Money Stock Equals Total Debts by Banks
– Theory and Flow of Funds Analysis in Japan[*]–

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Abstract

Money stock is defined as the sum of cash, demand deposits, and time deposits. Its quantity and behavior decisively affect various macroeconomic variables such as GDP and price level. Yet its true nature has been obscured in economics. Where does it come from? How does it get created, and how much? In this paper we apply Accounting System Dynamics framework to investigate the process of money creation by building a simple model, then apply theoretical insights obtained to a case study on the Flow of Funds Accounts in Japan since 1980. Then, we found that money stock equals the total debts by banks held by domestic non-banking sectors such as non-financial corporations, households, and the government, though the unsettled divergence between money stocks and total debts during 1994-2015 needs further improvements. Our finding from the current analysis has demonstrated that the nation's money supply is determined by private and public debts financed by the banking sector, and confirmed the consistency of deposit creation theory at a

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macroeconomic scale. In other words, we have theoretically and empirically confirmed that money is created when public and private sectors come to borrow at interests under the current system based on fractional reserve banking.

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Introduction

In the midst of great economic difficulty during the Great Depression, Robert H. Hemphill, who was a credit manager at the Federal Reserve Bank of Atlanta at the time, realized the inherent instability and fragility of financial system under fractional reserve requirement, and wrote down the following forward to Irving Fisher's proposal on full-reserve banking system [3, 1935]:

> *Neither the banker nor the borrower ordinarily realize that a loan just completed, is putting into circulation that much new money ...*
> *If all bank loans were repaid, no one would have a bank deposit, and there would not be a dollar of currency or coin in circulation.*
> *This is a staggering thought. We are completely dependent on the commercial banks. Someone has to borrow every dollar we have in circulation, cash or credit.*

The role of deposit creation in the Great Depression was a central part of analyses by the founders of the Chicago school [6, 1995], Irving Fisher [2, 1932] [1, 1933] [3, 1935] and other economists in the U.S at the time [4, 1939]. Instead, economic textbooks and literatures in later years presented divergent views on the basic role of banks [7, 2015]. A large portion of general equilibrium family of models developed since 1970's have abstracted away the fundamental role of money due to its theoretical equilibrium framework and the neutrality assumption of money [5, 2017]. Econometric models are often used for short-term forecasts and tend to pay less inquiries into system structure in the real-world, from which dynamic behaviors are observed to be generated. Money creation still seems a relatively unfamiliar topic to students of economics and finance, and remains largely uninteresting among the general public despite its significance and relevance to a wider range of policy discussions today. These situations reflect the absence of introductory materials on the topic of money creation that connect both theoretical and empirical analyses.

In this paper, we first study the process of deposit creation, using worksheets that represent a national economy, by considering exemplary transactions among five domestic sectors, that is, producers (non-financial corporations), households, banks, government, and central bank in section 1. In Section 2, the same transactions considered in Section 1 are translated into a simple system dynamics model by applying the accounting system dynamics framework [8, 2013], and analyze how money stock increases along with the increase in the corresponding amount of bank loans. With the insights gained in Section 2, the theoretical analysis will be extended to a case study of Japanese money creation using Flow of Funds Account (FFA) statistics in Section 4.

1   Money Creation by Bank Loan

1.1   Stock Approach Model of Bank Lending

The amount of loans made by individual banks in a given period is determined by various internal and external factors such as risk attitudes and perceived profitability, which is a function of various costs including wholesale funding rates influenced directly by the prevailing policy rate. Expectations are formed from locally available information, and fed into a complex process of "Asset Liability Management" decisions within each banking institutions. In addition to controlling interest rate, central bank such as the Bank of Japan once utilized another policy tool, called the window guidance, in which the central bank assigned credit quotas to each bank.

Yamaguchi and Yamaguchi [9, 2016] examined two different views of bank lending transactions by building simple ASD models, and called them the flow approach model of intermediation theory of banking and stock approach model of credit creation theory of banking, respectively. The flow approach describes that bank loans are made out of excess cash held by banks prior to the transaction. In the stock approach, new loans are made and financed by creation of new deposits, after which banks look for reserves in money market to meet the legal reserve requirement. They showed that both approaches are fundamentally the same.

Yet, the stock approach differs from the flow approach in the sense that money stock is first created as checkable/transferable deposits. In this paper we make use of the stock approach. In either way, demand deposits, once created, are withdrawn according to depositor's need for cash. To meet the customer's demand for cash, banks withdraw cash from their own deposits or reserves account held at the central bank. On the other hand, non-banking sectors such as financial institutions other than banks, producers and households may hold excess amount of demand deposits. They may occasionally save a fraction of demand deposits in their bank account as time deposits for higher interests. In this way, money stock once created by bank loans keeps circulating in the form of cash, demand and time deposits. As borrowers repay their debt to banks, corresponding amount of deposits are destroyed from their balance sheets, and money stock decreases from the circulation. In an economy operating under the fractional reserve banking system, creation and destruction of money stock keep occurring simultaneously. Stock approach modeling can describe money creation process in this way.

Monetary Aggregates & A Life Cycle of Money

Figure 1 shows the amount of monetary aggregates discussed above, and how they move around as a result of depositor's need and preference. As described in more detail in the next section, the figure uses conventional notation of stock-flow diagram used in system dynamics modeling. Box indicates stock (level) variable, which either accumulates or depletes by the flow variables denoted by

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bi-directional arrows. Small clouds connected to arrows indicate that sources of contents in stock variables are left out of the analysis, meaning they are out of the boundary of system in question. Black arrows in the figure indicate flows of existing money in the economy, whereas blank arrows indicate flows that increases/decreases base money (M_0) and deposits out of nothing.
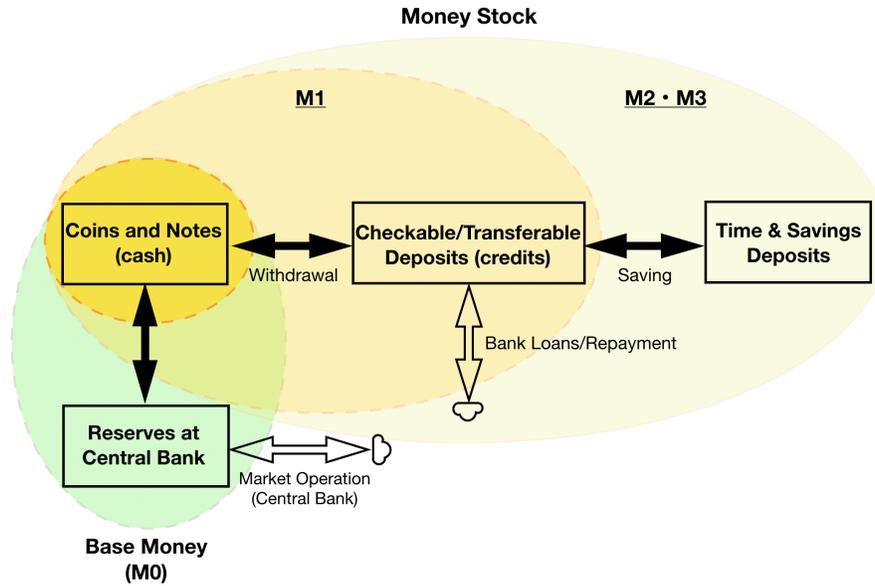
Figure 1: Monetary Aggregates and Life Cycle of Money

How are bank deposits created in the economy, then? Before proceeding to this analysis on Japanese case in Section 4, it is essential to to establish common understanding of money creation process through exemplary transactions.

1.2 Worksheet of Six Sectors in National Economy

Let us first conceptualize out economy from the highest level of aggregation. Figure 2 illustrates balance sheets of six macroeconomic sectors: central bank, commercial banks, the government, producers (non-financial corporations), households and overseas. Flow of funds account attempts to view our national economy inclusively by describing inter-sector transactions among these six aggregate sectors and looking at changes in the balance sheets. Therefore, all flows of fund in the economy can be thought of as transactions between individuals and institutions within and across these aggregate sectors. In other words, the six sectors constitutes a cosmos of our macroeconomy at its simplest form in which all relevant behaviors of our economic system emerge.

Figure 2: Worksheet of Six Sectors in National Economy

By using the worksheet format shown in Figure 2, we now discuss how money creation in our economy can be described. First, we look at bank lending transactions between producers, banks and central bank, and fill in numerical numbers for each transaction into the worksheet, then expand the scope of our numerical analysis to other sectors step by step.

Quadruple-Entry Bookkeeping

For the purposes of financial reporting and business management, commercial transactions are usually recorded according to a *double-entry bookkeeping* rule. In macroeconomic analysis, however, each transaction has to reflect changes in the accounts of at least two sectors who are involved due to the need for tracing the flow of funds among them. For instance, payments are made through transfer of deposits from one sector to another. Therefore, existing deposits are subtracted from payers account while corresponding amounts are increased in payees account. This rule is known as *quadruple-entry bookkeeping*, which theoretically ensures balances in accounts of all involved sectors for every transaction. Thus, balances of the amount of all transaction items have to be attained among assets and liabilities sides.

The double-entry balancing rule within each sector has to be checked by the *balance sheet test*, and quadruple-entry balancing rule among involved sectors

has to be checked by the *flow of funds test*, respectively. These tests are applied to the following examples of worksheets as well as to our ASD model in Section 2. That is, our accounting system dynamics (ASD) modeling employ all inter-sector payments through bank accounts.

1.3 Producers going into Debt

Transaction steps of producers are listed below. A capital letter in round brackets at the end of some transaction item indicates the name of sectors. For example, Demand Deposits (P) denotes the item of producers sector.

Transactions of Producers

1. Producers request 1,000 million yen of loans.

2. Banks approve the loan applications, and make loans of 1,000 million yen to the producers account. Simultaneously, Producers receive 1,000 million yen as Demand Deposits (P) as their assets and records Debts (P) as liability.

3. To meet the required reserve ratio of 1%, Banks borrow 10 (=1,000x0.01) million yen from Central Bank as CB Debts and acquire Reserves as assets.

4. Producers pay wages of 970 million yen out of their Demand Deposits (P) to households, and interest of 30 million yen to banking sector, assuming 3% interest rate per unit time of year.

5. Banks process these payment requests from Producers by transferring deposits to households account and receive interest earnings, which are recorded as Demand deposits (H) and equity of banks respectively.

6. Banks pay dividends to their shareholders. Bank's shareholders are separately denoted as Bankers in the balance sheets, and they belong to households sector simultaneously shown by Demand Deposits (of Bankers) account.

Observations

In step 1 in particular, producers incur debts by taking loans from banks, after which the corresponding amount of deposits are credited to their bank account, thereby increasing the balance-sheets of both banks and producers. Figure 3 illustrates changes in balance-sheets as a result of all of the above transactions.

Central Bank

Assets		Liabilities	
		Reserves	10
G Bonds			
		G Deposits	
CB Loans	10		
		Equity	

Government

Assets		Liabilities	
G Deposits		Debts (G)	
		Equity	
		G Expenditures	
		Interest	

Banks

Assets		Liabilities	
Reserves	10	CB Debts	10
		Demand Deposits (P)	1,000
Bank Loans	1,000		-970
			-30
G Bonds			
		Demand Deposits (H)	970
		(of Bankers)	30
		Time Deposits	
		Equity	
		Interest	30
		Dividends	-30

Producers

Assets		Liabilities	
Demand Deposits (P)	1,000	Debts (P)	1,000
	-970		
	-30		
		Equity	
		Income	
		Costs (Wage	-970
		Interest	-30

Households

Assets		Liabilities	
Demand Deposits (H)	970	Debts (H)	
(of Bankers)	30		
Time Deposits		Equity	
		Income (Wages)	970
		Interest Dividends (Bankers)	30

Figure 3: Money Creation by Bank Loans - Producers

1.4　Households going into Debt

Transaction steps of producers are listed below. Similarly, a capital letter in round brackets at the end of transaction item indicates the corresponding sector name. Demand Deposits (H), for example, denotes the item of households sector.

Transactions of Households

1. Households decide to purchase houses and requests 1,000 million yen of Loans from Banks as Debts (Households)

2. Banks approve the loan applications, open its accounts for households, and make loans of 1,000 million yen.

3. Banks borrow 10 (=1,000x0.01) million yen from Central Bank to meet the required reserve ratio of 1%.

4. Households can now readily use Demand Deposits account for payments of 970 million yen to producers.

5. Households incur debt obligation on their loans and pay interests of 30 million yen to Banks at the interest rate of 3% per year.

6. Banks process these payment requests by Households by transferring respective amounts to producers account, and record interest earnings as their Equity.

7. Banks then pay dividends of 30 million yen to their shareholders out of their Equity.

Observations

In this scenario, transactions begin with households purchasing either newly-built houses or existing properties. In the former case, producers could have gone into loans with banks to acquire some building materials before the construction contract are crossed, which goes back to the previous case of producers going into debt. The latter case assumes new purchasing power are injected into the economy as a result of property investments. Historically there have been massive bank lending that has triggered asset price bubbles. The Japanese case of bubble economy in the 80's was not an exception.

From transaction step 4 through 5, one can easily observe that banking institutions financed their loans through creation of deposits, at which interest accrued. Then, from step 6 through 7, the corresponding portion of national income is sucked into the shareholders of bankers (shareholders) when household's account were debited while that of banker's were credited. These changes are reflected in the balance sheets of the Households and Banks as shown in Figure 4.

(Start with Debts (H) of 1,000 million yen)

Central Bank		
Assets	Liabilities	
	Reserves	10
G Bonds		
	G Deposits	
CB Loans	10	
	Equity	

Government		
Assets	Liabilities	
G Deposits	Debts (G)	
	Equity	
	G Expenditures	
	Interest	

Banks		
Assets		Liabilities	
Reserves	10	CB Debts	10
		Demand Deposits (P)	970
Bank Loans	1,000	Demand Deposits (H)	1,000
G Bonds			-970
			-30
		(of Bankers)	30
		Time Deposits	
		Equity	
		Interest	30
		Dividends	-30

Producers		
Assets		Liabilities
Demand Dep	970	Debts (P)
		Equity
		Income	970
		Costs (Wages)
		Interest

Households		
Assets		Liabilities	
Demand Deposits (H)	1,000	Debts (H)	1,000
	-970		
	-30		
(of Bankers)	30	Equity	
Time Deposits		Income (Interest)	-30
Houses	970	Dividends (Bankers)	30

Figure 4: Money Creation by Bank Loans - Households

1.5   Government going into Debt

Simplified transactions by the government sector are listed as below. As in the previous cases, a capital letter in round brackets at the end of transaction item indicates the corresponding sector name. Debts (G), or G Deposits, for example, denotes the item of the Government sector.

Transactions of Government

1. Government issues Bonds with a face value of 1,000 million yen as Debts (G) in order to finance its fiscal deficits at 3% interest rate.

2. Banks as primary dealers underwrite the newly issued Bonds of 1,000 million yen out of their Reserves at Central Bank.

3. Central Bank then processes the payment request by transferring 1,000 million yen from Bank's Reserves to G Deposits accounts.

4. Government is now ready to use its Deposits at the Central Bank for its expenditure. Specifically it pays welfare subsidies of 970 million yen to households sector, and accrued interests of 30 million yen on bonds held by Banks at the 3% interest rate.

5. Central Bank processes the payment request by the Government by transferring the corresponding amount from the governments' reserve account to that of Banks. Banks then credit the receiving amount to the deposit account of households, and interest as their earnings (Equity).

6. Banks borrow 10 (=1,000x0.01) million yen from Central Bank to meet the required reserve ratio of 1%.

7. Banks pay dividends out of their Equity to bankers (shareholders of banks) from the 30 million yen previously earned from interest on bonds.

Observations

At transaction step 3 the reserves held by banks initially decrease as a result of investments in government bond. Note also that no additional increase in money stock is observed at the end of transaction step 4. All the payment transactions are reflected in the liability side of central bank's balance sheet shown in Figure 5. Hence, no direct money creation occurs when banks *lend* to the government in the form of newly-issued investment of bonds (primary market).

When the government spends money into the economy, however, deposits recorded in the balance sheet of Banks increase, resulting in the expansion of money stock. As in the above cases of producers and households going into debt, the government borrowing financed by banking institutions eventually create new deposits once they are spent into non-banking sectors such as producers and households.

(Start with Debts (G) of 1,000 million yen)

Central Bank

Assets		Liabilities	
		Reserves	-1,000
G Bonds			970
			30
			10
		G Deposits	1,000
CB Loans	10		-970
			-30
		Equity	

Government

Assets		Liabilities	
G Deposits	1,000	Debts (G)	1,000
	-970		
	-30		
		Equity	
		G Expenditur	-970
		Interest	-30

Banks

Assets		Liabilities	
Reserves	-1,000	CB Debts	10
	970		
	30	Demand Deposits (P)	
	10		
Bank Loans			
		Demand Deposits (H)	970
G Bonds	1,000	(of Bankers)	30
		Time Deposits	
		Equity	
		Interest	30
		Dividends	-30

Producers

Assets		Liabilities	
Demand Deposits (P)		Debts (P)	
		Equity	
		Income	
		Costs (Wages)	
		Interest	

Households

Assets		Liabilities	
Demand Deposits (H)	970	Debts (H)	
(of Bankers)	30		
Time Deposits		Equity	
		Income	970
		Interest	
		Dividends (Bank	30

Figure 5: Money Creation by Bank Loans - Government

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1.6   Market Operation by Central Bank

What happens when central bank injects liquidity into the market through its asset purchase operation? Let us consider a scenario in which central bank decides to ease a borrowing condition. Though the central bank under the current system functions as the lender of last resort, direct underwriting of the government bonds is prohibited by law in most nations. Market operations by the central bank, therefore, is confined to the purchase of existing financial assets from financial institutions such as banks. This essentially results in the injection of additional liquidity into reserve accounts of banks held at the central bank. Hence, simplified transaction steps of the central bank are listed below. Figure 6 illustrates all changes in the balance-sheets as a result of these transactions.

Transactions of Central Bank

1. Central Bank purchases G Bonds of 600 million yen held by Banks.

2. The Government divides interest payment of 30 million yen accrued on its bonds according to the holding ratio: 12 million yen are paid to Banks and 18 million yen to the Central Bank, respectively.

3. Those interest earned by the Central Bank are payed out as dividends to its shareholders called central bankers. 18 million yen goes to the Central Bankers' demand deposits out of the Central Bank's Equity.

4. 12 million yen goes to Bankers' demand deposits out of Banks' Equity.

Observations

Only the Bank's Reserves increases as a result of market operation of 600 million yen while money stock remains unaffected during transaction step 1. Therefore, purchase or withdrawal operation by the central bank directly affects base money. This is illustrated by arrows connecting to the stock of Central Bank Reserves in Figure 1. Only after step 3 and 4 does money stock increase slightly, but this becomes a separate transaction from market purchase operation.

Moreover, we have simply assumed that all interest earnings from government bonds are paid to shareholders of central bank as dividends in the above example. Interest revenues from government bonds constitutes a large portion of total profits of central bank in many nations, but it becomes a source of operational costs of borrowing to the government.

Central Bank

Assets		Liabilities	
		Reserves	-1,000
G Bonds	600		970
			600
			12
		(Dividends payment)	18
			10
		G Deposits	1,000
CB Loans	10		-970
			-12
			-18
		Equity	
		Interest	18
		Dividends	-18

Government

Assets		Liabilities	
G Deposits	1,000	Debts (G)	1,000
	-970		
	-12		
	-18	Equity	
		G Expenditur	-970
		Interest (Ban	-12
		Interest (CB)	-18

Producers

Assets		Liabilities	
Demand Deposits (P)		Debts (F)	
		Equity	
		Income	
		Costs (Wages)	
		Interest	

Banks

Assets		Liabilities	
Reserves	-1,000	CB Debts	10
	970		
	12	Demand Deposits (P)	
	18		
	10		
	600	Demand Deposits (H)	970
Bank Loans		(of Bankers)	12
		(of C Banker	18
G Bonds	1,000		
	-600	Time Deposits	
		Equity	
		Interest	12
		Dividends	-12

Households

Assets		Liabilities	
Demand Deposits (H)	970	Debts (H)	
(of Bankers)	12		
(of C Banker	18		
Time Deposits		Equity	
		Income	970
		Interest	
		Dividends (Bankers)	12
		Dividends (C Bankers)	18

Figure 6: Money Creation by Asset Purchase Operation - Central Bank

1.7 Money Stock as Total Domestic Debts

So far we have examined how money stock increases as non-banking sectors (producers, households and government) are going into debt with banks by considering exemplary transactions. The relationship between debts and money stock for each sector is summarized in Figure 7 below. It shows that total debts outstanding in the economy, which is 3,000 million yen, are equal to the sum of money stock in the economy, that is, 3,000 million yen. It also shows that checkable deposits, which are initially created by bank loans, are held by different economic sectors as a result of various inter-sector transactions.

Debts (Loans)		Money Stock (M1) = Demand Deposits		
		Producers (Assets)	Households (Assets)	
Producers	1,000		Demand Depoists (H)	970
			(Bankers)	30
Households	1,000	Demand Deposits	970	Demand Deposits	
			(Bankers)	30
Government	1,000		Demand Deposits (H)	970
			(Bankers)	30
CB/Govern ment (QE)	(Sales of G Bonds only)		(Bankers)	(12)
			(CB Owners)	(18)
Total Debts	3,000	Total Deposits		3,000
		(Details)		
		Demand Deposits (P)	970	Demand Deposits (H)	1,940
			(Bankers)	90

Figure 7: Money Stock as Total Domestic Debts - Hypothesis

We are now in a position to examine whether the above relation holds true by constructing a ASD model of the worksheet examples. To reflect our economic reality in more detail, we will addionally assume several transactions; that is, the government bonds are held not only by banks but also households, and a fraction of demand deposits are saved as time deposits.

2 Accounting System Dynamics Model

In Section 1 we have begun our analysis with exemplary transactions in which producer's debts directly result in an increase in money stock as deposit creation by banks. Then we have expanded the similar analysis into other non-banking economic sectors. In this section we analyze the same transactions by translating them into Accounting System Dynamics model.

2.1 Stock-Flow Diagram - Five Domestic Sectors

There are five macroeconomic sectors as in the worksheet example. Figure 8 illustrates balance sheets of macroeconomic sectors such as the government, producers and households sector, while Figure 9 illustrates those of central bank and banks.

2.2 Parameters & Behavioral Assumptions

Several assumptions are made in the ASD model in addition to the parameters and transaction values used in the worksheet examples (such as Required Reserve Ratio = 1%, Interest Rate = 3%). A list shown below is three behavioral assumptions introduced in our model structure.

1. Households save a fraction of checkable deposits as time deposits.

2. Any shortages in bank's reserves resulting from deposit creation are swiftly adjusted by direct loans from central bank.

3. Newly issued government bonds are purchased by banks and non-banking sector of households.

Central banks in the real world constantly monitor and forecast expected level of shortage/surplus of bank reserves in order to keep inter-bank interest rate within the range of their policy rates. Assumption 2 in the above list presumes that any shortage of reserves perceived by the central bank is instantaneously supplied through its lending facility (direct loans of reserves to banks). Shortages in reserves are calculated as difference between legally required and current amount of reserves, which are in turn calculated by the reserve ratio and deposits outstanding. Our simplified ASD model here focuses on a relationship between the level of debts and money stock in the economy as a whole, thereby abstracting away more detail model structure describing the adjustment process of inter-bank interest rate[1]. Finally, our ASD model introduces a behavioral assumption in which households as a non-banking sector invest into government bonds by purchasing them from banks. This contrasts with the worksheet example in previous section where only the banks hold all government bonds outstanding. Balance sheets illustrated in Figure 8 and 9 reflect these changes.

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[1] Yamaguchi [10, 2017], for example, attempts to incorporate interest rate adjustment process in generic model of national economy with explicit structure of deposit creation process based on the stock approach modeling.
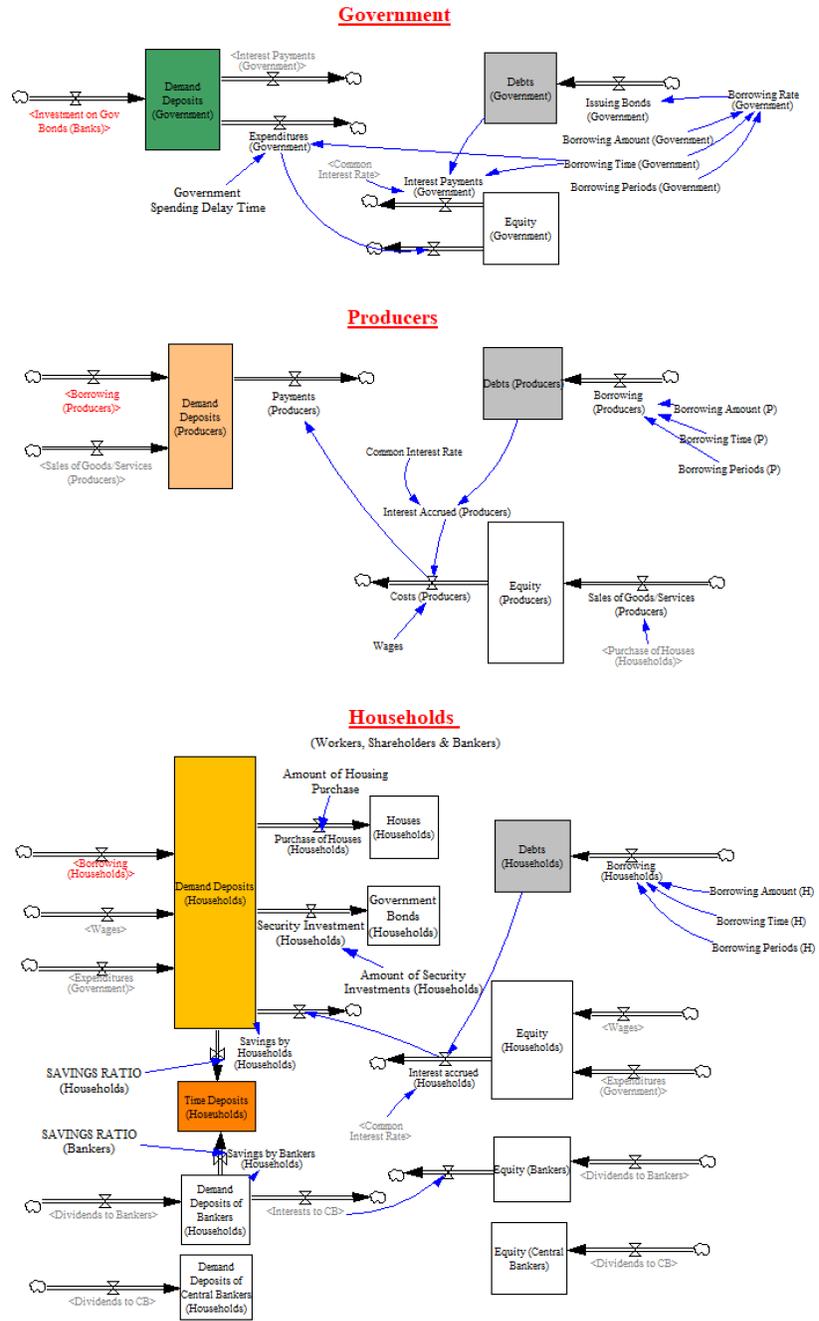
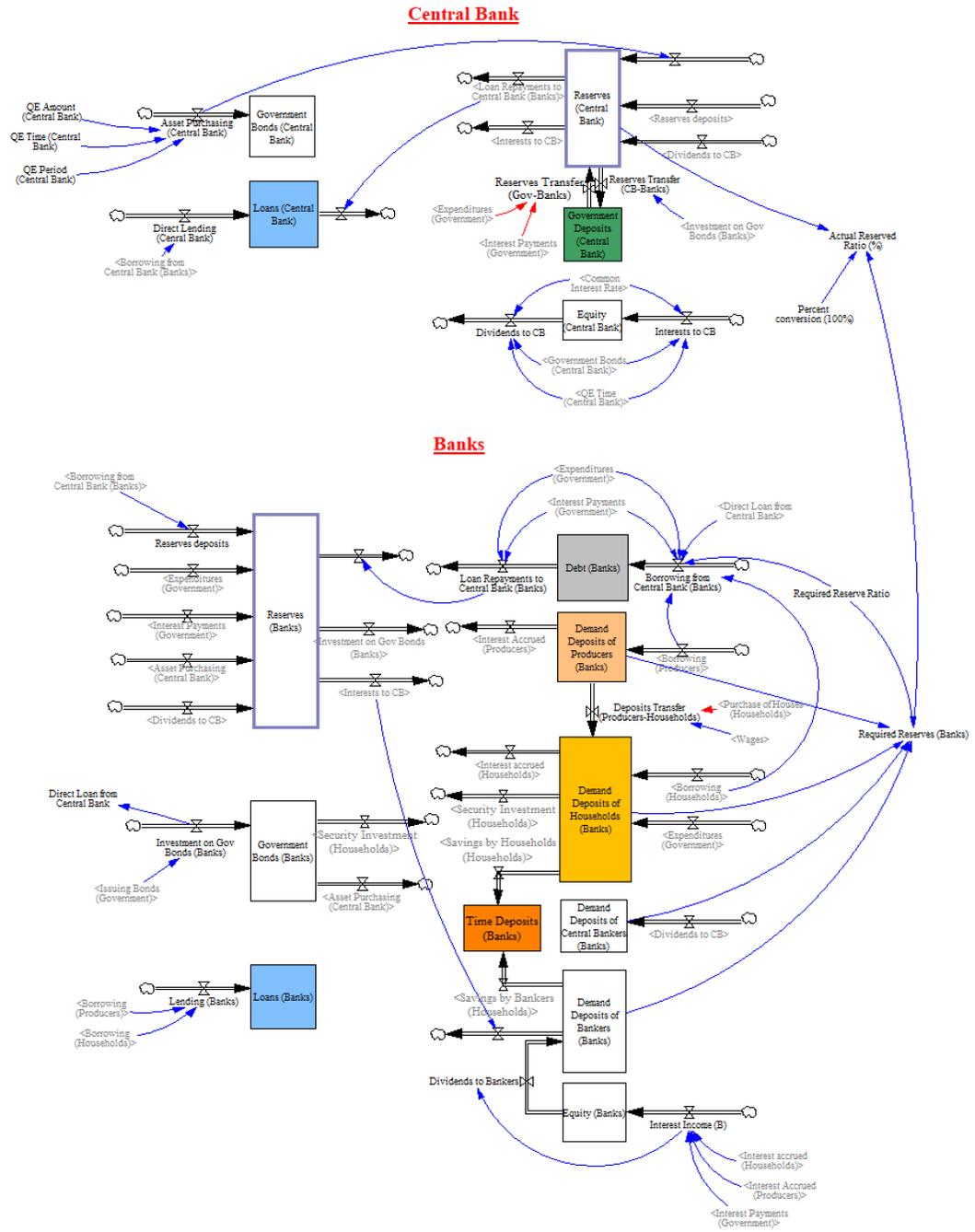Figure 8: Overview of Simple ASD Macroeconomic Model (1)

Central Bank

Banks

Figure 9: Overview of Simple ASD Macroeconomic Model (2)

2.3 Tests of Balance Sheet and Flow of Funds

Our ASD model has cleared both balance sheet test and flow of funds test discussed in Section 1 . Figure 10 presents balance sheet test in which balance sheets of central bank, banks, producers, households and government are all shown to be in balance. Figure 10 presents flow of funds test in which transaction items such as demand deposits, loans, reserves and debts are are shown all in balance between assets and liabilities across sectors.
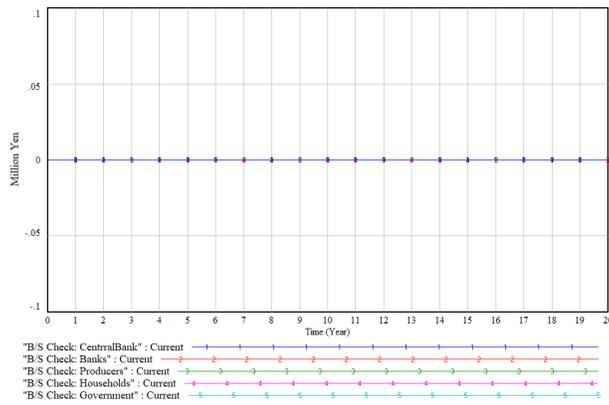

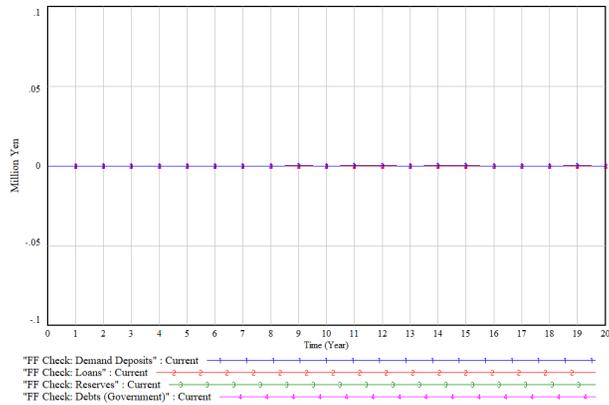Figure 10: Internal Consistency Check 1 - BS Test Results

Figure 11: Internal Consistency Check 2 - FF Test Results

3 Behaviors of the ASD Model

3.1 Definitions of Money Stock & Total Domestic Debts

Let us now examine a relationship between money stock and debts in domestic economy. Firstly, we define money stock as M_3, and total debts based on transaction items in the simulation model.

Definition of Money Stock (M_3)

As explained in Figure 1, money stock (M_3) covers cash outstanding (coins and banknotes), demand deposits and time deposits in domestic economy. In our model here, cash outstanding is excluded from our analysis. Therefore, money stock is defined as the sum of the following four items in our simulation model:

1. Demand (Transferable) Deposits (Households) - Assets

2. Demand (Checkable) Deposits (Producers) - Assets

3. Demand Deposits (Government) - Assets

4. Time Deposits (Households) - Assets

More specifically, demand deposits of households are calculated as the sum of deposits held by households, bankers and central bankers as illustrated in Figure 8. The first three items in the list comprises money stock (M_1) in the model. M_3 is calculated, then, by adding time deposits of households sector to M_1.

Definition of Total Domestic Debts

Following a similar conceptualization in worksheet example, we define total domestic debts as the sum of the following items in the model:

1. Debts (Producers) : Liabilities

2. Debts (Households) : Liabilities

3. Debts (Government) : Liabilities

Figure 12 presents our simulation result. As in worksheet examples, the simulation starts with initial state of 0. Then, producers and households go into debt with banks at simulation time 2 and 6 respectively. Increase in debts are observed by the increase in Loans (Banks) shown by a green line and Total Debts shown by a thick line in light blue color. Then, at time=11, government debt increases which is shown by a pink line.
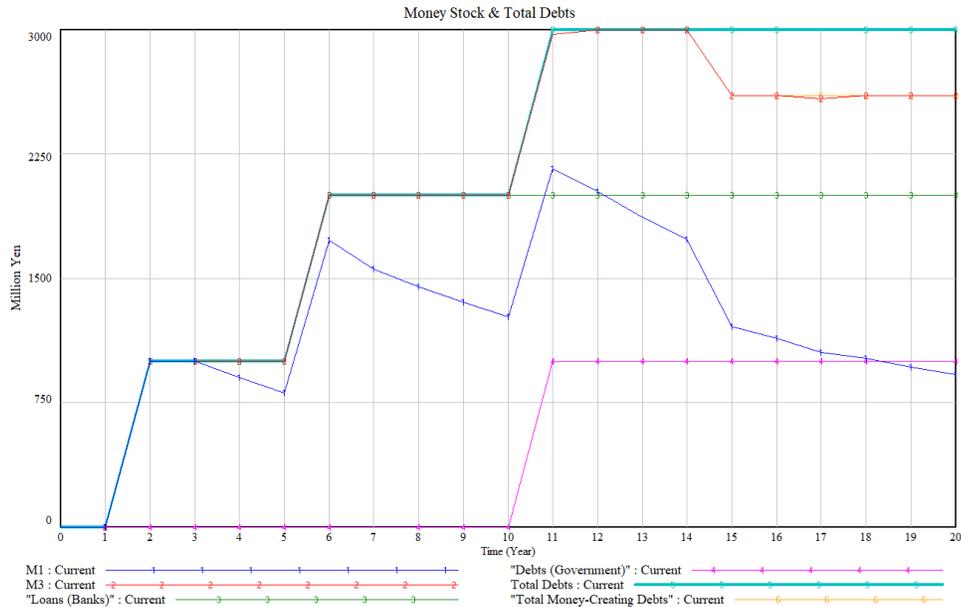
Figure 12: Money Stock equals Total Bank Loans

Our simulation results indicates that money stock as measured in M_3 (red line 2) increases along with total amount of debts (light blue line 5) . This is indeed consistent with what has been observed from our analysis in the worksheet examples in the previous section 1.7.

3.2 Money Stock (M_3) equals Total Debts by Banks

3.2.1 Definition of Total Domestic Debts by Banks

Can we conclude, then, that all public debts (i.e. newly-issued government debts) increase supply of money stock in the economy? The answer would be negative if we strictly follow the quadruple accounting rule. Why? The simulation result shown in Figure 12 assumes that newly-issued government bonds (of 1,000 million yen) at time=11 are all purchased and held only by banks. In other words, the simulation until time=14 precisely follows examples assumed in the worksheet in Section 1. What happens if non-banking sectors also invest in government bonds? Specifically, let us assume that households invest 350 million yen simulation at time=15 by purchasing them from banks. As shown in Figure 12, M_3 and total debts begin to diverge after simulation time=14, and the equality of the two data series no longer holds.

The observed discrepancy occurs due to a reduction in deposits of households, or more generally, that of non-banking sectors. In the previous definition, total domestic debts are defined as liabilities of each sector. As we have just seen, however, this approach has deficiency in accurately capturing total bank

debts since not all government debts are financed and held only by banks in the real world. Therefore, total domestic debts by banks have to be revised with the sum of following items in the model:

1. Loans (Banks) : Assets

2. Government Bonds (Banks) : Assets

3. Government Bonds (Central Bank) : Assets

The revised definition is shown by yellow line 6 in Figure 12 with a different legend name called "Total Money-creatingDebts".

3.2.2   Money Stock (M_3) equals Total Debts financed by Banks

The revised definition is shown to accurately captures M_3 even after time=14. We can now conclude that money stock (M_3) equals total domestic debts (private and public) financed *by banks*. This will become our key insight for a case analysis in Section 4. We examine it with time-series data obtained from the Japanese economy.

Our analysis also indicates that asset purchase operation by central bank does not directly increase money stock as long as they are purchased from financial institutions holding reserve account at the central bank. This is because market operation essentially swaps the government bonds held by banks to central bank within the above revised definition of total debts by banks.

However, if government bonds are initially purchased by banks in the primary market, they must have already contributed to money creation when the government spends these funds back into the economy as discussed in previous section. Hence, we now obtain another insight about behaviors of money stock; that is, market operations do not affect money stock per se. These observations will be applied to our case analysis on Japanese economy in the next section.

4   Analyzing Flow of Funds Account in Japan

4.1   Flow of Funds Statistics in Japan

This section tries to examine numerical and simulation results obtained from the previous sections as applied to the Japanese economy. Flow of Funds Account (FFA) statistics is compiled and published by the Bank of Japan on quarterly basis. It is known to be one of the most comprehensive data set for financial accounts data available in the world. Due to the data availability, and richness of supplementary guides on the statistics provide by the bank, we decided to consider it as a point of reference for Flow of Funds analysis in our current research. FFA by the Bank of Japan is made available in a matrix format from the bank's Website.[2] The columns into which economic entities are classified

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[2] Bank of Japan's website for FFA statistics and related materials are available at: http://www.boj.or.jp/en/statistics/sj/index.htm/

are known as sectors. They are broadly divided into six sectors, and these sectors are further broken down into sub-sectors. In total, there are 45 sectors.[3] Appendix shows all sectors classified in the statistics in Japan.

Transaction items are classified into rows. They consist of top-level domain items such as Currency and deposits (A), Deposits with Fiscal Loan Funds (B), Loans (C), Debt securities (D), and sub-items under each corresponding items in the top-level such as Currency (A-a), Deposits with the Bank of Japan (A-b), Government deposits (A-c), Bank of Japan loans (C-a), Loans by private financial institutions (C-c). In summary, there are 51 rows (transactions items) and 45 columns (sectors) at the most detail level, which is equal to 2,295 cells in the FFA matrix for a single year. Accordingly, time series data from 1980 through 2017 includes the total of 87,210 data points. If it is a quarterly data, it contains 348,840 data in total.

In order to systematically handle such a large set of FFA data, we have also built a separate model with system dynamics modeling software in the background, which imports all stock and flow item data since 1980. Use of this data visualization model has helped us to quickly jump across all sectors in the original FFA and compare different time series swiftly when testing working hypothesis. This is in contrast to the interactive Web application at the Bank of Japan's Website which requires to reload the page every time users want to add new items, and maximum number of items for graph comparison is constrained to 18 data series per single session.

4.1.1 Definition of Money Stock (M_3)

We have selected 5 sectors from the FFA to examine the relationship between money stock and total debts by banking sector in Japanese economy during 1980-2017. They are: central bank (1-1), depository corporations (1-2), non-financial corporations (2), general government (3), and households sector (4). Overseas sector is omitted from the current analysis.

Then, have calculated money stock directly from FFA data to keep consistency of data types, coverage and collection methods such as collection timing and frequency. This is performed by taking net values of transferable (A-d) and time deposits (A-e) of depository corporations (sector 1-2). Specifically, net values are obtained by subtracting items on asset side from liability items of the depository corporations.

After performing the subtraction to derive net values for total deposits, we have defined money stock (M_3) in our case analysis as the sum of the following data components:

1. Currency (A-a) of Central Bank (1-1) : Liabilities

2. Transferable deposits (A-d) of Depository corporations (1-2) : Net values

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[3] Data series of ″Postal savings″ and ″Private life insurance companies″ are available only until the third quarter of 2007.

3. Time and savings deposits (A-e) of Depository corporations (1-2) : Net values

4.1.2 Definition of Total Domestic Debts by Banks

Let us next define total domestic debts by banks. FFA data from Japan shows that a large proportion of the total government bonds are held by banks, insurance and pension funds rather than the households sector. As explained in Section 2, government bonds held by the central bank must also be taken into account as a component of total debts since they might have been purchased from banks by QE policies. From these observations, we define total domestic debts in our case as the sum of the following data components selected from FFA data:

1. Loans by private financial institutions (C-c) of Depository corporations (1-2) : Assets

2. Treasury discount bills (D-a) and Central government securities and FILP bonds (D-b) of Depository corporations (1-2) : Assets

3. Treasury discount bills (D-a) and Central government securities and FILP bonds (D-b) of Central bank (1-1) : Assets

4.2 Money Stock (M_3) equals Total Debts by Banks

Figure 13 shows the results from our analysis where units are denominated in Billion Yen. Money stock (M_3) shown by blue line 1 equals total domestic debts by bank loans shown by red line 2 during the period between 1980-1994 with high accuracy both in trend and absolute values. They indicate that total domestic (private and public) debts financed by banks determine money stock (M_3), and confirm consistency of deposit creation theory at a macroeconomic level under the current system of fractional reserve banking.

Remarks on the Divergence between M_3 and Total Debts by Banks

A divergence is also observed between money stock (M_3) and the total debts by banks in Figure 13 starting from around the year 1993 until recently. We have not yet reached plausible conclusion as to the divergence at this point. However, we consider several working hypothesis that may explain the divergence observed between tM_3 and total debts by banks as follows:

- Missing transaction items that must be included in the proxy data for total debts by banks

- Potential overlaps over one of data components in M_3 calculated from FFA statistics

- Incorrect specification of banks, thereby failing to account for additional types of loans that change money stock
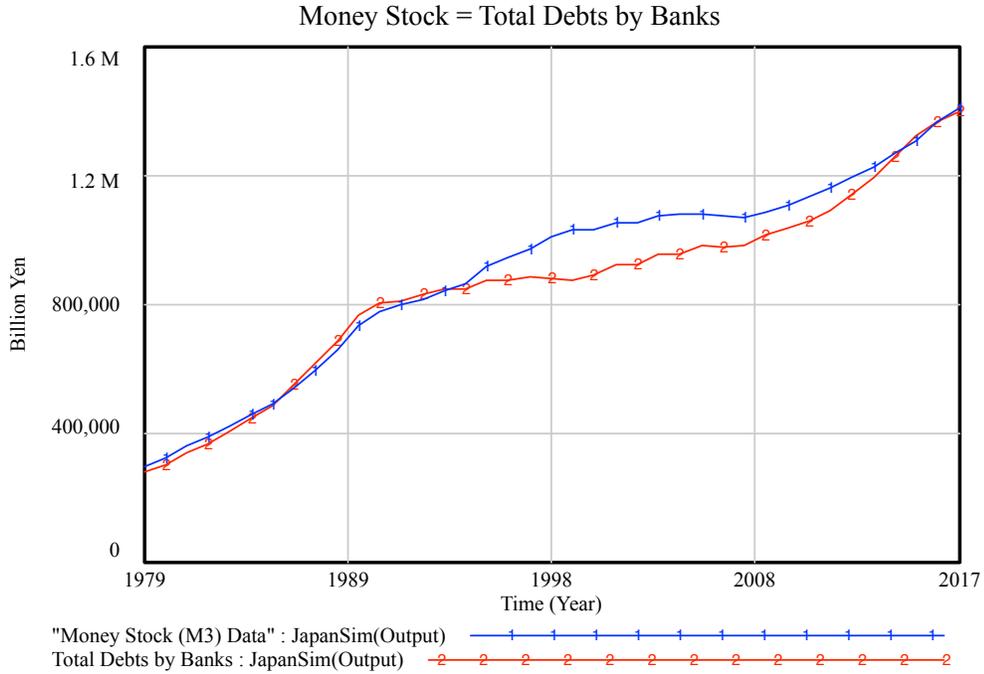
Figure 13: Money Stock Equals Total Bank Loans (1980-2017)

- Inaccuracy in one of data source included as one of data components in the two proxy data series

The hypothesis 1 in the above list may be stemming from insufficient treatment of the overseas sector in defining total debts by banks as current analysis excludes the overseas sector. Possibility of the hypothesis 2 can be checked, for instance, by comparing M_3 (FFA) against M_3 (Money Stock Statistics).

To test the hypothesis 4, sophistication of data selection can be performed. We have made several challenges unsuccessfully due to the limited level of details in bank loan data under the current FFA statistics. Hence, not all transaction items available in the original data source may correspond precisely to each of desired data series in the two proxy data series. Accordingly, we need to improve the current analysis by enhancing, say, data availability in the statistics.

4.3 Further Observations from FFA Data Analysis

Bank's Business Model as Lender to the Government

Additional observations of the Japanese economy are summarized here. Since around the mid 90's, not long after the asset price bubble burst, the amount of government bonds held by banks continue to increase as shown by red line

2 in Figure 14. Indeed, the Japanese government has implemented a series of fiscal spending to help sustain the level of aggregate demand. Around the same time since 1997, a signifiant repayment of debts by banks (and partially credit defaults) occurred as producer's debt declined significantly as shown by blue line 4 in Figure 14.

Accordingly a proportion of government bonds among bank's portfolios has grown relative to loans to non-financial sectors.

Why Did M_3 Sustain its Growth?

When bank loans get repaid, money stock must decrease accordingly. The Great Depression in the 1930's was one of the earliest event when such phenomena was observed at dramatic scale in the U.S economy. Fisher [3, 1935] noted that in 1929, total circulating medium was reported to be 27 billion dollars. Out of the 27 billion, 4 billion were cash and 23 billion were "check-book money" (bank deposits). By 1933, however, the figures dramatically changed. Fisher wrote:

> *An essential part of this depression has been the shrinkage from the 23 to the 15 billions in checkbook money, that is, the wiping out of 8 billions of dollars of nation's chief circulating medium which we all need as a common highway for business.* (p.15)

Unlike the Great Depression, however, the sharp decline of bank loans during 1990's has not resulted in the decline of money stock in Japan. For the readers who have followed previous analysis in Section 1 and 2, such phenomenon is conceivable. The fiscal spending by the Japanese government is reflected by the amount of the government debts shown by pink line 4 in Figure 14. As already mentioned earlier, government bonds held by banks have continued to increase correspondingly. At microeconomic-level it is a plausible and consistent behavior of profit-seeking financial institutions to look for alternative target for lending when loans to private non-financial corporations are being repaid rapidly. In this sense the efficacy of fiscal spending could well be justified, with the assumption that demand from private sectors are weak, banks perceive profitability on loans including the government bonds, and retain their risk appetite.
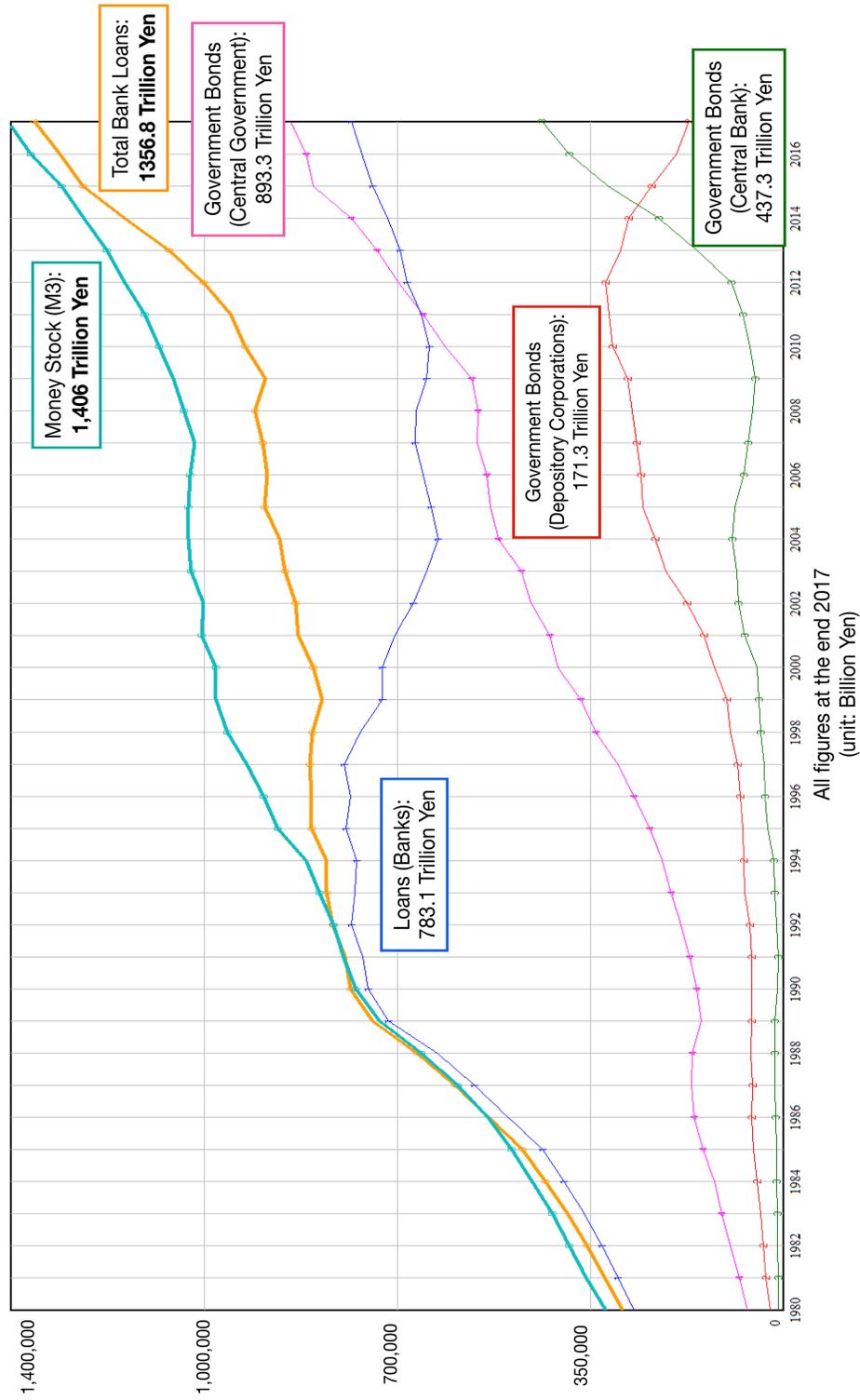
Figure 14: Money Stock, Public and Private Debts (1980-2017)

The chart contains the following labels:

- Total Bank Loans: **1356.8 Trillion Yen**
- Government Bonds (Central Government): 893.3 Trillion Yen
- Money Stock (M3): **1,406 Trillion Yen**
- Loans (Banks): 783.1 Trillion Yen
- Government Bonds (Depository Corporations): 171.3 Trillion Yen
- Government Bonds (Central Bank): 437.3 Trillion Yen
- All figures at the end 2017 (unit: Billion Yen)

Y-axis values: 1,400,000; 1,000,000; 700,000; 350,000; 0

X-axis years: 1980, 1982, 1984, 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016

Conclusion

This paper studied money creation process from a macroeconomic perspective. The stock approach modeling of bank lending was first revisited to emphasize its need for analysis on money creation. By applying accounting system dynamics modeling framework, it is then analyzed that money stock increases when domestic non-banking sectors go into debts with banks. Building on theoretical insights gained from simulation model in Section 2, the macroeconomic relationship between money stock (M_3) and total debts by banks was analyzed against historical data from the Flow of Funds statistics in Japan. For this analysis, a separate reference data model was developed and utilized for visualization of the large set of time-series data since 1980. As implied by deposit creation theory, growth of money stock (M_3) is accompanied by the equal amount of total debts financed by banks. However, the intermediate divergence between two proxy data series during a period of 1994 - 2015 indicates a room for improvement in precision. Current research also omits the overseas sector from its analysis. To account for the divergence, four hypotheses were formulated for improvements in future research, and enhancing availability of detail data in the underlying statistics was proposed. Results from our case analysis indicate effectiveness of the employed analytical frameworks in examining the historical behavior of key macroeconomic variables.

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Appendix: Sectors of FFA Statistics in Japan

Table 1. *List of Sectors and Major Institutions* (last update: October 2013)

Names of sectors	Major financial institutions	Code*
Financial institutions		1
Central bank	Bank of Japan	1-1
Depository corporations		1-2
Banks		1-2-1
Domestically licensed banks	Domestically licensed banks, holding companies	1-2-1-1
Foreign banks in Japan		1-2-1-2
Financial institutions for agriculture, forestry, and fisheries	Norin Chukin Bank, Agricultural Cooperatives, Credit Federations of Agricultural Cooperatives, Fishery Cooperatives, Prefectural Credit Federations of Fishery Cooperatives	1-2-1-3
Financial institutions for small businesses**	Shinkin banks, Shinkin Central bank, Shoko Chukin Bank, Credit Cooperatives, Sinkumi Federation Bank, The Rokinren Bank, Labor Banks, Japan Post Bank	1-2-1-4
Postal savings (until 3rd Quarter 2007)		1-2-2
Collectively managed trusts		1-2-3
Insurance and pension funds		1-3
Insurance		1-3-1
Life insurance	\<Other than the following\> Japan Post Insurance (former Japan Post Postal Life Insurance Services)	1-3-1-1
Of which: private life insurance companies (until 3rd Quarter 2007)	Private life insurance companies, holding companies	1-3-1-1-1
Nonlife insurance	\<Other than the following\> a part of the National Special Accounts, independent administrative institutions, credit insurance institutions, etc.	1-3-1-2
Of which: private nonlife insurance companies	Private nonlife insurance companies, holding companies	1-3-1-2-1
Mutual aid insurance	The National Mutual aid Insurance Federation of Agricultural Cooperatives, Prefectural Mutual Aid Insurance Federations of Fisheries Cooperatives, National Federation of Workers and Consumers Insurance Cooperatives, Prefectural Federations of Workers and Consumers Insurance Cooperatives	1-3-1-3
Pension funds		1-3-2
Corporate pensions	Employees' pension funds, former qualified retirement pension plans, defined-contribution pension plans (corporate-type), defined-benefit corporate pension	1-3-2-1
Other pensions	Defined-contribution pension plans (personal-type), National Pension Fund, etc.	1-3-2-2
Other financial intermediaries		1-4
Securities investment trusts	Investment trust management companies	1-4-1
Bond investment trusts		1-4-1-1
Of which: MMF, MRF		1-4-1-1-1
Stock investment trusts		1-4-1-2
Nonbanks		1-4-2
Finance companies	Finance companies (excluding construction, real estate), securities finance company, former Industrial Revitalization Corporation of Japan, The Resolution and Collection Corporation, etc.	1-4-2-1
Structured-financing special purpose companies and trusts		1-4-2-2
Public financial institutions		1-4-3
Fiscal Loan Fund		1-4-3-1
Government financial institutions	Special Account for Public Investment and Loans other than the Fiscal Loan Fund, government financial institutions, other government-affiliated corporations and independent administrative institutions whose main business is financial intermediation	1-4-3-2
Financial dealers and brokers	\<Other than the following\> "Tanshi" companies (money market dealers), Banks' Shareholdings Purchase Corporation (special account)	1-4-4
Of which: securities companies	Securities companies, holding companies	1-4-4-1
Financial auxiliaries (financial institutions other than intermediaries)	Institutions that guarantee financial instruments, stock exchanges, financial exchange, Banks' Shareholdings Purchase Corporation (general account), foreign exchange brokers, foreign exchange margin trading firms	1-5

Figure 15: Sectors in Flow of Funds Account in Japan

Nonfinancial corporations				2
	Private nonfinancial corporations		Profit-making corporations, medical corporations, etc.	2-1
	Public nonfinancial corporations		Certain government-affiliated corporations such as public corporations, government financial corporations and independent administrative institutions, Enterprise Special Accounts of the Central Government, local public corporations, local public enterprises	2-2
General government				3
	Central government		Central Government General Account, National Special Accounts that are not included into other sectors, certain government-affiliated corporations such as government financial corporations, certificated corporations, other independent administrative institutions	3-1
	Local governments		Urban and rural prefectures, towns, villages and special wards	3-2
	Social security funds		<Other than the following> Part of the National Special Accounts, health insurance associations, funds, etc.	3-3
		Of which: public pensions	Part of the National Special Accounts, long-term accounts of mutual aid associations, Farmers' Pension Funds	3-3-1
Households				4
Private nonprofit institutions serving households				5
Overseas				6

Figure 16: Sectors in Flow of Funds Account in Japan (continued)