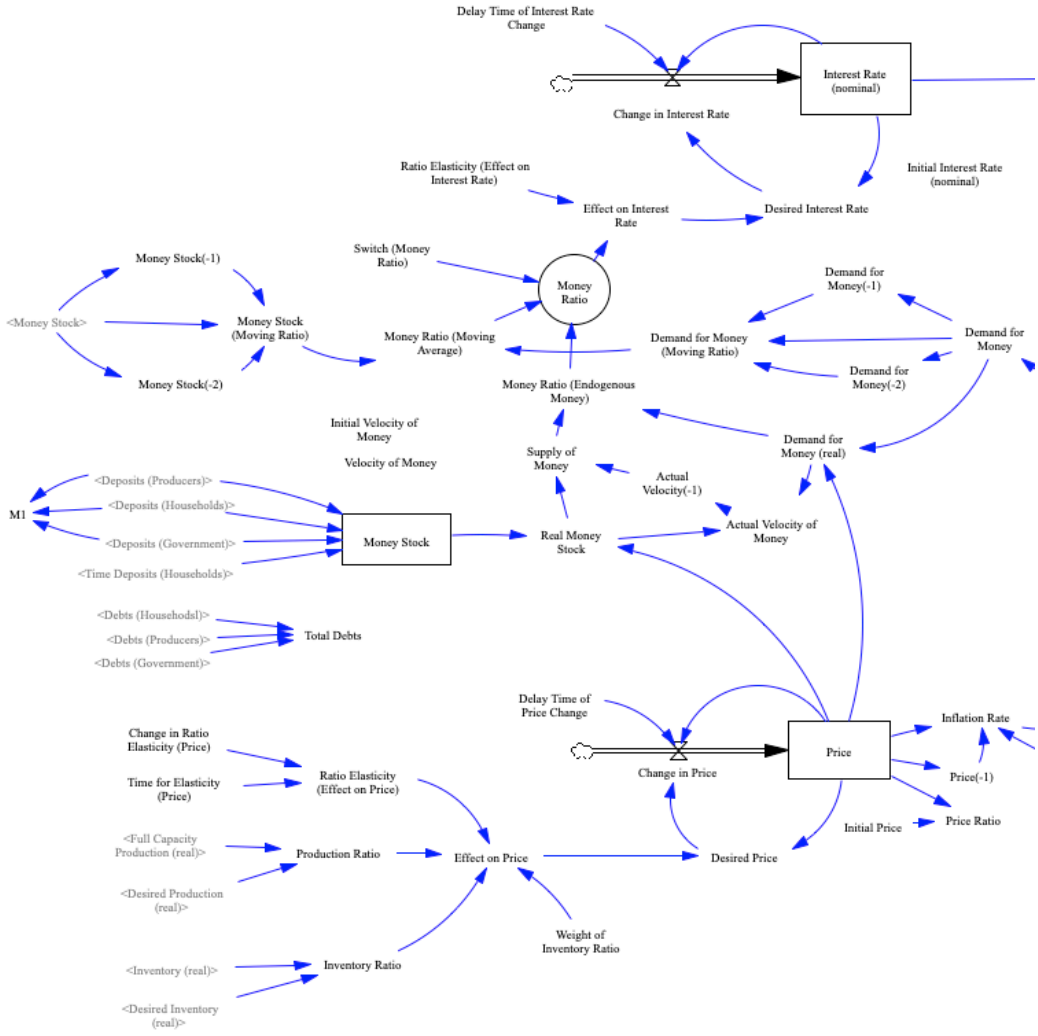

Figure 2: Price and Interest Rate Adjustment Processes

$$P^* = \frac{P}{\left((1-\omega)\frac{Y_{full}}{Y^D} + \omega\frac{I_{nv}}{I^*_{nv}}\right)^e} \tag{14}$$

where $\omega, 0 \leq \omega \leq 1$, is a weight between production ratio ($\frac{Y_{full}}{Y^D}$) and inventory ratio ($\frac{I_{nv}}{I^*_{nv}}$), and e is the elasticity of desired price, which is called Ratio Elasticity (Effect on Price) in our model. Figure 2 above illustrates long-run adjustment processes of price and interest rate.

Revised Consumption Decisions

Consumption has been assumed so far to be determined by a constant marginal propensity to consume as expressed in equation (24). In the long-run ASD model as discussed above, price is explicitly assumed to be flexible. Accordingly it is now appropriate to consider that consumer's expenditure responds to prices. Specifically, marginal propensity to consume c is now assumed to be dependent on a ratio price elasticity of consumption such that

$$c(P) = \frac{c}{\left(\frac{P}{P_0}\right)^{\varepsilon}} \tag{15}$$

where P_0 is an initial price level and ε is a ratio price elasticity of consumption. As a ratio price level goes up (*i.e.* inflation), marginal propensity to consume gets smaller. In this way, consumption is affected by the relative size of prices against the initial price and its elasticity. Accordingly, the revised consumption function becomes

$$C(P) = C_0 + c(P)Y_d \tag{16}$$

The consumption function thus defined has a feature of a downward-sloping demand function, similar to a demand curve of consumers at a microeconomic level.

4 Validations of the Long-run ASD Model

Our long-run ASD model of both endogenous money and loanable funds is now complete. Let us now examine the model with the following four validation tests as proposed in Part II.[4]

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

Built-in model tests performed by the SD simulation software (Vensim) such as "Check Model" and "Units Check" must be all cleared as a reliable model. Our model have passed both tests. Recall that in Part I we have pointed out that the extended IS-LM model with expected inflation presented by Mankiw (2016, Chapter 12) failed to pass this unit consistency check.

(2) Validation of ASD Model: B/S and F/F Checks

Accounting system requires that balance sheets of all sectors must be in balance at any point in time and their transactions are coherent. This first test to ensure such consistency of the model is called balance sheets (B/S) check. Furthermore, the flow-of-funds account framework requires that all assets and liabilities (equity) of all financial transaction items in the model must be in balance across all macroeconomic sectors involved at every time step. This second test is called the flow-of-funds (F/F) check. Left diagram of Figure 3 illustrates that, for

[4]Validation test (4) of Non-Equivalence Checks is added to the revised Part II paper.

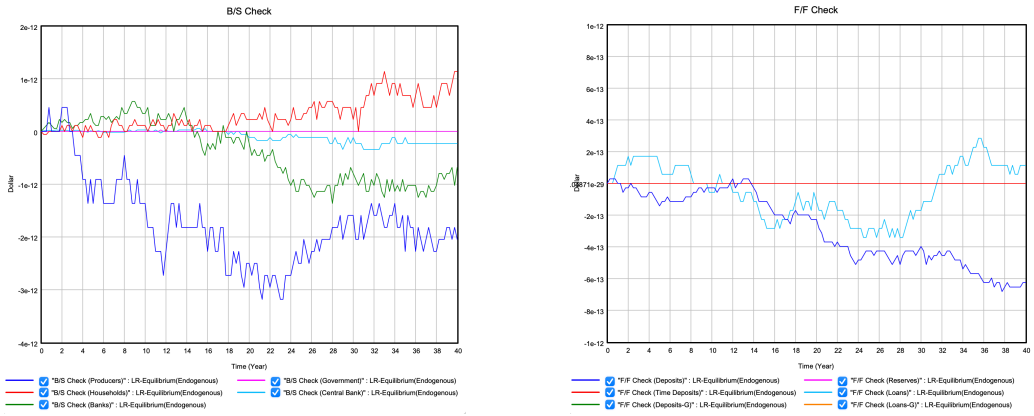

Figure 3: Validation Test (2) - Balance Sheets (B/S) and Flow-of-Funds (F/F) Checks

the Long-run Endogenous Money model, balances of each sector's balance sheet are almost zero, indicating that the model passes the B/S check for all macroeconomic sectors. The right diagram illustrates 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 check on the Long-run Loanable Funds model are also confirmed.

(3) Validation of Macroeconomic Model: Debt Money Check

We have mathematically presented in Part II that money stock is equal to the total debts under the debt money system. Yamaguchi and Yamaguchi (2021b) reported that, under the current debt money system, the following three relations hold in the Japanese economy between 1980 and 2019 (line numbers in parentheses are those shown in Figure 4 in the next page).

1. Total Money Stock (M_3) $\simeq$ Total Debts (line 1 $\simeq$ line 2)
2. Time Deposits (M_T) $\simeq$ Private Debts (by Producers and Households) (line 3 $\simeq$ line 4)
3. M_1 (= Currency + Demand Deposits) $\simeq$ Government Debts (line 5 $\simeq$ line 6)

Yamaguchi (2021) found further that the similar relationships were observed in the U.S. economy, following the Japanese case. Total money stock is M_2 in the U.S. case. Empirical results indicate that the first relation must hold in any economy operating under the current debt money systems. Hence, this additional validation test for macroeconomic models is called Debt Money check in Part II.

Figure 4 shows that all of the above three relations of Debt Money Check hold for the cases of Long-run flexible price (to be discussed in the following section) where the primary balance ratio is changed from 1.0 to 1.1. Left diagram of Loanable Fund case shows that all three relations hold at constant levels. Right diagram of Endogenous Money case shows that total increasing money stock defined as M_2 is equal to total debts, while the remaining two relations also hold approximately.

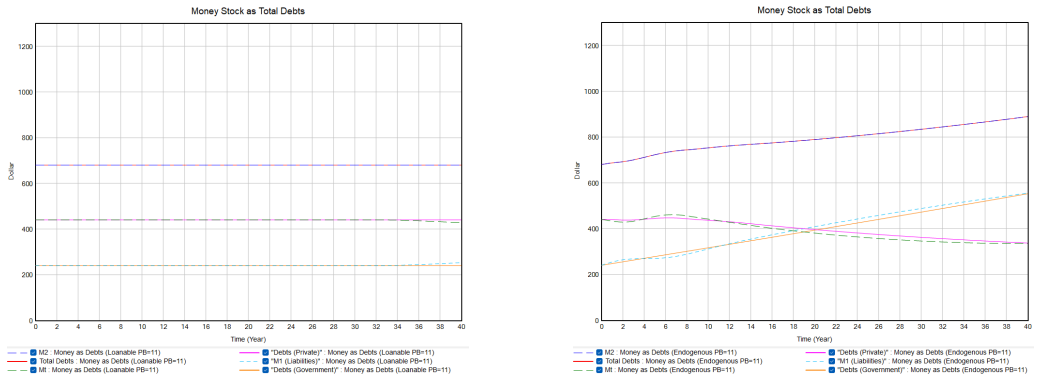

Figure 4: Validation Test (3) - Debt Money Check: Money Stock $\simeq$ Total Debts

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

Our fourth validation test is the relations of the four macroeconomic aggregates newly introduced in Part II such as Production (GDP), Production (Unit Cost Basis), Aggregate Demand (Expenditure) and Income at Factor Cost. They are in general not equivalent. Only at the equilibrium in which Unsold Products = 0, as illustrated in Figure 5 below, we have the following equivalence relations (numbers within parentheses indicate simulation line numbers in the figure):

$$\begin{aligned} \text{Production (GDP) (1)} &= \text{Production (Unit Cost Basis). (2)} \\ &= \text{Aggregate Demand (3)} \\ &= \text{Income at Factor Cost (4) + Depreciation (Cost) (6)} \\ &\geq \text{Income at Factor Cost (4)} \qquad (17) \\ &\quad \text{(for Depreciation (Cost)} \geq 0) \end{aligned}$$

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 5 is a simulation of these equivalence relations in which investment is increased by \$30 at t = 15. Around the time t=18 and t=26 when Unsold Products (at Price) is positive (line 5), the following relations are observed:

$$\begin{aligned} \text{Production (GDP) (1)} &> \text{Production (Unit Cost Basis) (2)} \\ &> \text{Aggregate Demand (3)} \\ &> \text{Income at Factor Cost (4)} \qquad (18) \end{aligned}$$

Around the time t=22 when Unsold Products is negative, these relations are reversed such that

$$\begin{aligned} \text{Aggregate Demand (3)} &> \text{Production (Unit Cost Basis) (2)} \\ &> \text{Production (GDP) (1)} \\ &> \text{Income at Factor Cost (4)} \end{aligned} \tag{19}$$

In other words producers are responding to aggregate demand by drawing down their inventories (and they may be making adjustments to reduce production in the background). These relations indicate that macroeconomic models that presume only the equivalence (equation (17)) must be refuted as defect models from our ASD approach of dynamic off-equilibrium analysis.

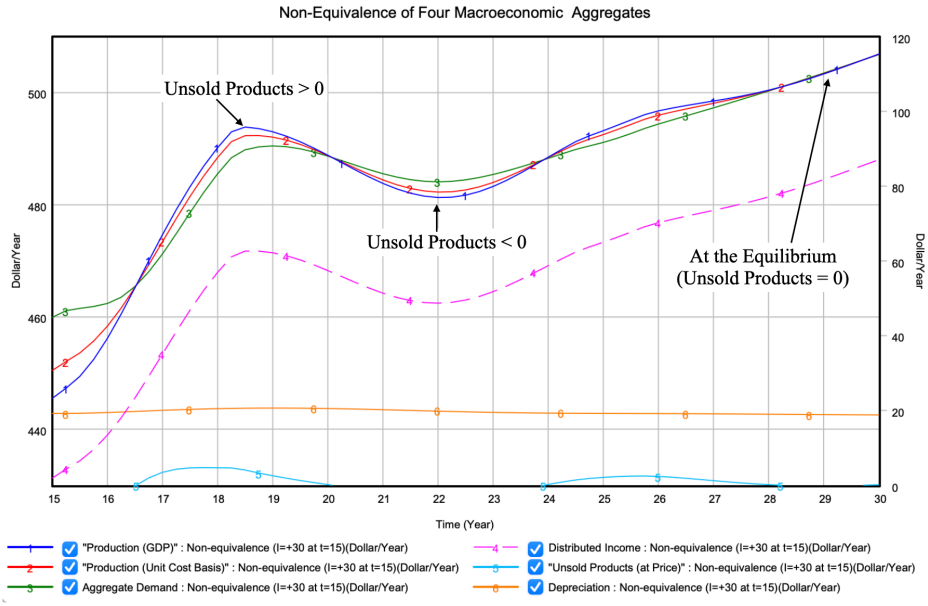

Figure 5: Validation (4) – Non-equivalence of Four Macroeconomic Aggregates

The above four tests constitute validation of our long-run ASD macroeconomic model of both endogenous money and loanable funds. Hence, the long-run ASD model becomes one of the most comprehensive models in the sense that theoretical controversies between neoclassical and Keynesian schools of economics are now uniformly analyzed under the same model only by changing model parameters. So far these controversies in the mainstream economics have given us an impression that their macroeconomic models are mutually exclusive and cannot be integrated like oil and water. Our ASD approach of macroeconomic model here has unified these controversies as if they are different behaviors caused by the same underlying macroeconomic system structure. Table 1 classifies macroeconomic models that have been under controversies so far. They are now unified as the long-run ASD macroeconomic model developed in Part III.

5 Behaviors of the Long-run ASD Model

Let us now run the long-run endogenous money ASD model and analyze its behaviors. The model assumes a growing economy by default.

5.1 Long-run Flexible Price Equilibria

In the long run price P must be flexible. This price flexibility is assumed by default in the model such that Initial Ratio Elasticity (Price) = 3. A left diagram of Figure 6 demonstrates long-run equilibria thus attained under the endogenous money (Case 8); that is, full capacity production (line 1 in blue), desired production (line 2 in red) and production (line 3 in green) are all matched. This long-run equilibrium is attained under the additional assumption that Inventory Gap does not affect price fluctuation; that is, Weight of Inventory Ratio = 0.

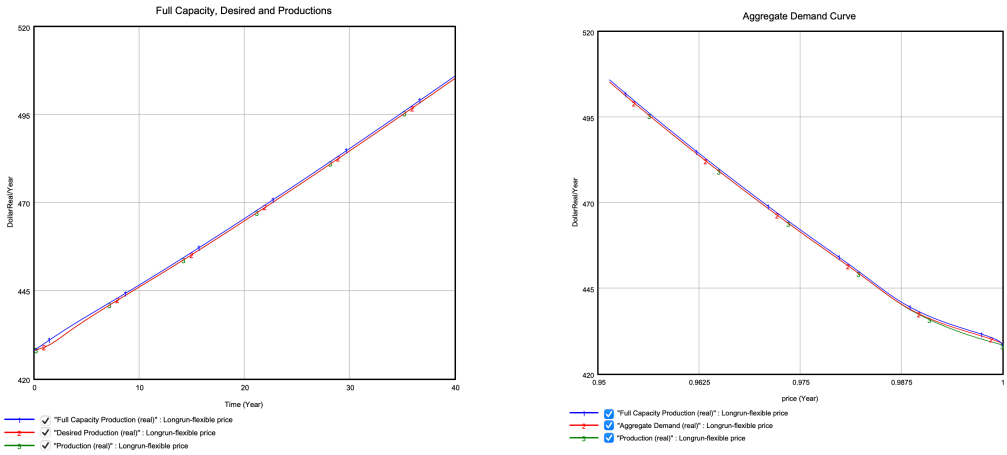

Figure 6: Long-run: Flexible Price Equilibria (left) and Aggregate Demand Curves (right)

Aggregate Demand Curve

Let us now examine if the long-run equilibrium exhibits a long-run aggregate demand curve. Its existence is derived as follows. First, let us rewrite the simple IS-LM equilibrium of production obtained in Part I as a function of price:

$$Y(P) = A + B\frac{M^s}{P}V \tag{20}$$

where A and B are combined constant amounts. Then it becomes clear that this equation only provides a relation between Y and P. Hence, $Y(P)$ is called an aggregate demand function of price. Only when price is flexible in the long run, full capacity production becomes equal to the production as presented in the above left diagram such that

$$Y_{full} = Y(P) \tag{21}$$

This is how the long-run aggregate demand function is theoretically derived. It can be also interpreted as the long-run aggregate supply function. Right phase diagram of Figure 6 indeed demonstrates full capacity production (line 1 in blue), aggregate demand curve (line 2 in red) and production (line 3 in green) as functions of price in the long run.

5.2 Stability of Long-run Flexible Price Equilibria

Long-run equilibria attained under price flexibility can be shown to be stable in the sense that any outside shocks can be absorbed in the long-run as the neoclassical (general equilibrium)

theory claims. Let us consider the case in which outside shocks of investment increase and decrease take place such that $\Delta I = \pm 25$ from the initial level of $I = 60$ at t=12. Left diagram of Figure 7 shows how off-equilibria caused by outside shocks of investment increase (lines 1,2,3) and investment decrease (lines 4,5,6) are restored to the equilibria in the long-run. In a similar way, let us consider another case of off-equilibria caused by outside shocks of changes in MPC (marginal propensity to consume) by $\Delta mpc = \pm 0.05$ from the initial level of $mpc = 0.6$ at t=12. Right diagram shows how equilibria are restored in the long run when mpc is increased and decreased.

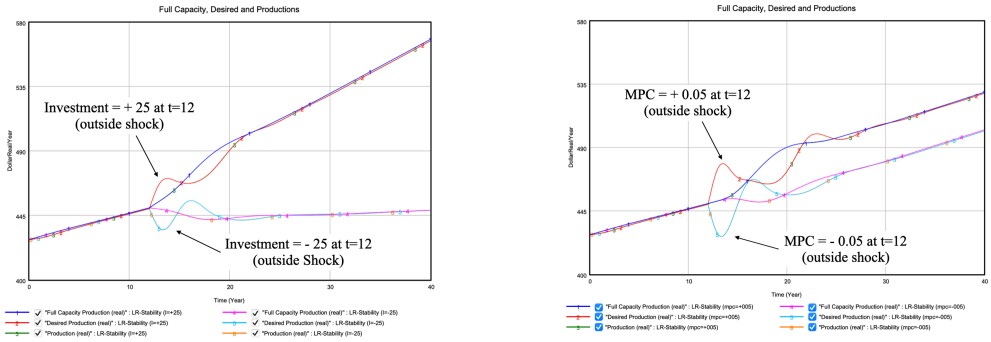

Figure 7: Stability of Long-Run Equilibria under Flexible Price

In this way, our long-run endogenous money ASD model is able to attain a long-run stability. That is, it can successfully cover the features of neoclassical growth model as well.

5.3 Long-run Flexible Price Disequilibria

Price flexibility does not always guarantee long-run equilibrium if flexible price is partly affected by the inventory gap. Price flexibility is assumed to be obtained by the linear combination of GDP and inventory gaps in equation (14). So far, to attain long-run equilibria price has been assumed to be affected only by the GDP gap. Now suppose price flexibility is 20% affected by the inventory gap; that is, Weight of Inventory Ratio = 0.2. Then, as the right diagram

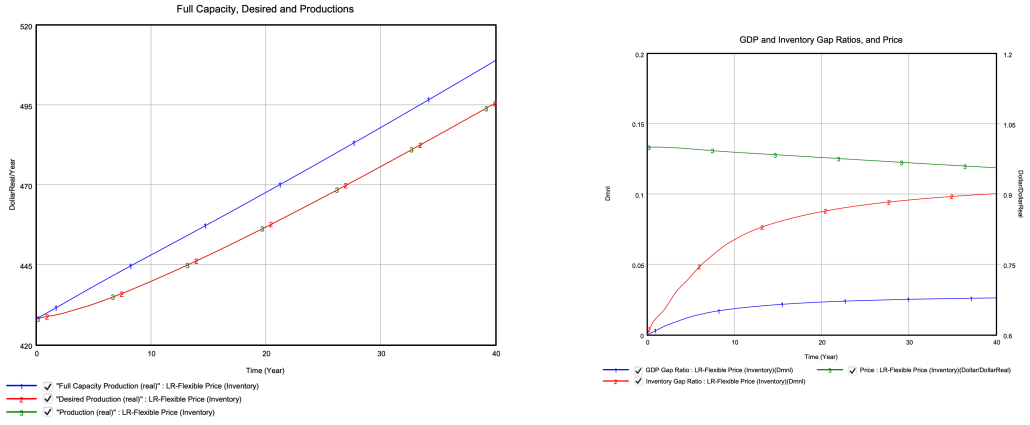

Figure 8: Flexible Price Disequilibria caused by Inventory Gap

of Figure 8 shows, both GDP Gap (line 1 in blue) and Inventory Gap (line 2 in red) start to

increase under a slightly decreasing but stable price (line 3 in green). Simultaneously, in the left diagram, both desired production (line 2 in red) and production (line 3 in green) begin to break from full capacity production (line 1 in blue), indicating disequilibria in the long run under the same price flexibility of Initial Ratio Elasticity (Price) = 3.

This is an entirely unexpected off-equilibrium behavior under price flexibility in the long-run against the neoclassical view of long-run equilibria under price flexibility as discussed above. Price flexibility caused by inventory gap can be interpreted as a hidden short-run price flexibility in the long run. Our simulation here indicates that this hidden short-run price flexibility triggers a long-run disequilibria. Traditional neoclassical theory seems to have totally neglected the impact of this hidden short-run price flexibility on the long-run disequilibria.

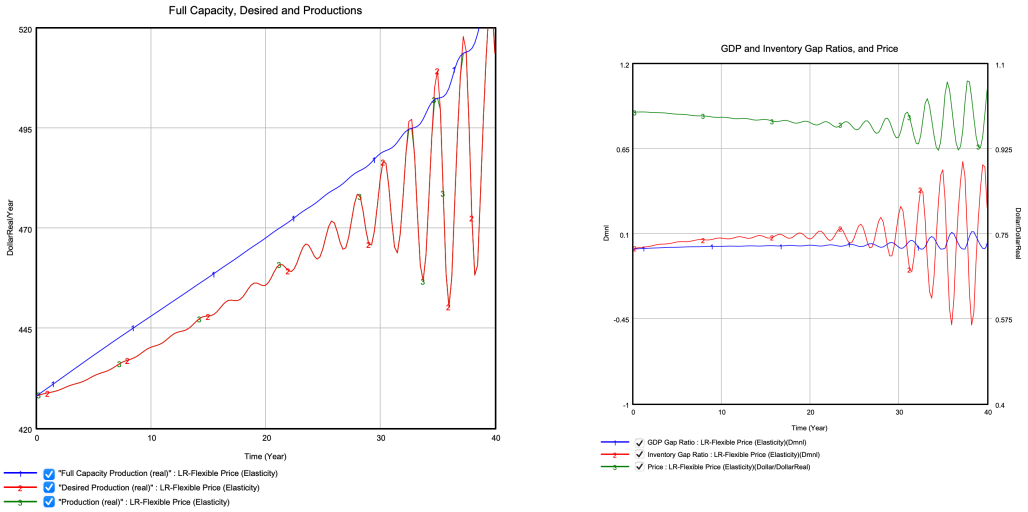

Figure 9: Flexible Price Disequilibria fixed by Price Elasticity

If long-run price flexibility cannot exclude the influence of short-run price flexibility caused by the Inventory Gap, how can we restore the long-run equilibrium? First of all, we have increased the value of Initial Ratio Elasticity (Price) from 3 to 5 to enhance the price flexibility furthermore. Left diagram of Figure 9 illustrates that long-run equilibrium can only be attained cyclically around the peaks of business cycles (lines 2 and 3). Right diagram shows that price (line 3) as well as GDP (line 1) and inventory gap (line 2) ratios all begin to fluctuate under such circumstances. Then, we have tried many simulations of combined parameter values unsuccessfully. As a last resort, we have introduced Keynesian fiscal policy with the same results as we discuss in the following section.

Finally we have asked if it's possible to avoid the price fluctuation caused by Inventory Gap, first of all. In real economy, price is all the time affected by a combination of Inventory and GDP gaps as defined in equation (14), thus it becomes almost impossible to separate two gaps so as to statistically identify Inventory Gap as a main cause of long-run disequilibria. This implies that our long-run macroeconomic behaviors are destined to produce economic recessions as short-period business cycles. If this is the case, our long-run ASD model demonstrates for the first time in macroeconomics, to the best of our knowledge, that business cycles are normal behaviors of the economy even under the long-run price flexibility. In other words, long-run equilibrium is an illusion caused by the flawed view of neoclassical theory. This is an unexpected finding in this paper.

A Remark on Public Money as "Exogenous Money"

In Part II we have pointed out that loanable funds ASD model may be applicable to the economic system in which money stock is exogenously controlled by the monetary authority such as the public money system. This implies that business cycles of this type may not be avoidable even under the public money system. Yet, if labor market is not linked with full capacity production, as we have assumed in the production function (6), no significant unemployment issue takes place under the public money system. Unemployment becomes an issue only when labor is freely traded in the labor market and linked with economic recessions under the current debt money system, which causes booms and busts through endogenous money creation and destruction by the banking sector.

5.4 Long-run Sticky (Fixed) Price Disequilibria

One of the core principles of the Keynesian theory is that "aggregate demand determines income" against the classical view that "supply creates its own demand" (Say's law). We have demonstrated in Part II that this Keynesian view holds only under the endogenous money. Hence, our next question here is whether the Keynesian view still holds in the long-run in which capital accumulation takes place and production capacity grows along with technological progress. In other words, we are interested in examining if our macroeconomy has a built-in mechanism of creating the aggregate demand that continuously catches up with the production capacity.

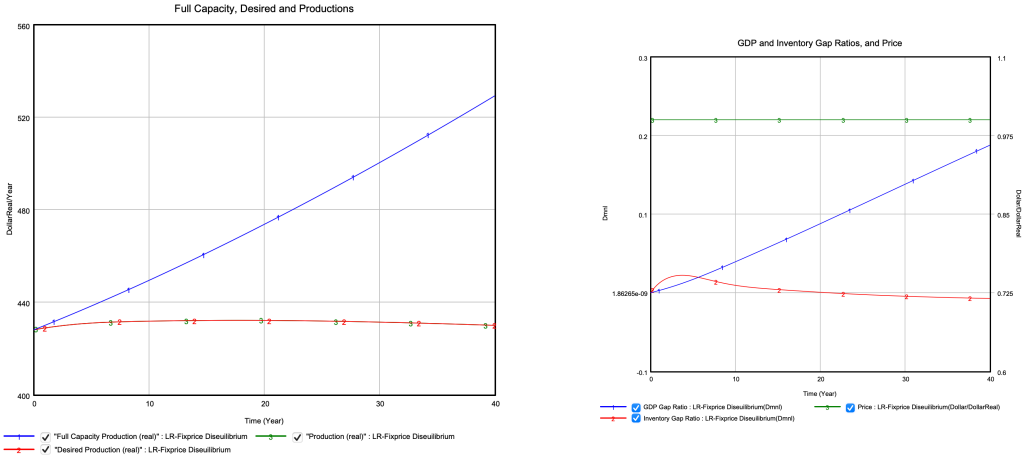

Figure 10: Long-run: Fixprice Disequilibria (left) and GDP gap (right)

A left diagram of Figure 10 illustrates long-run behaviors of production when price is fixed; that is, Initial Ratio Elasticity (Price) = 0. Full capacity production (line 1 in blue) begins to grow faster than the levels of desired production (line 2 in red) and production (line 3 in green). That is, (desired) production fails to catch up with full capacity production when price is sticky. A right diagram indicates that GDP gap ratio (line 1 in blue) continues to expand under such a condition, while Inventory gap ratio (line 2 in red) gets stable.

We have tried to find out a long-run equilibrium under sticky price condition by manipulating many possible combinations of parameter values unsuccessfully, similar to the case of long-run flexible price disequilibria discussed in the above section. It is now clear from our ASD

modeling perspective that the Keynesian theory of aggregate demand equilibria does not hold as long as price is fixed irrespective of short run or long run.

Fiscal Policy under Sticky Price Disequilibria

Faced with this short-run disequilibrium caused by sticky (fixed) price disequilibria, let us now introduce Keynesian fiscal stimulus policy to see if it can overcome this 'built-in' recession under sticky price. Specifically, let us introduce an increase in government spending by increasing Primary Balance Ratio = 1.14 (from 1.0) at t = 10. Figure 11 shows that we can attain full capacity production equilibrium even under sticky price if government spend more to increase aggregate demand. Notice how desired production (red line) overshoots the full

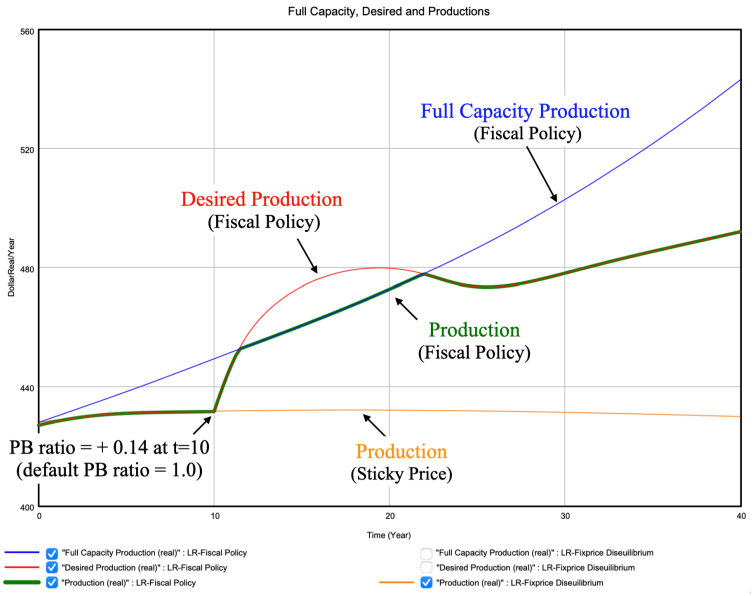

Figure 11: Keynesian Fiscal Policy (PB = 1.14 at t=10) under Sticky Price

capacity production level (blue line) between t=11 and t=22. Accordingly, production (green line) is constrained by the smaller amount of full capacity production. This is the essence of Keynesian fiscal policy under sticky price. Beyond the year t=22, another recession begins to take place. If full capacity production level is to be maintained further, fiscal spending needs to be continued. This is why the government is destined to continue deficit spendings incessantly under debt money system. A bottom left diagram in Figure 12 illustrates the behaviors of GDP and inventory gap ratios (line 1 and line 2) caused by this fiscal policy.

Yet this fiscal policy has its price to pay, as Figure 12 reveals. That is, whenever fiscal policy is performed under sticky price, money stock (line 1 in blue) begins to increase (top left diagram), and as a result nominal interest rate (line 1 in blue) begins to decline (top right diagram) under the current debt money system. This is exactly the opposite behavior against the so-called "crowding out" effect that says that the government spending crowds out the corresponding amount of funds, which is assumed to be exogenously supplied in the Keynes's *General Theory*, from the money market, thus driving up the interest rates. Our ASD model correctly revealed that this crowding out effect does not occur under endogenous money.

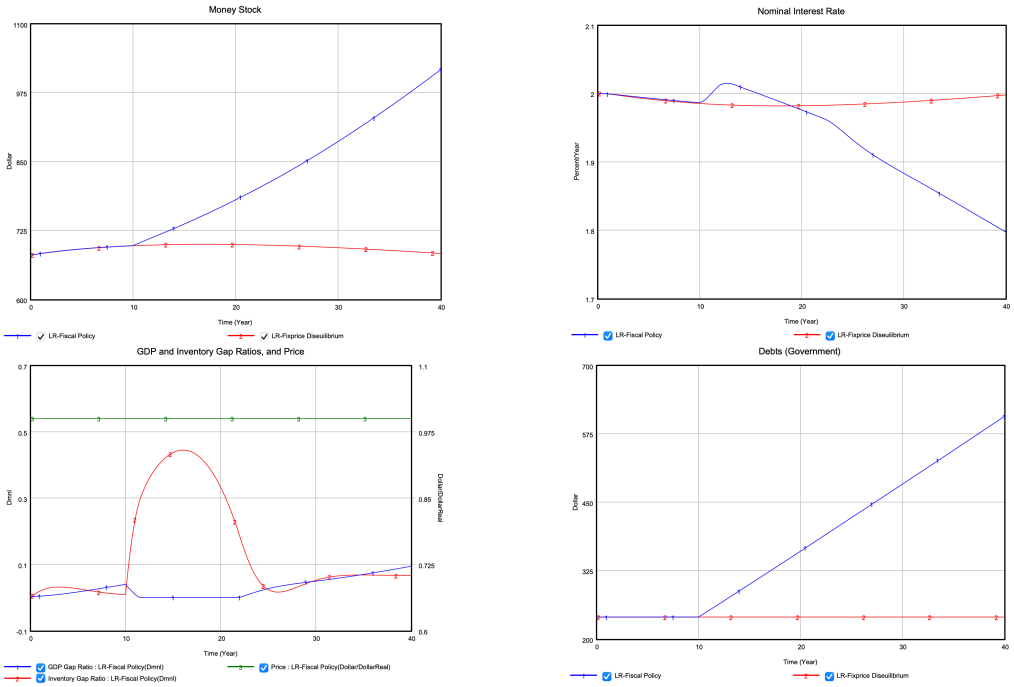

Figure 12: Effects of Keynesian Fiscal Policy under Sticky Price

To be worse, government debts (line 1 in blue) continues to accumulate (top right diagram), which eventually force the government to raise taxes to pay for the interest to bankers and money lenders as creditors of those treasury bonds. Our simulation shows that Keynesian fiscal policy cannot be a sustainable solution. This is the misapplication and fallacy of the Keynesian aggregate demand management policy and its side effect discussed in Part I, which mainstream macroeconomic models have largely neglected due to their methodological (modeling) limitation. Such failure of fiscal policy in macroeconomic arena may be a typical example of one of the systems thinking archetype known as "Fixes that Fail".

6 Japan's Lost 30 Years Finally Captured!

For the long-run ASD model developed in Part III to be claimed as a generic macroeconomic model of the debt money system, it has to be able to capture the two major events in history; that is, the Great Depression, starting in 1929 in the USA and Japan's lost 30 years, starting in 1991. In this section we will examine the case of Japan's lost 30 years as an extended case of the Great Depression, based on the observational assumption that the Great Depression and Japan's lost 30 years were caused by the same underlying mechanism; that is, endogenous money spending hypothesis. Specifically, the long-run endogenous money ASD model has to be examined if it can capture the following phenomena.

- Money-Debt Relationships (discussed as the model validation (3) in Section 4)
- Japan's Lost 30 Years as the Prolonged Great Depression ("Japan's Great Depression")
- "Point J" as the representative case of Japan's Lost 30 Years (discussed in Part II)

We have run simulations over 40 years period, from 1980 through 2020[5] for the following three cases: (1) "Japan as No.1," (2) Japan's Great Depression, and (3) Japan's Lost 30 Years. Table 3 presents parameter values used to simulate these three cases. It should be reminded

Japan as No. 1 ("What If" scenario)	(1) Primary Balance Ratio = 1.1 (← 1) (2) Initial Ratio Elasticity (Price) = 1 (← 3) (3) Price Elasticity of Consumption = 3 (← 2) (4) Repaying Withdrawal Ratio = 0.3 (← 0.8) (5) Initial Deposits (Households) = 120 (← 200)
Japan's Great Depression ("What If" scenario)	(6) $\Delta C_0 = -24$ at t=1992, $\Delta I_0 = -55$ at t=1990 $\Delta \bar{I}_H = -4$ at t=1992 (No Fiscal Policy)
Japan's Lost 30 Years	(7) $\Delta PB = 0.18$ at t=1991 (Fiscal Policy)

Table 3: Parameter Values for the Simulation of Japan's Lost 30 Years

here that this is not a data-fitting calibration against the historical data in Japan. Instead, it is regarded as an exploratory simulation to test if our ASD model can capture the behaviors of Japan's lost 30 years, at least qualitatively, using one-time changes in parameter values (indicated by Δ) as simple outside shocks.

6.1 Decomposition of Money-Debt Relationships

Using the parameter values in the Table, let us first show that the long-run ASD model can capture the decomposition of money-debt relationships in Japan. Figure 13 illustrates the three money-debt relationships we first identified in Japan (Yamaguchi and Yamaguchi, 2021b). They are briefly summarized as follows:

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

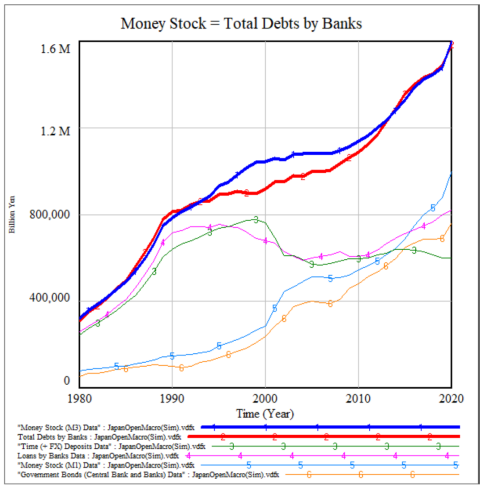

Figure 13: Money-Debt Relations in Japan

A left diagram of Figure 14 shows the behavior of Japan's nominal GDP (line 1 in thick blue) since 1980. To explain the Japan's lost 30 years, Money Stock (line 1 in thick blue) in Figure 13 is replaced with GDP. A right diagram of Figure 14 is simulation result under (3) Japan's Lost 30 Years that shows money-debt and its breakdown relationships such as $M_1, M_T, M_2(M_3)$ and debts by producers, households, and government. Comparing these two diagrams, it may be said that the model can reproduce Japan's money-debt relationships qualitatively.

[5]Initial simulation time t=0 in the model is specified as t=1980. Accordingly, simulation time t=11 implies 1991 and t=40 indicates 2020.

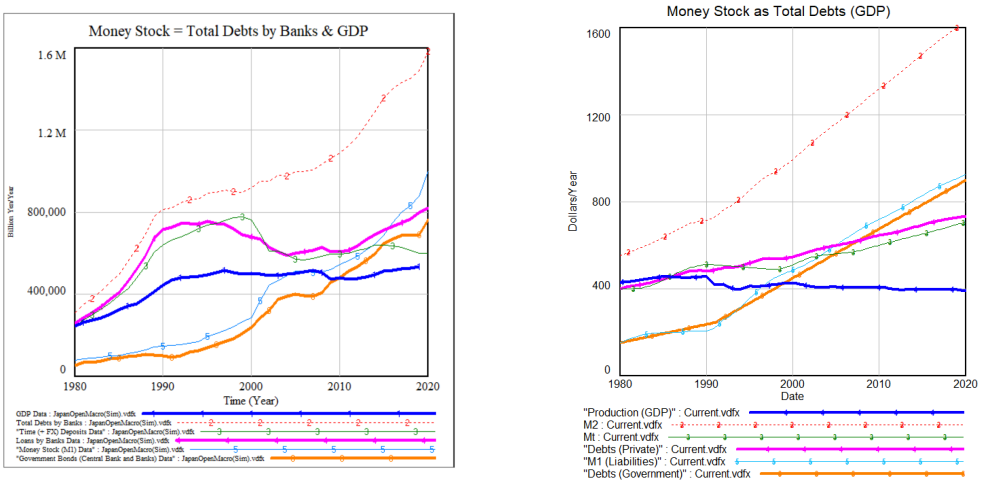

Figure 14: Japan's Lost 30 Years: Data (left) and Simulation (right)

Hence, the model, having captured the Japan's case qualitatively, can be used to analyze its macroeconomic behaviors under the debt money system by manipulating the parameter values. In this sense, the long-run ASD model developed in Part III may be claimed to be a standard macroeconomic model that embodies the paradigm shift discussed in Part II.

6.2 Japan's Lost 30 Years as the Prolonged Great Depression

Now let us run the long-run ASD model to perform the structural analysis of Japan's lost 30 years. To do so, we have run simulations as listed in Table 4 below, and obtained their behaviors as shown in Figures 15 and 16. "LR" stands for Long-Run. "LR-Japan as No. 1"

Endogenous Money ASD (Case 8)	Loanable Funds ASD (Case 7)
Line 1 (blue): LR-Japan as No.1	
Line 2 (red): LR-Japan's Lost 30 (Great Depression)	
Line 3 (green): LR-Japan's Lost 30 Years	Line 4 (dashed): LR-Japan's Lost 30 Years

Table 4: Legend Names for the Simulations of Japan's Lost 30 Years

(lines 1 in blue) shows the base run case as if Japan's high economic growth in the 1970s and 80s, called "Japan as No.1" (Vogel, 1979), continued, without the collapse of real estate bubble in 1990. "LR-Japan's Lost 30 (Great Depression)" (lines 2 in red) indicates "what if" scenario without the active fiscal spending implemented by the Japanese government; that is, $\Delta PB = 0$ at t=1991 (no fiscal policy). In other words, behaviors illustrated by lines 2 in Figures 15 and 16 could be interpreted as a hypothetical case of the prolonged Great Depression in Japan spread over 30 years. "LR-Japan's Lost 30 Years" (lines 3 in green) presents simulation under active fiscal policy; that is, $\Delta PB = 0.18$ at t=1991 (fiscal policy). Accordingly, lines 2 and 3 compare behaviors of the Japan's elongated recessions without or with fiscal policy.

For instance, production (GDP) shown at the top left diagram of Figure 15 indicates that Japan's GDP would have declined significantly (line 2 in red), compared with line 3 in green, if the government did not apply the active spending policy. And lastly, "LR-Japan's Lost 30 Years (Loanable Funds)" (lines 4 in dotted pink) is additionally included to see how Japan's

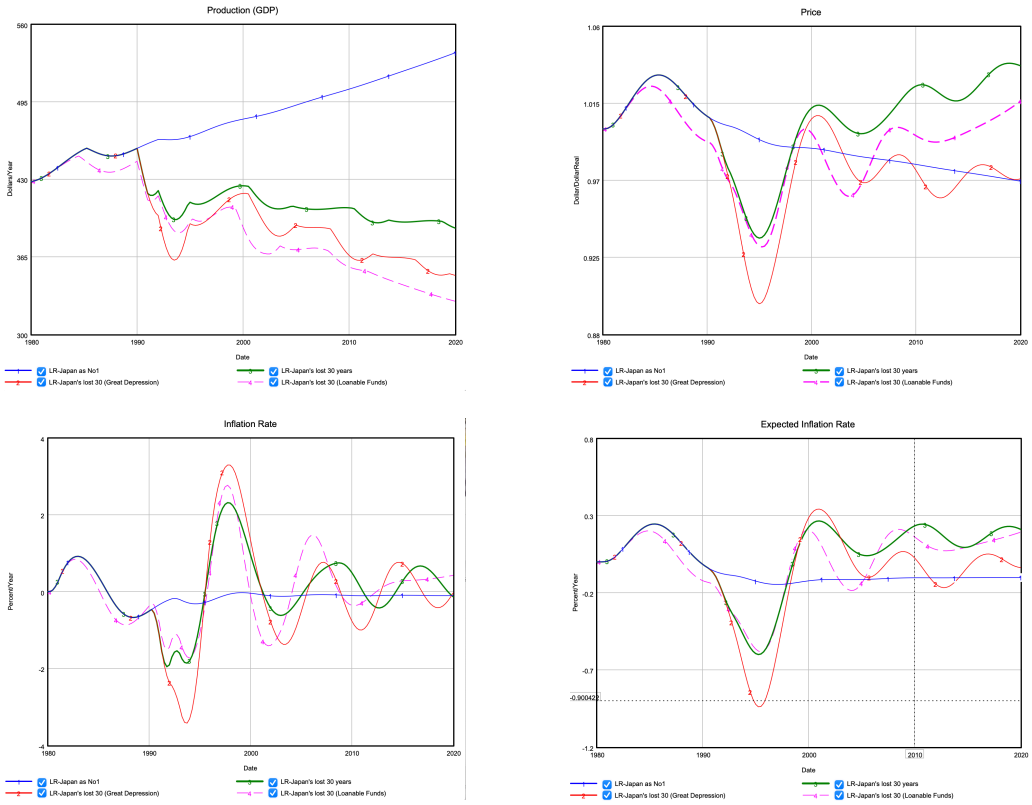

Figure 15: Japan's Lost 30 Years – Production (GDP), Price and Inflation Rates

lost 30 years could have been described under the Loanable Funds (LF) assumption, which mainstream economics assumes, either implicitly or explicitly. The top right diagram shows the behaviors of Price. Bottom diagrams show behaviors of inflation rate on the left, and expected inflation rate on the right hand side. Figure 16 show the behaviors of nominal and real interest rates, and real and nominal money stocks in clockwise.

In this way, we have now run four different simulations as comparative analysis of Japan's lost 30 years, and obtained the following three observations:

(1) Recession, *i.e.*, decline in production, and the corresponding changes in price, inflation and interest rates, without or with fiscal policies (lines 2 and 3), are observed to be similar in cyclical patterns.

(2) Endogenous money stocks (nominal and real) continue to increase even under recessions, contrary to the historical case of Great Depression where nominal money stock decreased.

(3) Money stock (nominal) under the loanable funds case remains constant, thus disqualified as the model of the current debt money system.

Our first observation is that behaviors of key macroeconomic variables are similar, without or with fiscal policy (lines 2 and 3), except their degrees of change. Whenever fiscal policy is applied, its economic behaviors (lines 3) become slightly mitigated. et patterns of recession behaviors remain the same, except money stocks (nominal and real) which continue to increase.

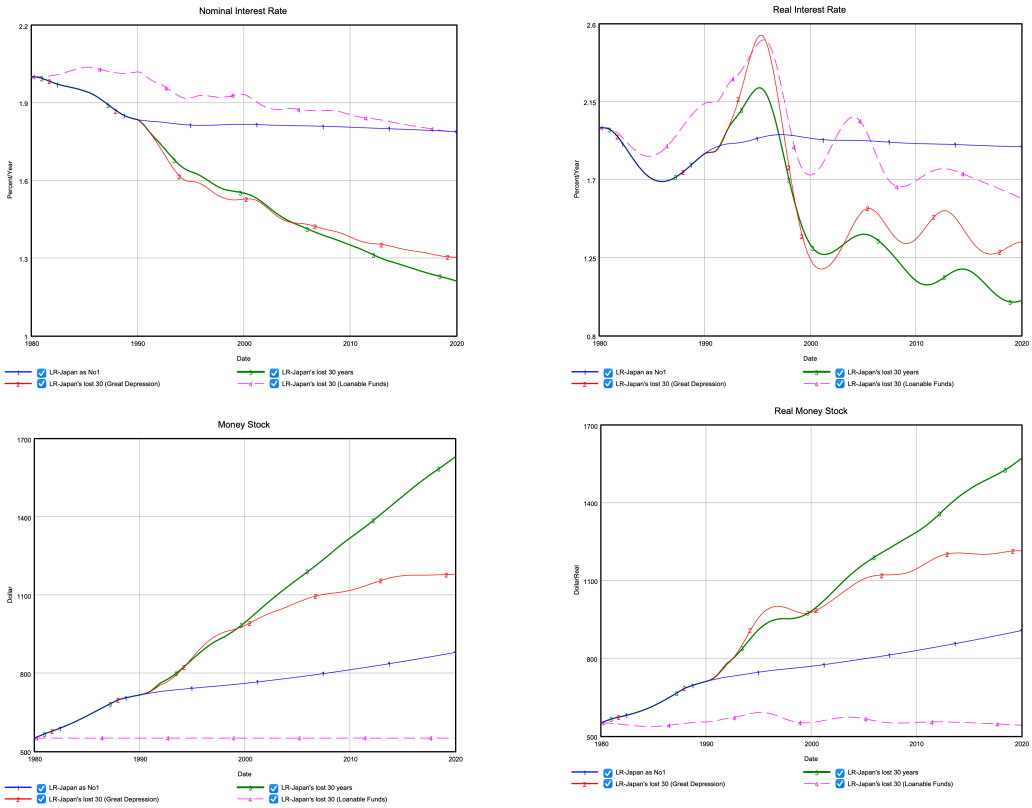

Figure 16: Japan's Lost 30 Years – Interest Rates and Money Stocks

	M^s	P	$\frac{M^s}{P}$	i	r
The Great Depression (1929-1933)	↓	↓	↑	↓	↑
Endogenous Money ASD Model (Part II)	↓	↓	↑	↓	↑
Loanable Funds ASD Model (Part II)	→	↓	↑	↓	↑
Endogenous Money Long-run ASD Model (Part III) (Japan's Lost 30 Years)	↑	↓	↑	↓	↑
Loanable Funds Long-run ASD Model (Part III) (Japan's Lost 30 Years)	→	↓	↑	↓	↑

Figure 17: Qualitative Evaluation of Japan's Lost 30 Years

For the comparative discussions of these observations, we have constructed qualitative evaluation table of Figure 17, as used in Part I and II, in terms of money stock M^s, price P, real money balance $\frac{M^s}{P}$, nominal interest rate i, and real interest rate r. First row in gray background shows the historical behaviors of these key variables during the Great Depression in the US. Second and third rows indicate our simulation behaviors obtained in Part II model. That is, the second row proved that our endogenous money model can qualitatively reproduce the behaviors the Great Depression, while the third row of Loanable Funds model failed to explain the decrease in money stock. Hence, loanable funds model as exogenous money model is rejected as legitimate macroeconomic model of the debt money system.

Fourth and fifth rows are newly added in this Part III to further analyze the behaviors of our long-run ASD model. Fourth row indicates that our model did not show a decrease in money stock as observed during the Great Depression. On the contrary, money stock (line 3

in green) increased as illustrated in the bottom left diagram of Figure 16, which is consistent with data observed in Japan as shown in Figure 13. This is entirely a new finding that goes against predominant understanding that economic recessions trigger monetary contraction.

Why could this happen? To analyze the cause of this monetary increase, Figure 18 is newly constructed in which money stock (line 1 in blue) is decomposed into time deposits of households (line 2 in red), deposits of households (line 3 in green) and producers (line 4 in pink), and deposits held by the government (line 5 in sky blue). During the first decade of bubble bust starting in 1990, time deposits (line 2) and demand deposits (line 3) of households indeed decreased slightly (deposits of the government is zero), as expected from the lesson learned during the Great Depression. However, this decrease was surpassed by the sharp increase in deposits by producers (line 4 in pink), resulting in the overall increase in total money stock.

Why did producer's deposits increase, then? During recessions, investment drop and producers loose their investment opportunities. The economy falls into recession when domestic private sector demand declines. During Japan's post-bubble period, the large increase in public investment that the government introduced in the 1990s, resulted in an increase in the money stock, and sustained its GDP at its level. Yet, money stock still ended up as deposits of producers and remained there. Remember that debt money can only contract when someone repay their debts. Indeed, if we increase the parameter value of Repayment Ratio (Households) from 0.02 (default value) to 0.09, then the decrease in households' deposits surpasses the increase in deposits held by producers, resulting in the contraction of total money stock.[6]

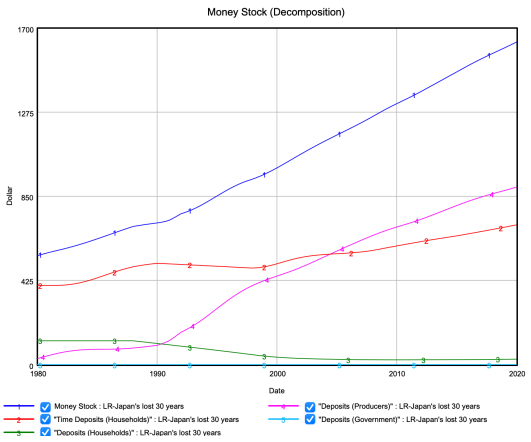

Figure 18: Decomposition of Money Stock under "LR-Japan's Lost 30 Years" scenario

In other words, the long-run ASD model can still handle monetary contraction whenever observed in a different economic circumstance. In this way, the fourth row of Figure 17 could be interpreted as generic behaviors of economic recessions under endogenous debt money system. As discussed in the above observation (1), these behaviors take place irrespective of fiscal spending policy or not. In other words, fiscal policy turned out to induce no significant impact on the recovery of recessions. As we will discuss in the last section below, only the fiscal policy that encourages private investment becomes the solution to get out of the recessions, specifically Japan's lost 30 years. This is our new finding on the efficiency of fiscal policy in this Part III.

Finally concerning our observation (3), we can easily confirm from the fifth row of Figure 17 that loanable funds ASD model in this Part III is not qualified, as proven in Part I and II, as the legitimate macroeconomic model of debt money due to the exogenous money.

In conclusion, economic recessions under the debt money system, whether the Great Depression, the Japan's lost 30 years, or any other recessions in general, may exhibit similar behaviors except that of money stock, which is affected by the government's fiscal response and private sector's repayment attitude. Hence, the long-run endogenous money ASD model developed in Part III could be the standard macroeconomic model of the present debt money system.

[6]This case of monetary contraction, if indeed applied, captures the behaviors of the Great Depression, however, at the cost of money-debt relationship observed during the lost 30 years in Japan. That is, in this case, the right diagram of Figure 14 no longer holds, and the long-run ASD model validation would be violated.

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

For our long-run ASD model to be a standard macroeconomic model, it has to be able to produce "point J" indicated in Part I and II. Figure 19 presents the phase diagrams of production (GDP) and nominal interest rate by the behaviors of Japan's lost 30 years obtained above from the model. Line 1 in blue indicates a base run growth path of Japanese economy as if "Japan as No.1". Line 2 in red indicates how production (GDP) and nominal interest rate would have been if no fiscal spending policy were applied in Japan. This corresponds to the elongated Great Depression of Japan discussed above. Bold line 3 in green indicates that 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 observed during the last lost 30 years in Japan. In this way the long-run ASD model has successfully captured the behaviors of Japan's lost 30 years!

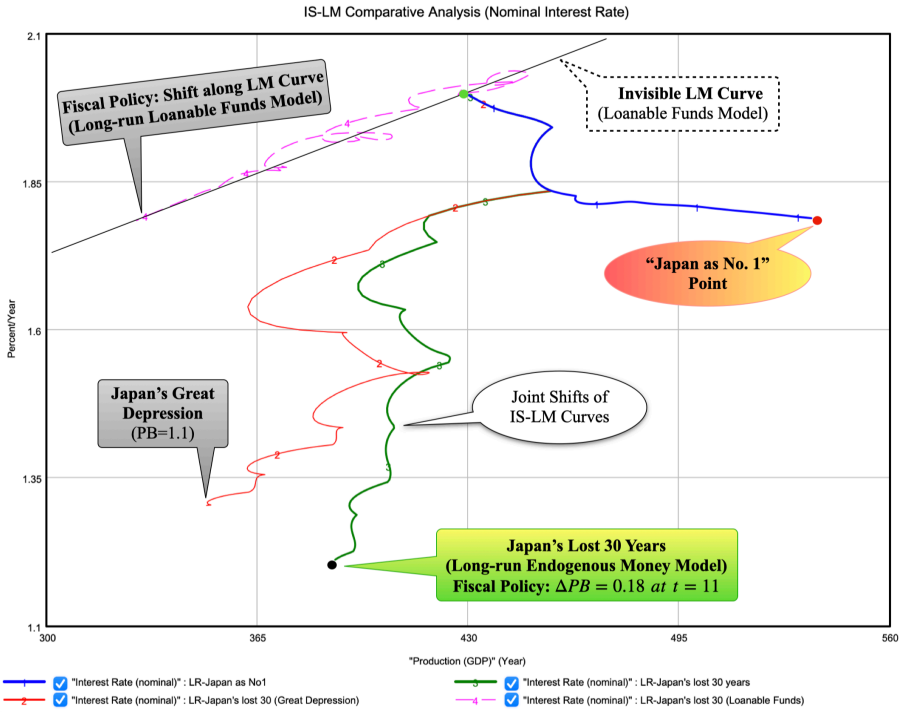

Figure 19: Point J of Japan's Lost 30 Years

On the contrary, as the dotted line 4 in pink illustrates, if we are obliged to apply mainstream macroeconomic model of exogenous money such as the long-run ASD model of loanable funds, 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. We can easily confirms these behaviors on the invisible LM curve by changing the levels of consumption, investment and government spending, whatever amounts we use. In other words, the model cannot produce a move toward the "point J" as long as it sticks 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 long-run ASD model as long as they are running under structurally similar economies of debt money system. By calibrating the model behaviors to actual case studies, policy-makers could use the long-run ASD model for examining potential impacts of their monetary and fiscal policies on the economy before its implementation. In this sense, we have indeed obtained the basic model of paradigm shift, proposed in this series of Part I, II and III, that can be applicable to diverse economic environments.

7 The Solution to Japan's Lost 30 Years

During this series of research, we have been asking a question: Is there a solution to get out of the Japan's lost 30 years? In the Japanese books Yamaguchi (2015) and Yamaguchi and Yamaguchi (2021b) we have asserted that public money is the solution. Now that we have completed the foundation model of paradigm shift in macroeconomics, we have rephrased the question: how can we find a recovery path in the phase diagram of Figure 19 from Point J to the point of "Japan as No.1" ?

Public Money Solution (issue Public Money)	$\Delta PM = 30$ starting at t=1995 for 21 years to subsidize $\Delta I = 55$
Debt Money (MMT) Solution (increase Gov. Debts)	(Pushy Fiscal Policy) $\Delta PB = 0.56$ ($\leftarrow 0.18$) at t=1996

Table 5: Two Solutions out of Japan's Lost 30 Years

By running the long-run ASD model, we have found two possible solutions that could bring back the Japanese econmy to the Japan as No.1 point in terms of production (GDP) as indicated in Table 5. The first solution called "Public Money Solution" is to issue public money to encourage the increase in private investment. As mentioned in "A Remark on Public Money" above as well as in Part II, loanable funds ASD model can be used for this simulation, because the exogenous money model is applicable under the public money system. The other path called "Debt Money Solution" is to expand fiscal (deficit) spending further and more vigorously, as recently suggested by the proponents of MMT (modern monetary theory).

Utilizing parameter values as indicated in the table after the bubble burst in early 1990s, we have run simulations and obtained two solution paths as illustrated in Figure 20. Line 1 in blue is our goal of the Japan as No.1 growth path. Line 2 in red is the current Point J of Japan's lost 30 years. Line 3 in green is the public money solution, while line 4 in dotted pink is the debt money solution. As long as these two solutions are viewed in the phase diagram, both seem to restore the production (GDP) level of Japan as No.1. Indeed, top left diagram of Figure 21 confirms both solutions attain similar levels of production (GDP) around 2020, though recovery path is more cyclical under the public money solution (for reasons yet analyzed).

Using diagrams of price, money stock and government debts in Figure 21, let us now compare behaviors of two solutions in more detail to find out which solution is workable and better. Let us examine the public money solution (lines 3 in green) first. As top right diagram illustrates, price fluctuates in the beginning but eventually gets stabilized. Money stock in the bottom left diagram continues to increase as public money is put into circulation, but eventually stops increasing around 2015. Government debts in the bottom right diagram does not increase at all and stays at zero throughout the period. This is simply because government needs not to borrow from banks under public money system. Instead, it can issue its own public money at interest-free. This is the public money solution we have asserted in the above-mentioned books.

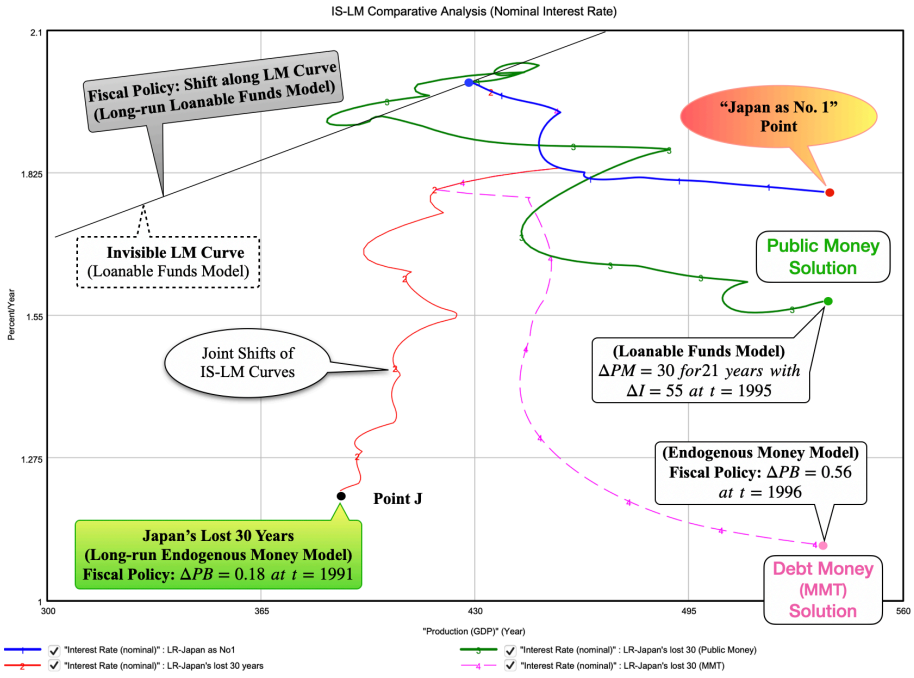

Figure 20: Two Solutions out of the Point J (Japan's Lost 30 Years)

In this way long-run ASD model of loanable funds, though a generic macroeconomic model, has justified the public money solution.

On the other hand, a group of people who are influenced by the MMT (here called the Japanese MMT faction) recently claims that Japan could have been out of the recessions of 30 years long if the government have made more aggressive fiscal spending policy by issuing government bonds (or borrowing money from banks). To examine their claims we have run the long-run ASD model of endogenous money as shown in Figure 21. Indeed, the debt money solution (lines 4 in dotted pink) demonstrates in the top left diagram that the production (GDP) gets restored to the level of Japan as No.1 (line 1 in blue). Hence, this debt money solution of MMT seems to be working as well as the public money solution. Yet, due to this debt money solution, money stock (line 4 in dotted pink) in the bottom left diagram continues to increase exponentially, which in turn causes hyper inflation as demonstrated by the price behavior (line 4 in dotted pink) in the top right diagram.

To be worse, government debts (line 4 in dotted pink) keeps accumulating as demonstrated in the bottom right diagram, driving government to debts hell. Eventually the government is forced to levy higher taxes to pay interests to bankers, which in turn widens the income inequality between bankers and non-bankers. In short, debt money (MMT) solution is shown here to be unsustainable and inequitable. These failures have been already analyzed as the critical flaw of MMT (Yamaguchi and Yamaguchi, 2021b, Chapter 3). Though our model is simple and generic, it has proven that debt money solution (or MMT solution) as a typical Keynesian fiscal policy is shown to be flawed in principle as sustainable macroeconomic policy.

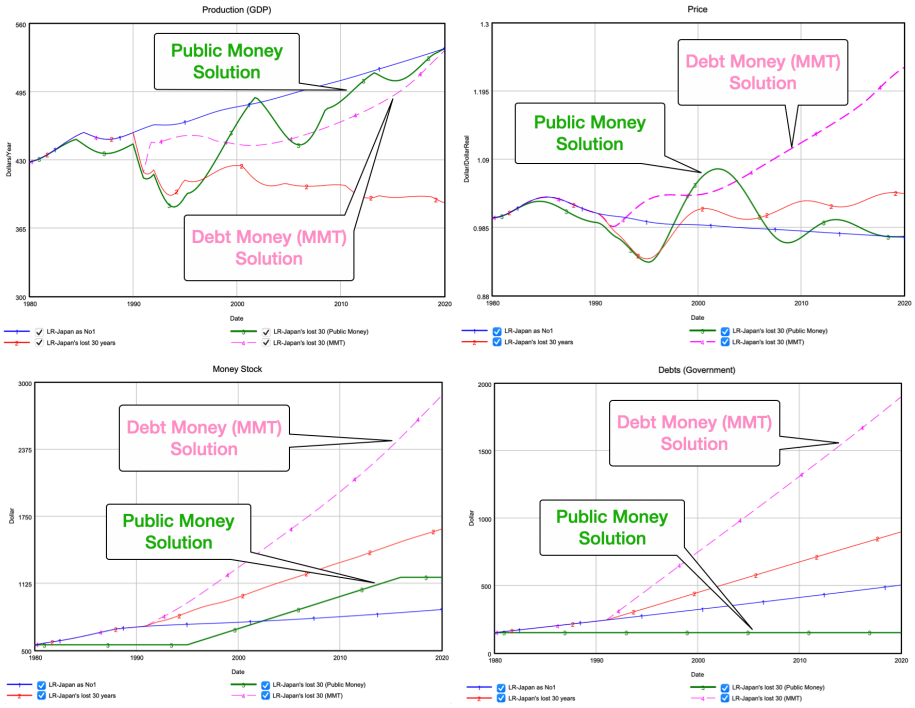

Figure 21: Solutions of Japan's Lost 30 Years – GDP, Price, Money Stock and Gov. Debts

8 Conclusion

In Part I of our trilogies on the macroeconomic modeling analysis, we have presented the Keynesian short-run IS-LM model as mathematical model of equations and corresponding SD simulation model. In Part II, we then expanded the Part I model by incorporating budget equations of all domestic macroeconomic sectors, first as mathematical model, and constructed its endogenous money ASD model. Finally, in this Part III, we have further expanded the endogenous money ASD model to the long-run ASD model by incorporating production function and potential capacity of output. Throughout our research, the two major economic events in history have been studied; the Great Depression in the 1930s and Japan's lost 30 years since 1990s. In this Part III, we have reconfirmed that our long-run endogenous money ASD model can explain the behaviors of the two events. This further implies the model could be a standard macroeconomic model for the analysis of recession under the debt money system in general.

Being convinced this way, we have further expanded our simulation analysis by running the model to find out which system, public money or debt money, could be the solution for saving Japan out of her lost 30 years. Our simulations have demonstrated that the public money system can save Japan without causing inflation and government debts, by stabilizing money stock. On the other hand, debt money (MMT) solution is shown to trigger hyper-inflation through the rapid increase in money stock, as well as to accumulate debts incessantly, driving the government down to debts hell.

In conclusion, the short-run endogenous money model developed in Part II and long-run endogenous money model in Part III could be the standard macroeconomic models that fully embody our paradigm shift in macroeconomics. And indeed, the ASD modeling approach

provides the methodological foundation for our *paradigm shift in economics as a science*.

Discussion

Without simulation-based analyses, the search for the causes of imminent economic problem become nothing more than battles of opinions among different "schools of thought," such as the Classical, Neoclassical, Keynesian, monetarist, and so on. Differences that (are believed to) exist among these schools encourage students to choose a particular "faith" rather than investigating the origins of their differences. For us, as researchers utilizing system dynamics approach, differences of opinions among these schools seem to be originating from differences in (1) behavioral and (2) structural assumptions about the economic system, besides their methodological differences (terminology, mathematical techniques, modeling procedures, etc.)

Typical examples of behavioral assumption are the rationality of economic entities, the labor's share (which affects disposable income), or the propensity to consume (or save). These behavioral assumptions can be represented in SD models as different assumption on variables and parameters. Structural assumptions, on the other hand, are expressed, depending on how the researchers formulate them, by both variability of variables as well as the direction of causalities among model variables and parameters. For example, because of difference in the assumption on price flexibility and degree of confidence in the ability of price mechanism to clear the goods market, conventional textbooks have introduced two separate models for short and long-run cases (here we are using "short-run vs. long-run" in the conventional sense of the terminology, not in the way as we defined in Section 2 of this paper). As explained in Part I, however, the price adjustment process in our dynamic IS-LM models have enabled us to simulate and uniformly analyze various cases of price rigidity as varying assumptions on the price elasticity, which we introduced simply as a parameter (note that it could also be made endogenous). Another example of structural assumption is the market structure and degree of competition among producers in the goods market, which are determined by domestic and international regulations, business practices in certain industries, or by management decisions of individual businesses. As illustrated in Table 1, exogenous vs. endogenous money has been the overarching theme that defines the structural assumption on money and banking system. The two contrasting assumptions can be tested with a "switch" in our models, making it much more tangible for students to learn their effects on the overall macroeconomic dynamics.

Besides theoretical and methodological differences, there are other fundamental issues, such as cognitive biases, differences in world views among researchers themselves (Meadows, 1980), and issues relating to observation, collection, and types of data to be taken into account in economic models (Forrester, 1980). However, by translating those differences into a causal model and studying their effects in simulation, we can begin to provide systematic explanations to the origin of those seemingly "irreconcilable" differences that have existed between different schools of thought. This way our approaches to economic issues will become more constructive and oriented toward problem-solving. It is in this methodological approach that we believe there is still much role for simulation-based analysis in economics. By following this approach, we have submitted in our previous papers (Yamaguchi and Yamaguchi, 2022a,b) that recent policy failures in Japan come from the failures of mainstream macroeconomic analysis grounded on the IS-LM model and proposed the paradigm shift, methodologically and theoretically. Depending on research questions, future research may expand the model to analyze interest and income inequality, or incorporate population dynamics and labor market. Furthermore, one can also expand it into open economies (Yamaguchi, 2022) to investigate spill-over effects through foreign exchange rate, or incorporate input-output structure to investigate price dynamics in more detail, or incorporate energy and material resources and constraints for ecological modeling.

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Appendix 1: Endogenous Money ASD Model (Part II)

$$
\begin{aligned}
Y &= AD && \text{(Aggregate Demand Equilibrium)} && (22)\\
AD &= C + I + G && \text{(Aggregate Demand)} && (23)\\
C &= C_0 + cY_d && \text{(Consumption Decisions)} && (24)\\
Y_d &= Y - T && \text{(Disposable Income)} && (25)\\
T &= T_0 + tY - T_r && \text{(Tax Revenues)} && (26)\\
I &= \frac{I_0}{r} - \alpha r && \text{(Investment Decisions)} && (27)\\
G &= \bar{G} && \text{(Government Expenditures)} && (28)\\
\frac{M^s}{P}V &= L^d && \text{(Equilibrium of Money)} && (29)\\
L^d &= aY - bi && \text{(Demand for Money)} && (30)\\
r &= i - \pi^e && \text{(Fisher Equation)} && (31)
\end{aligned}
$$

$$
\begin{aligned}
PC + PT + PI_H + S &= W + \Pi + \Delta D_H && \text{(Households Budgets)} && (32)\\
W + \Pi &= PY && \text{(Distributed Income)} && (33)\\
PI_H &= \Delta D_H && \text{(Housing Budgets)} && (34)\\
I_H &= \bar{I}_H && \text{(Housing Investment)} && (35)\\
W + \Pi + PI_P &= PY + \Delta D_P && \text{(Producers Budgets)} && (36)\\
I_H + I_P &= I && \text{(Private Investment)} && (37)\\
PG &= PT + \Delta D_G && \text{(Government Budget)} && (38)\\
\Delta D_H + \Delta D_P + \Delta D_G &= \Delta LF && \text{(Loanable Funds of Debts)} && (39)
\end{aligned}
$$

$$
\begin{aligned}
(\Delta LF &= S\ ) && \text{(Savings as Loanable Funds by Banks)}\\
\Delta LF &= \Delta M^s && \text{(Endogenous Deposits Creation)} && (40)\\
M^s &= \int \Delta M^s dt && \text{(Endogenous Money Stock)} && (41)
\end{aligned}
$$

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:

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

Appendix 2: Long-run Endogenous Money ASD Model

$$
\begin{aligned}
Y &= AD && \text{(Aggregate Demand Equilibrium)} && (42)\\
AD &= C + I + G && \text{(Aggregate Demand)} && (43)\\
C &= C_0 + cY_d && \text{(Consumption Decisions)} && (44)\\
Y_d &= Y - T - \delta K && \text{(Disposable Income)} && (45)\\
T &= T_0 + tY - T_r && \text{(Tax Revenues)} && (46)\\
I &= \frac{I_0}{r} - \alpha r && \text{(Investment Decisions)} && (47)\\
G &= \bar{G} && \text{(Government Expenditures)} && (48)\\
\frac{M^s}{P}V &= L^d && \text{(Equilibrium of Money)} && (49)\\
L^d &= aY - bi && \text{(Demand for Money)} && (50)\\
r &= i - \pi^e && \text{(Fisher Equation)} && (51)
\end{aligned}
$$

$$
\begin{aligned}
\frac{dK}{dt} &= I - \delta K && \text{(Net Capital Accumulation)} && (52)\\
Y_{full} &= F(K, L) && \text{(Production Function)} && (53)\\
\frac{dP}{dt} &= \Psi(Y - Y_{full}) && \text{(Flexible Price)} && (54)
\end{aligned}
$$

$$
\begin{aligned}
PC + PT + PI_H + S &= W + \Pi + \Delta D_H && \text{(Households Budgets)} && (55)\\
W + \Pi &= PY && \text{(Distributed Income)} && (56)\\
PI_H &= \Delta D_H && \text{(Housing Budgets)} && (57)\\
I_H &= \bar{I}_H && \text{(Housing Investment)} && (58)\\
W + \Pi + PI_P &= PY + \Delta D_P && \text{(Producers Budgets)} && (59)\\
I_H + I_P &= I && \text{(Private Investment)} && (60)\\
PG &= PT + \Delta D_G && \text{(Government Budget)} && (61)\\
\Delta D_H + \Delta D_P + \Delta D_G &= \Delta LF && \text{(Loanable Funds of Debts)} && (62)
\end{aligned}
$$

$$
\begin{aligned}
(\Delta LF &= S\ ) && \text{(Savings as Loanable Funds by Banks)} &&\\
\Delta LF &= \Delta M^s && \text{(Endogenous Deposits Creation)} && (63)\\
M^s &= \int \Delta M^s dt && \text{(Endogenous Money Stock)} && (64)
\end{aligned}
$$

The long-run endogenous money model consists of the above 23 equations with 23 unknowns such that

$$Y, AD, C, I, G, Y_d, T, i, r, L^d, S, I_H, W + \Pi, I_P,$$

$$\Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, \Delta M^s, M^s, K, Y_{full}, P$$

and 15 exogenously determined parameters:

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

Appendix 3: Long-run Loanable Funds ASD Model

The long-run loanable funds model consists of the above 21 equations; (43) through (62) and (5). It has corresponding 21 unknowns such as

$$Y, AD, C, I, G, Y_d, T, i, r, L^d, S, I_H, W + \Pi, I_P,$$

$$\Delta D_H, \Delta D_P, \Delta D_G, \Delta LF, K, Y_{full}, P$$

and 15 exogenously determined parameters:

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