Chapter 5

Money and Its Creation

This chapter[1] first explores the nature of money with its classification table, then its creation by a fractional reserve banking system under the current debt money system. Following the classification of money, two different approaches of money creation are introduced; that is, flow approach of banks as intermediaries and stock approach of banks as deposit(credit) creators. Then, two simple models of gold standard by these two approaches are constructed and behaviors of money stocks are comparatively analyzed. The models are further expanded to those of discount loans by central bank and government securities that allow the central bank to exercise a discretionary control over base money through open market operations. Throughout these comparative analyses, behaviors of money creation processes are demonstrated to be identical in essence among these two approaches as if they are heads and tails of the same coin, bringing century-long disputes of economists between flow and stock approach groups to an end.

5.1 What is Money?

5.1.1 Aristotle's Definition of Money

What is money? Where does it come from? These are fundamental questions that have been repeatedly raised through human history. *The Lost Science of Money* by Zarlenga [113, 2002] is one of the best books on money for authentic economists to explorer these questions. In the book, Greek philosopher Aristotle (384-322 BC) is quoted to have articulated money as follows:

[1]This chapter is based on the paper [96, 2004]: Money Supply and Creation of Deposits – SD Macroeconomic Modeling (1) – in "Proceedings of the 22nd International Conference of the System Dynamics Society", Oxford, U.K. , July 25-29, 2004, ISBN 0-9745329-1-6. It is further revised for the Edition 3.0 on the basis of the paper [111, 2016]: The Heads and Tails of Money Creation and its System Design Failures – Toward the Alternative System Design – in "Proceedings of the 34th International Conference of the System Dynamics Society", Delft, the Netherlands, July 17-21, 2016.

> and this is why it has the name *nomisma* - because **it exists not by nature, but by law (*nomos*)** and it is in our power to change it and make it useless. [113, 2002, p.34].

Following Aristotle, let us begin to define money similarly as *legal tender*. What is *legal tender*, then? Legal tender is money that people cannot refuse to accept in exchange for commodity. In other words, money is *legal tender* that coflows along with commodity inseparably as illustrated in Figure 5.1.

From SD modeling point of view, in order to model coflows of money and commodity, we need at least following three pieces of information on money: money as stock, its unit to define the amount of stock, and its flow amount as a medium of exchange for commodity. Hence, from these modeling requirements we can easily derive three essential functions of money as explained in many standard textbooks[2]:

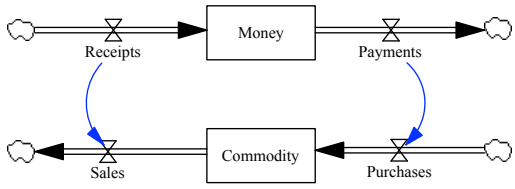

Figure 5.1: Coflow of Money and Commodity

- Unit of Account (unit of money stock as *information* has to be determined before modeling)
- Medium of Exchange (flow amount of money stock has to be determined to coflow commodity)
- Store of Value (money has to be modeled as the amount of stock)

In short, money has to be declared as legal tender first of all. Whenever it is put into circulation, then, it begins to entail three inevitable functions mentioned above, not *vice versa* at all. It can be easily understood consequently that SD modeling method is essential for the dynamic description of money.

According to the double-entry bookkeeping rule of accounting, commodity transaction with cash as money in Figure 5.1 can be equivalently described in Table 5.1 as follows:

[2]One more important function of money is that it plays as *means of control*. Historically those who lend money have been always in a position to control borrowers as their debt slaves. This means of control is fully analyzed in the recent Japanese book of this author [107, 2015].

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

Table 5.1: Journal Entries of Transaction with Cash

in which plus sign (+) implies the increase in amount and minus sign (-) its decrease. In this transactions, buyers have to give up their cash assets to increase their commodity assets, while sellers have to give up commodity assets to increase their cash assets. In short, commodity transactions with cash are always booked as increase and decrease of assets simultaneously.

Meanwhile, Adam Smith (1723-1790), known as the father of economics, reversed the above definition of money by Aristotle as follows:

> By the money price of goods it is to be observed, I understand always, *the quantity of pure gold and silver* for which they are sold, without any regard to denomination of the coin. [113, p.313].

In this way, Adam Smith reversely defined money as commodity. Advancing his idea more axiomatically, many textbooks currently define money as the entity that meets the above three functions. According to this axiom of money, gold and silver are best qualified as ideal money *by nature*, because their physical nature meets three functional conditions of money perfectly. This reversed definition of money as commodity has become a root cause of confusion for centuries among mainstream economists as well as ordinary people who are heavily influenced by them. Consequently, we logically refute this definition of money as commodity.

5.1.2 Issuance of Legal Tender

In order to define money as legal tender, there must be specific laws that stipulate the issuance of money legally. Historically such laws hav been established by public (sovereign) authorities such as kings, queens, sovereign states, and modern legislative branches of governments such as Congresses, Parliaments and Diets. In other words, the intended issuers of legal tender had to establish its law first, then issue money by themselves *at interest-free*. Money as legal tender issued in this way by public (sovereign) authorities are called here *public money*.

The issuance of money as legal tender has been exercised in a similar fashion even today. For instance, in Japan "Currency Unit and Money Issuance Act (revised in 1987)" enables the government to issue coins (called money) by a unit of yen (¥); that is, 1, 5, 10, 50, 100 and 500 yen coins. On the other hand, "Bank of Japan Act (revised in 1997)" enables the Bank of Japan, a privately

owned central bank[3] with 55% ownership of the government, to issue "Bank of Japan Note" with denominations of 1000, 2000, 5000 and 10000 yen notes.

In the Constitution of of the United States of America, the issuance (coinage) of money is clearly stipulated in Article 1 as follows:

> Section 8. The Congress shall have power to lay and collect taxes, duties, imposts and excises, $\cdots$;
>
> To coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures;

The reader is, therefore, advised to examine his or her nation's monetary laws that stipulate money as legal tender.

At a closer look at these current laws of legal tender, the reader may find that the main issuers of legal tender have been separated from historical public (sovereign) authorities since modern banking system emerged in the 18th and 19th centuries. To speak more straightforwardly, the powers of issuing legal tender by public (sovereign) authorities have been replaced with global bankers. In this way, legal tender has been nowadays issued mostly by private issuers such as privately owned central bank and commercial banks *at interest*. Such type of money is called *debt money* (including functional-money to be discussed below).

5.1.3 Classification of Money

Considering these transitions of issuers of money, our definition of money needs to reflect two monetary faces in terms of its issuance and fiat status. Front face of money is defined according to the issuance of money: public money issued by public (sovereign) authorities at interest-free, or debt money issued by banks at interest. Back face of money is defined according to the fiat status of money: money is issued as legal tender or functional-money. First and second rows of Table 5.2 illustrate our definition of money by its front and back faces.

Money functions, at its abstract level, as a unit of account or a piece of information, as discussed above, so that it needs a medium to carry its information value. Accordingly, 3rd row through 7th row of our classification table indicate various media of monetary values. Historically, media of information value took a form of commodities such as shell, silk (cloth) and stones; of precious metals such as gold, silver and copper coins; of papers such as Goldsmith certificates and (central) banknotes. In short, information values as money have been inseparable from their media, and any form of media that performs three features of money as legal tender, as discussed above, has been accepted as money that has a purchasing power.

[3]The expression "a privately owned" here means that the shares of Bank of Japan are owned by private individuals and institutions and freely traded in the stock market. Yet, there is no annual shareholders' meeting held in by the Bank of Japan. National Bank of Belgium, on the other hand, holds annual shareholders' meeting and its shares are traded in the stock market. For a brief comparative survey on differences of central bank ownership around the world, see Rossouw [65, 2014].

Classification of Money

Front: Issuance	Public Money	Debt Money (at interest)	
Back: Fiat Status	Money as Legal Tender		Functional-Money
Non-metal Commodities	Shell, Cloth (Silk) Woods, Stones, etc		
Metal Coinage	Non-precious Metal Coins Gold, Silver & Copper Coins		Metal Ingots (such as Gold)
Paper Notes	Public Money Notes by PM Admin.	Goldsmith Certificates Central Bank Notes	
Digital Cards & Accounts	Digital Public Money (PM)	Central Bank Reserves (Central Bank Digital Currency: CBDC)	Bank Deposits (Credits by Loans)
Blockchain	(since 2008) To be covered in Part V		(Bitcoin, etc.)

Table 5.2: Public Money vs Debt Money

Tangible media currently in use are coinage and banknotes. Coins are minted by the government as subsidiary currency. Hence, they are public money by definition. On the other hand, banknotes are issued by central banks that are independent of the government and privately owned in many countries. For instance, Federal Reserve System, the central bank of the United States, is 100% privately owned [37, 2006] and Bank of Japan is 45% privately owned. Banknotes are loaned out to banks at interest. Hence, they are debt money by definition. Meanwhile, metal ingots such as gold ingots have historically functioned as money to pay for international imbalances of trades, etc. Hence, they are additionally classified under functional-money in parenthesis.

Intangible media of information values as money have been separated, under the information technology, from physical media such as metal and paper, and nowadays made available as electronic money (intangible digits) kept in digital cards and digital accounts. Most important example of digital accounts are bank deposits which are classified under functional-money (as explained below). Furthermore, recent blockchain technology enables us to send electronic money peer-to-peer directly, faster and safely at lower cost without banks as intermediaries[4]. Our classification of money is now completed as in Table 5.2.

5.1.4 Base Money as Legal Tender

Let us now examine the component of legal tender more in detail. In Japan *currency*, or cash, consisting of the Government *coins* and Bank of Japan *notes*, is specifically defined by law as legal tender in a sense that it cannot be refused to accept as a means of payment; that is why it is alternatively called *fiat money*.

[4]Bitcoin, originally proposed by Satoshi Nakamoto with blockchain technology in 2008, is one such example, though it's not claimed as *legal tender*. Accordingly, it should be classified under functional-money, similar to metal ingots such as gold. Money of the futures under blockchain technology will be covered, as one of the most important subjects, in Chapter 18 of Part VI: Electronic Public Money.

Figure 5.2 illustrates the state of currency (coins and banknotes) as legal tender.

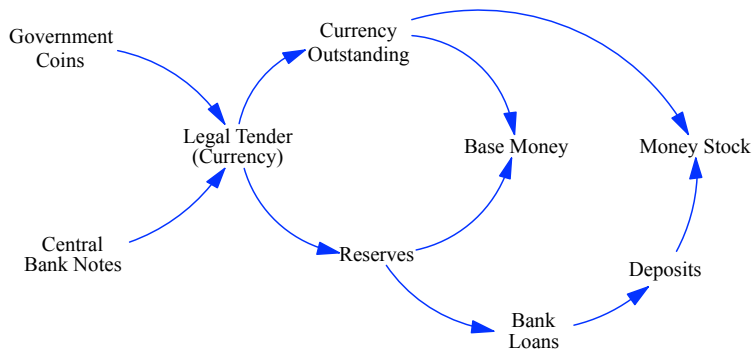

Figure 5.2: Base Money as Legal Tender

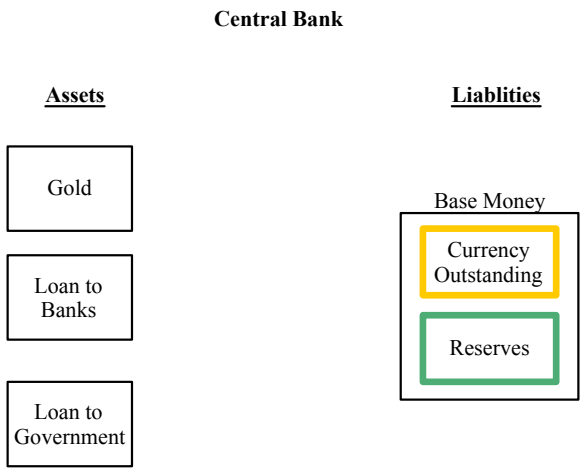

Figure 5.3: Issuance of Base Money Backed by Various Types of Assets

Once currency as legal tender is being put into circulation under the current fractional reserve banking system, it begins to be split into two parts: currency outstanding and reserves with the central bank, as explained below. The sum

of these parts are called *base money*[5]: that is,

$$\text{Base Money} = \text{Currency Outstanding} + \text{Reserves} \tag{5.1}$$

Hence, base money is by definition the only legal tender as illustrated in Figure 5.2.

Although central bank is legally allowed to issue base money, it can issue base money only when someone comes to borrow at interest. Those who come to borrow from the central bank are mainly commercial banks and government. Accordingly, the practice of issuing base money has to be backed by various asset purchases such as gold, loans to banks and loans to government, as illustrated in Figure 5.3, according to the double-entry accounting rule. Base money is booked as liabilities in the balance sheet of the central bank, and backed by various types of assets such as gold, discount loans to commercial banks and loans to the government (securities).

5.1.5 Bank Deposits as Functional-Money

So far banks deposits are not discussed under the classification of money. Are they money? Under the current debt money system of fractional reserve banking, banks can create deposits out of nothing by granting loans to non-banking sectors such as producers, consumers and government, to be explained below. Figure 5.4 illustrates that bank deposits thus created are used for transactions

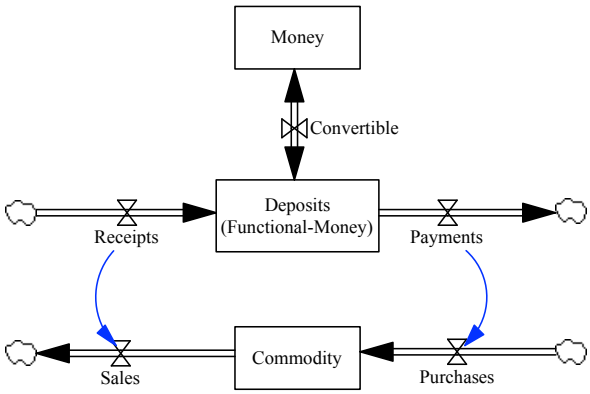

Figure 5.4: Deposits as Functional-Money

[5]Base money is alternatively named *monetary base* in the following chapters of this book, and they are interchangeably used. In the older version of the book, *monetary base* is used, while in this new version, *base money* is used wherever contents are updated. This is because "monetary base" gives us a misleading impression that bank deposits, being created out of monetary base as explained below, constitute the expanded base of currency as legal tender. Base money is, on the contrary, the only *legal money*.

as if they are money.

This transaction is booked by the double-entry accounting rule as in Table 5.3. Hence all transactions are booked under the assets of balance sheet as in Table 5.1. Does this imply that deposits, created out of nothing through loans, become legal tender, similar to cash, such that no one can refuse to accept? According to Masaaki Shirakawa, former governor of the Bank of Japan, the

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

Table 5.3: Journal Entries of Transaction with Deposits

answer is negative.

> Contrary to the central banknotes, creditors can refuse to accept bank deposits as the payments of debt obligations because of credit risks associated with bankruptcies of debtors' banks. However, in normal times, bank deposits **function as money** because of creditors' confidence that bank deposits can be converted to central banknotes [68, p.13, 2008] .

What is meant here is that deposits are accepted for commodity transaction in Figure 5.4 only when their convertibility assumption with money is presumed by their recipients. In this sense, they are not legal tender. Henceforth, deposits are in this book regarded as f*unctional-money*, and the misleading naming of "credit creation" that has been used in standard textbooks is interchangeably replaced with "functional-money creation".

Assuming that *deposits function as money*, standard textbooks define another concept of *monetary aggregate* in addition to *money* as

$$\text{Money Stock} = \text{Currency in Circulation} + \text{Deposits} \tag{5.2}$$

Money stock[6] thus defined is the expanded amount of money available in the economy as medium of exchange, regulating transactions and economic activities.

Though this concept of money stock is theoretically rigorous to capture the expanded amount of money available in the economy, it is hard to calculate it statistically in practice. Accordingly, money stock is practically obtained more easily according to the monetary data available at the central bank and commercial banks by the following formula:

[6]Money stock is alternatively named *money supply*, and they are interchangeably used in this book.

$$\text{Money Stock (Data)} = \text{Currency Outstanding} + \text{Deposits} \tag{5.3}$$

This relation is illustrated in the above Figure 5.2. The difference of these two definitions is "vault cash" held by commercial banks such that

$$\text{Currency Outstanding} = \text{Currency in Circulation} + \text{Vault Cash (Banks)} \tag{5.4}$$

Money stock thus defined begin to play a role as money as if it is legal tender under the assumption of its convertibility with money.

5.1.6 Debt Money vs Public Money System

Debt money system is defined as a system in which money is issued by private central bank at interest, and deposits are created out of nothing by commercial banks and function as money at interest. In this system money is only created when government and commercial banks come to borrow from the central bank, and producers and consumers come to borrow from commercial banks in the form of bank deposits (called functional-money). To distinguish this type of money from *public money*, it is called *debt money* or *money as debt* here.

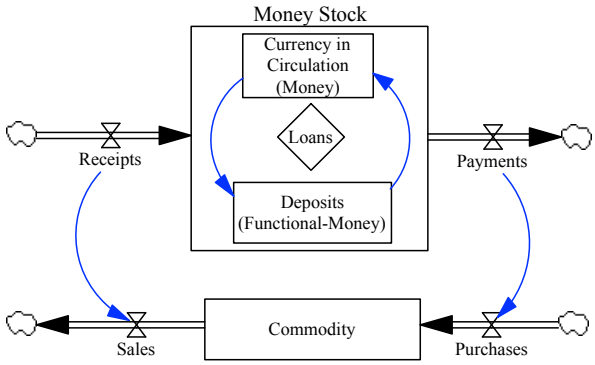

Figure 5.5: Debt Money System

Current macroeconomies are being run under this type of debt money. Hence, our economic system is *a debt money system* as illustrated in Figure 5.5. Almost all of macroeconomic textbooks in use such as [38, 1997], [53, 2003], [58, 2006], [54, 2008] justify the current macroeconomic system of debt money, as if it is the only system, without mentioning the alternative system of public money.

Accordingly, it is essential to understand the workings of the current debt money system in detail as most economists do so. In this book, Parts II, III and IV are wholly devoted to the study of macroeconomic systems of *debt money*. Money thus used in these parts should be understood as debt money from now on without specifically mentioning it. Workings of a macroeconomic system of

public money will be fully investigated in Part V as an alternative system to the current macroeconomic system of debt money.

5.2 Classification of Money in Japan

5.2.1 Money Stocks in 2018

So far we have introduced basic concepts of money such as base money and various types of money stock. In actual monetary analysis, money stocks have to be further classified according to the nature of bank deposits. Following the definition of the Bank of Japan,[7] we have further defined money stocks, whenever appropriate in this book, as follows [110, 2019].

M_0 consists of Government Coins (Public Money), Banknotes and Bank Rserves at the Central Bank. This type of money is simultaneously regarded as *legal tender* in the sense that no one cannot reject its receipts. It is called *base money* or monetary base.

M_1 consists of Government Coins, Banknotes and Demand Deposits that can be used daily as means of payments or transactions. Demand deposits are created out of nothing by depositing a fraction of total demands as *reserves* at the central bank. Thus, a fractional reserve banking system is institutionalized under the current debt money system.

M_f is newly defined as $M_1 - M_0$, or more simply as demand deposits less reserves, which is created out of nothing by bank loans and only *functions as money* for payments during a normal period of economic activities. In case of *bank runs* this amount of deposits fails to be withdrawn because of the non-availability of its corresponding base money. Thus, the reader may cynically regard this type of deposits as *ficticious* or *fake money*[8].

M_T is the amount of demand deposits that leaked out of circulation. It is equivalent of *time deposits*, which yields higher interest but with a fixed period of time at the cost of liquidity.

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[7] The Bank of Japan defines various concepts of the amount of money as follows.
M_0 = Base Money
M_1 = Currency Outstanding + Demand Deposits
M_2 = M_1 + Quasi-money + CD (Certificate of Deposit)
(Quasi-money = Time Deposits + Foreign Exchange Deposits,
excluding the Japan Post Bank, Japan Agricultural Cooperatives, etc.)
M_3 = M_1 + Quasi-money + CD (Certificate of Deposit)

[8] When functional-money is more comprehensively defined as money stock that is not backed up by M_0 (denoted here by $\bar{M}_f$), we have, for the money stock M_3, $\bar{M}_f \equiv M_3 - M_0 = M_f + M_T$. Thus, M_T (Time Deposits) must be interpreted as a part of functional-money in the expanded sense as illustrated in Table 5.5. This makes sense, because in a case of bank runs, both M_f and M_T may not be thoroughly withdrawn by depositors.

Money Stock	Trillion Yen	(% of M_1)	(% of M_3)
Coins (Public Money)	4.8	0.6	0.3
Banknotes	107.6	12.9	7.6
Reserves	393.9	47.4	27.6
Base Money M_0	506.3	60.9	35.5
Functional Money M_f	324.9	39.1	22.8
Money Stock M_1	831.2	100.0	58.3
Time Deposits M_T	594.5		41.7
Money Stock M_3	1,425.8		100.0

Table 5.4: Money Stock & its Composition in Japan (2018)

Classification of Money Stock in Japan (trillion yen as of 2018)

Money (Front) (Issuance)	Public Money 4.8	Debt Money (at interest) (99.7%) 1,420.9 (Total Sum of Firms, Households and Government)			
Money Stock (Classified)	Coins 4.8	Banknotes 107.6	Reserves 393.9	Functional-Money (M_f) 324.9	
Base Money (M_0)	506.3				
Money Stock (Classified)	Currency (Cash) 112.4		Demand Deposits 718.8		Time Deposits(M_T) 594.5
Money Stock (M_1)	831.2				
Money Stock (M_3)	1,425.7				
Money (Back) (Fiat Status)	Legal Tender (35.5%) 506.3			Expanded Functional-Money ($\underline{M_f}$) (64.5%) 919.4	

Table 5.5: Classification of Money (Front & Back)

M_3 consists of M_1 and M_T and constitutes the whole amount of money available in the economy. In many countries this amount of money stock is called M_2. In Japan, deposits of Postal Savings used to be excluded from the amount of M_2. Hence, the total amount of deposits including Postal Savings needs to be additionally defined as M_3.

These money stocks are summarized in equations as follows:

$$
\begin{aligned}
M_0 &= \text{Government Coins} + \text{Banknotes} + \text{Reserves (Legal Tender)} && (5.5)\\
M_1 &= \text{Government Coins} + \text{Banknotes} + \text{Demand Deposits} \\
&= \text{Government Coins} + \text{Banknotes} + \text{Reserves} + \text{Functional Money} \\
&= M_0 \text{ (Base Money)} + M_f \text{ (Functional Money)} && (5.6)\\
M_3 &= M_1 + M_T(\text{Time Deposits}) \\
&= M_0 + M_f + M_T. && (5.7)
\end{aligned}
$$

Table 5.4 indicates the amount of Japanese money stocks and their decomposition values in the year 2018. Note that public money of government coins is negligible amount of 0.6% of money stock M_1, and 0.3% of money stock M_3. Yet, public money has survived in Japan !

Table 5.5 illustrates our most comprehensive definition of money stocks in Japan. Various types of money stocks defined above are sandwiched between front face and back face of our money definitions. This table provides the astonishing fact that 99.7% of money stock in Japan are debt money, while only 35.5% of money stock are legal tender. Historically, before the establishment of the Bank of Japan in 1882, money stocks in Japan have been 100% public money and 100% legal tender. In this sense, Japanese monetary system today is heavily dominated by the debt money system.

5.2.2 Money Stocks between 1980 and 2018

Let us now observe how money stocks of 2018 obtained in Tables 5.4 and 5.5 have behaved overtime. Figure 5.6 illustrates behaviors of money stocks between 1980 and 2018.[9] Government Coins is denoted by line 1, Banknotes by line 2, Reserves by line 3, Base Money M_0 by line 4, Functional Money M_f by line 5, and Money Stock M_1 by line 6, respectively.

[9] Time-series data for this case study in Japan are taken from the Flow of Funds Account (FFA) statistics by the Bank of Japan: http://www.boj.or.jp/en/statistics/sj/index.htm. FFA data are provided in a matrix format consisting of 51 rows (transactions items) and 45 columns (sectors); that is, 2,295 cells for a single year. In order to systematically handle such large set of FFA data, we have built a model for this case study with system dynamics modeling software called Vensim that imports all stock and flow data since 1980.

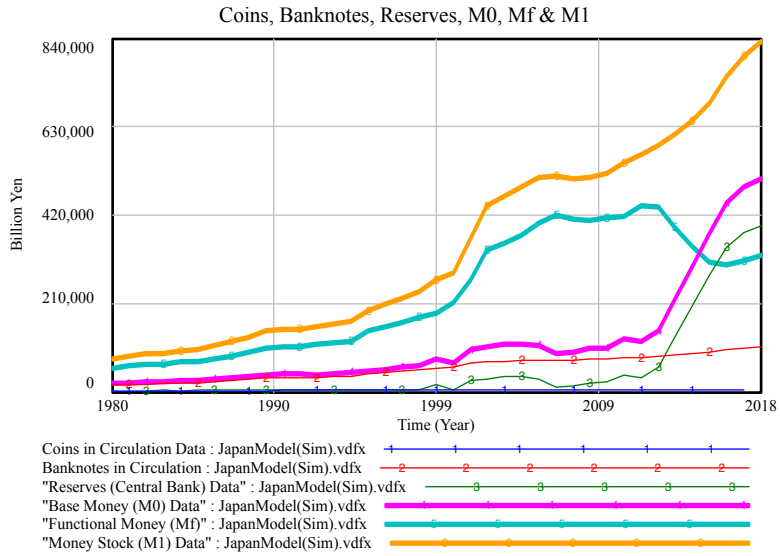

Figure 5.6: $M_0 + M_f = M_1$ in Japan (1980 - 2018)

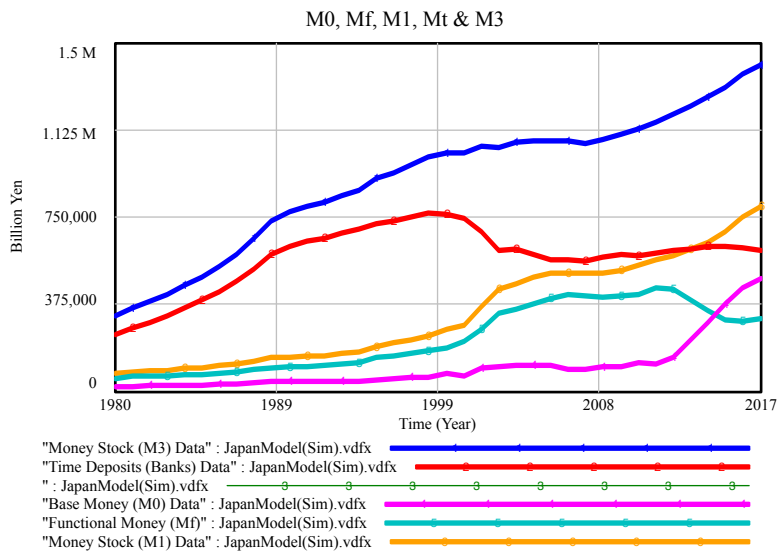

Figure 5.7: $M_0 + M_f = M_1$ and $M_1 + M_T = M_3$ in Japan

Figure 5.7 further illustrates behaviors of all money stocks between 1980 and 2018. Base Money M_0 is shown by line 4, Functional Money M_f by line 5, and Money Stock M_1 by line 6; up to these lines, line numbers are the same as in

Figure 5.6. Then, Time Deposits M_T is added by line 2, and Money Stock M_3 by line 1, respectively.

Yet, it is essential to understand that interest-free government coins (called here *public money*) manage to survive even under the system of debt money at interest! Functional money that cannot be converted to legal tender in a time of *bank runs* is close to 40% of M_1 in 2018. In other words, this is the amount of money created out of nothing, which endogenously increases or decreases, depending on our economic activities, causing booms and bust. To stabilize the economy, M_f needs to be eliminated; that is $M_f = 0$, so that banks cannot create money out of nothing. This was the original idea of monetary reform called t*he Chicago Plan*. This subject will be discussed in Part V: Macroeconomic Systems of Public Money.

5.3 Flow Approach of Functional-Money Creation

5.3.1 Three Sectors and Twofold Double Entry Rule

Under the debt money system, deposits are introduced as a part of money stock in addition to base money. As discussed above, deposits are not money as legal tender, but function as money; that is, functional-money. Where do deposits come from, then, and how are they created?

For the analysis of money stock and deposits creation, it is sufficient to reorganize six macroeconomic sectors illustrated in Figure 4.1 in the previous chapter into three sectors: the central bank, commercial banks and non-financial sector (consisting of producers, consumers, and government). Foreign sector is excluded in this analysis. Figure 5.8 shows the reorganized three sectors among which deposits is being created.

This does not imply, however, that three sectors are always required for understanding a process of functional-money creation. Historically, there was a time when central bank did not exist, yet functional-money has been created for economic activities. This suggests that for designing a new monetary system for sustainable macroeconomies, the central bank needs not be necessarily required. The reason why the central bank is included in our modeling here is to reflect the currently existing macroeconomic sectors in our model. Yet, it does not justify its existence for sustainable macroeconomy. We will fully explore the issue in Part V.

How can we describe economic transactions and circulation of money among three sectors? The method we employ here is based on the accounting system dynamics in which balance sheet plays a key role. Balance sheet is an accounting method of keeping records of all transactions in both credit and debit sides so that they are kept in balance all the time as follows:

$$\text{Assets} = \text{Liabilities} + \text{Equity} \tag{5.8}$$

As already discussed as the Principle 5 in Chapter 3, a modeling method of corporate balance sheet is based on the double entry rule of bookkeeping. In

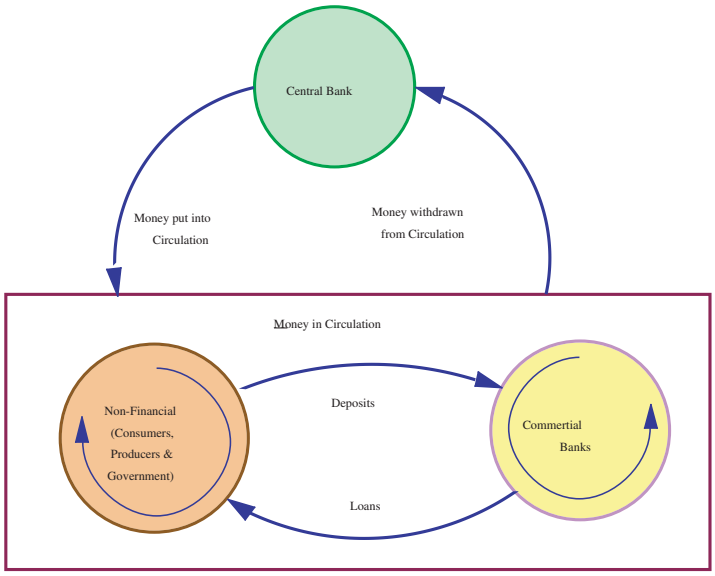

Figure 5.8: Three Sectors for Money Stock

system dynamics modeling, this principle is compactly illustrated as Figure 3.5.

Hence, all transactions of the central bank, commercial banks and non-financial sector are modeled respectively as inflows and outflows of money in their balance sheets. Moreover, macroeconomic transactions of money among three sectors not only influence their own balance sheets, but also other's balance sheets simultaneously. For instance, whenever a commercial bank makes loan to a producer, it affects the balance sheets of both the bank and the producer, simultaneously. In other words, one transaction in macroeconomy activates twofold double entries of bookkeeping among two sectors. In this sense, macroeconomic transactions can be said to be governed by *a twofold double entry rule*. This makes our modeling a little bit more complicated compared with the case of corporate balance sheet in which we only need to focus on the balance of credit and debit sides of a specific company.

5.3.2 A *Fractional Reserve* Banking: Flow Approach

Under the current debt money system of modern capitalist market economy, currencies consisting of government coins and central banknotes are in circulation. Whenever they are newly created, they are booked as currency outstanding under liabilities in the balance sheet of central bank[10]. To balance the account,

[10]To be precise, government coins are not liabilities of the central bank. Yet, in practice, the Bank of Japan, for instance, integrates them as a part of its currency outstanding as

the central bank needs to back them with corresponding assets. In this chapter, we consider three major assets such as gold, discount loans to banks and loans to government (purchase of securities) as illustrated in Figure 5.3.

This amount of currency outstanding becomes base money, out of which currencies begin to circulate among macroeconomic sectors. Once currency outstanding is put into circulation, they begin to be used for transaction payments. If more than enough currencies are in circulation, they will be deposited with commercial banks, out of which a fraction is further deposited with the central bank as reserves. Money in this way begins to be used as currency in circulation and deposits.

To model this circulation of currency by system dynamics method, two approaches turn out to be equally feasible; that is, flow approach of banks as intermediaries and stock approach of banks as deposit(credit) creators. Let us start with the flow approach first. According to this approach, commercial banks are assumed to run their banking business by accepting savings (deposits) from depositors and making loans to investors out of the deposits. Hence, banks are ostensibly regarded as being mere intermediaries just like other financial institutions and nothing more.

When commercial banks receive deposits, they are obliged to keep the deposits at a safe place to meet the request of depositors for withdrawal in the future. However, through such banking practices they gradually realized that only a portion of deposits were to be withdrawn. Accordingly, they started to make loans out of deposits at interest, so that they can earn extra income of interest. In this way, once-prohibited usury became a dominating practice, and modern banking practices have begun.

To meet insufficiency of deposits against a sudden withdrawal, private banks secretly formed a cartel. One such example is the Federal Reserve System in the United States that was created in 1913. Fascinating story about its birth was described in [37, 2006]. Though it is a privately owned bank, it pretends to be the public central bank.

Once central banks are established in many capitalist economies, they begin to request a portion of deposits from commercial banks to protect liquidity shortage among banks. Specifically, commercial banks are required by law to open an account with the central bank and keep some portion of their deposits in it in order to meet unpredictable withdrawal by depositors. These deposits of commercial banks at the central bank are called required reserves. Now commercial banks can freely make loans out of their deposits (less required reserves) without any risk. This modern banking system is called a *fractional reserve* banking system.

Let us explain this banking practice as intermediaries by illustrating conceptual Figure 5.9. The itemized numbers below are the same as those in the Figure.

(1) First, banks collect deposits from the non-banking public sector consisting of households, producers and non-banking financial institutions in our model.

monetary data due to the small amount of their values.

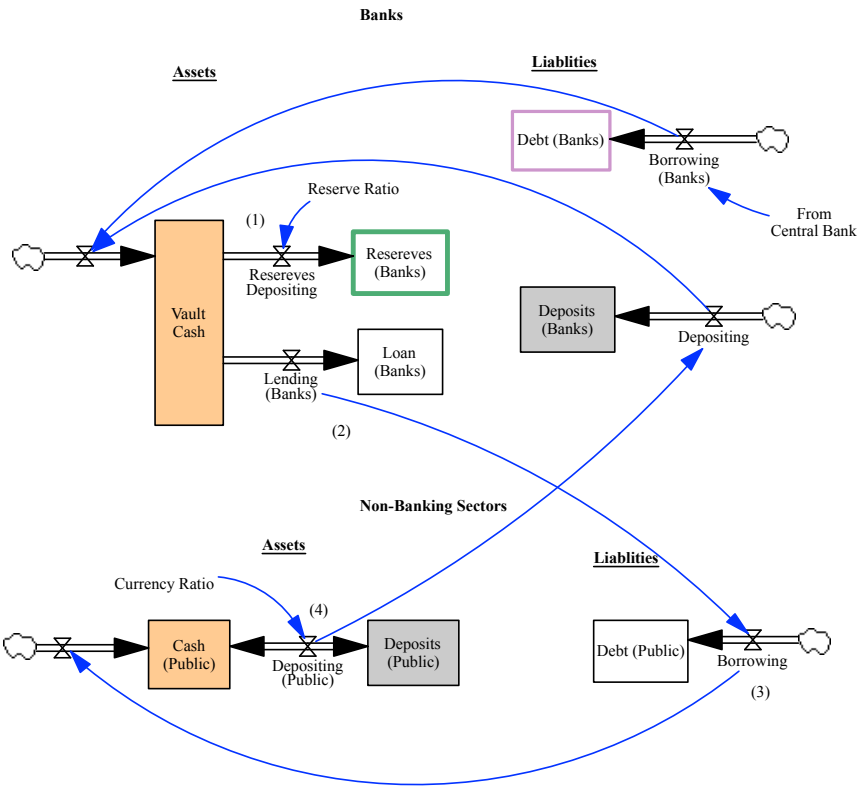

Figure 5.9: Flow Approach of Money Creation

Under the current fractional reserve banking system, a portion of deposits thus collected is required to be reserved with the central bank to avoid risks of cash deficiencies, according to a required reserve ratio[11] such that

$$\text{Required Reserve Ratio } (\beta) = \frac{\text{Required Reserves}}{\text{Deposits}} \tag{5.10}$$

(2) Then, the remaining amount of deposits are loaned out to borrowers.

(3) Now borrowers receive cash as assets.

[11] Whenever appropriate, a reserve ratio is further broken down as follows:

$$\begin{aligned}\text{Reserve Ratio } (\beta) &= \frac{\text{Required Reserves}}{\text{Deposits}} + \frac{\text{Excess Reserves}}{\text{Deposits}} \\ &= \beta_r + \beta_e. \end{aligned} \tag{5.9}$$

(4) Since the public as a whole needs not to hold all the amount of cash at hand as liquidity[12], a portion of cash is deposited with banks according to a currency ratio(α) such that

$$\text{Currency Ratio } (\alpha) = \frac{\text{Currency in Circulation}}{\text{Deposits}} \tag{5.11}$$

In other words, one dollar put into circulation is further divided between currency in circulation and deposits according to the following proportion:

$$1 \Rightarrow \begin{cases} \frac{\alpha}{\alpha+1} & : \text{Currency in Circulation} \\ \frac{1}{\alpha+1} & : \text{Deposits with Banks} \end{cases} \tag{5.12}$$

Let us now consider how one dollar put into circulation keeps being used for transactions. From the equation (5.12), $1/(\alpha+1)$ dollars are first deposited, out of which commercial banks are allowed to make maximum loans of $(1-\beta)/(\alpha+1)$ dollars. This amount will be put into circulation again as a loan to the non-banking public sector. In a capitalist market economy, producers in the non-banking public sector is always in a state of liquidity deficiency. In this way, one dollar put into circulation keeps being loaned out repeatedly for transactions. The accumulated total sum of money stock put into circulation through bank loans is calculated as follows;

$$\begin{aligned} &\text{Accumulated money stock put into circulation through bank loans} \\ &= 1 + \frac{1-\beta}{\alpha+1} + \left(\frac{1-\beta}{\alpha+1}\right)^2 + \left(\frac{1-\beta}{\alpha+1}\right)^3 + \cdots \\ &= \frac{1}{1-\frac{1-\beta}{\alpha+1}} \\ &= \frac{\alpha+1}{\alpha+\beta} \end{aligned} \tag{5.13}$$

This is a process of creating money in circulation *out of nothing* by commercial banks, in which one dollar put into circulation is increased by its multiple amount. It is called money multiplier (m); that is,

$$\text{Money Multiplier } (m) = \frac{\alpha+1}{\alpha+\beta} (= \frac{\alpha+1}{\alpha+\beta_r+\beta_e}) \tag{5.14}$$

Since $1 \geq \beta \geq 0$, we have

$$1 + \frac{1}{\alpha} \geq m \geq 1 \tag{5.15}$$

Hence, money multiplier can be easily calculated if currency ratio and required reserve ratio as well as excess reserve ratio are given in a macroeconomy. Three sectors in Figure 5.8 play a role of determining these ratios. Depositors in

[12] Among the non-banking public sector, producers and financial institutions tend to borrow for real and financial investment, while households tend to save out of their income revenues.

the non-financial sector (consumers & producers) determine the currency ratio: how much money to keep at hand as cash and how much to deposit. Central bank sets a level of required reserve ratio as a part of its monetary policies, while commercial banks decide excess reserve ratio: how much extra reserves to hold against the need for deposit withdrawals.

In this way, an additional dollar put into circulation will eventually create its multiple amount of money stock, which is being used as currency in circulation and deposits with banks as follows:

$$1 \Rightarrow \begin{cases} \frac{\alpha}{\alpha+1}\frac{\alpha+1}{\alpha+\beta} = \frac{\alpha}{\alpha+\beta} & : \text{Currency in Circulation} \\ \frac{1}{\alpha+1}\frac{\alpha+1}{\alpha+\beta} = \frac{1}{\alpha+\beta} & : \text{Deposits with Banks} \end{cases} \tag{5.16}$$

In a real economy, then, how much real currency or cash is actually being put into circulation? It is the sum of currency in current circulation and reserves that commercial banks withhold at the central bank. This sum indeed constitutes a real part of money stock issued by the central bank through which creation of deposits and money stock are made as shown above. In this sense, the sum is occasionally called high-powered money; that is,

$$\text{High-Powered Money} = \text{Currency in Circulation} + \text{Reserves} \tag{5.17}$$

To interpret the amount of money stock created by high-powered money, let us calculate a ratio between money stock and high-powered money as follows:

$$\begin{aligned} &\frac{\text{Money Stock}}{\text{High-Powered Money}} \\ &= \frac{\text{Currency in Circulation} + \text{Deposits}}{\text{Currency in Circulation} + \text{Reserves}} \\ &= \frac{\text{Currency in Circulation/Deposits} + 1}{\text{Currency in Circulation/Deposits} + \text{Reserves/Deposits}} \\ &= \frac{\alpha+1}{\alpha+\beta} \end{aligned} \tag{5.18}$$

This ratio becomes exactly the same as money multiplier obtained in equation (5.14). Thus, money stock can be uniformly expressed as[13]

$$\text{Money Stock} = m * \text{High-Powered Money} \tag{5.19}$$

In the above definitions, currency in circulation appears both in money stock and high-powered money. However, it is hard to calculate it in a real economy

[13] When money multiplier is calculated as the equation (5.14) and applied to the equation (5.19) to obtain money stock, it turns out that money suddenly jumps from the money stock defined in (5.2) as the currency ratio and reserve ratio are changed during a simulation. To avoid this problem, currency and reserve ratios need be constantly recalculated during the simulation. In the money creation model below, they are obtained as "actual currency and reserve ratios".

and in practice it is approximated by the amount of currency outstanding which is recorded in the balance sheet of the central bank. Accordingly, high-powered money is also approximated by the sum of currency outstanding and reserves, which is defined as base money in equation (5.1).

Base money is the amount of currency that the central bank can control. And most macroeconomic textbooks treat high-powered money equivalently as monetary base (base money). For instance, a well-established textbook says: "This is why the monetary base is also called high-powered money" [58, p. 394, 2006]. However, our SD modeling below strictly requires them to be treated differently.

If high-powered money is approximated by the base money, money stock could also be estimated similar to the equation (5.19) and it is called here money stock (base).

$$\text{Money Stock (Base)} = m * \text{Base Money} \tag{5.20}$$

It could be used as a reference amount of money stock with which true money stock is compared (or to which true money stock converges, as it turns out below).

In a real economy, however, money stock is calculated from the existing data as follows:

$$\text{Money Stock (Data)} = \text{Currency Outstanding} + \text{Deposits} \tag{5.21}$$

It is called money stock (data) here to distinguish it from the money stocks previously defined in equations (5.2) (or 5.19) and (5.20).

In this way, we have now obtained three different expressions of money stock such as the equations (5.19), (5.20), and (5.21). It is one of the purposes of this chapter to investigate how these three expressions of money stock behave one another under flow and stock approaches. By calculating actual currency ratio and reserve ratio at each time step in our model money stock can be dynamically obtained, as illustrated in Figure 5.10. This is the definition diagram of money stocks used from now on in our money creation models of both flow and stock approaches.

5.3.3 Money Convertibility Coefficient

Money stock thus calculated includes deposits as functional-money. To calculate a portion of legal tender out of money stock in circulation, equation (5.19) can be rewritten as

$$\text{High-Powered Money (as legal tender)} = mc * \text{Money Stock} \tag{5.22}$$

in which mc is defined as *money convertibility* coefficient. The coefficient thus defined is obviously a reciprocal of money multiplier m.

Under the default assumption of coefficient values in our model below; that is, $\alpha = 0.2$ and $\beta = 0.1$, money multiplier becomes $m = \frac{0.2+1}{0.2+0.1} = 4$, and

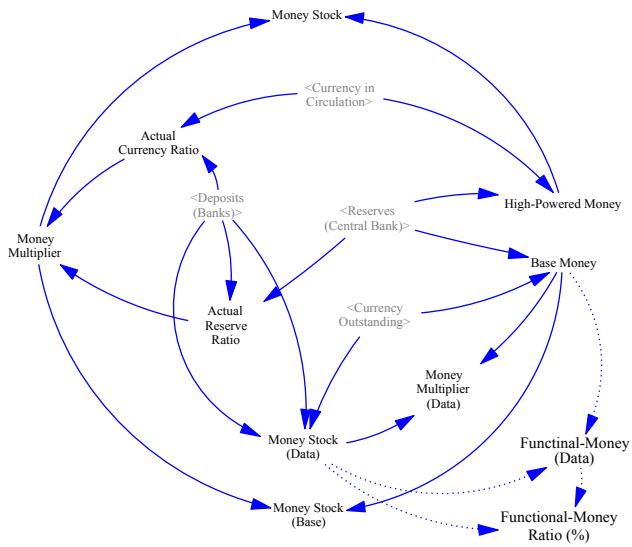

Figure 5.10: Money Stock Definitions for Flow and Stock Approaches

money convertibility coefficient becomes $mc = 0.25$[14]. That is to say, only 25% of money stock (as *functional-money*) could be convertible to *genuine money* as legal tender. This implies that under the fractional reserve banking in our model, for instance, only 25% of money stock in circulation for transactions could be convertible to legal tender, and the remaining 75% of money stock are functional-money (deposits) created by banks out of nothing. This amount is defined as Functional-Money Ratio (%) in Figure 5.10.

Money Multiplier and Convertibility Coefficient: Cases in Japan

With the introduction of money multiplier and money convertibility, it is worthwhile to examine how these values actually have taken place in Japan. As the left-hand diagram of Figure 5.11 indicates, money multiplier in Japan, which is obtained by m $= M_1/M_0$, has been stable between 3 and 4 from 1980 through 1999, and begun to increase to 5.6 in 2006 due to the introduction of QE policy between 2001 and 2006. Then, it has begun to decline to 1.6 in 2018 due to the failure of the second QE policies introduced in 2013. On the other hand, money convertibility coefficient in Japan, which is obtained by mc $= M_0/M_1$, has been less than 3% from 1980 till 2012, then, begun to increase due the QE policies as

[14]When $\beta = 1$ (100% reserve) under the public money system to be discussed in Part IV, we have $m = mc = 1$ so that the entire amount of money stock in circulation becomes legal tender.

shown in the right-hand diagram. In 2018 it became 60%. This implies Japanese depositors can convert 60% of their deposits to genuine money as legal tender in case of bank-runs. Yet, 40% of their deposits must be abandoned in case of bankruptcies of banks. Indeed we are forced to live in a fragile economic edifice constructed on shaky deserts.

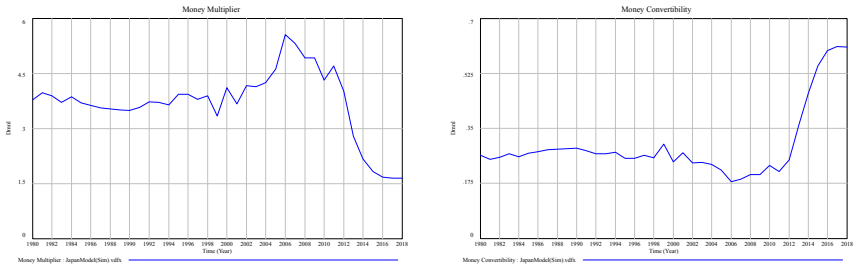

Figure 5.11: Money Multiplier and Convertibility Coefficient in Japan

5.3.4 Accounting Presentation of Flow Approach

Banks playing in practice as intermediaries are now described according to the double-entry bookkeeping rule. In the flow approach, bank loans do not seem to create deposits, simply because they are assumed to make loans out of cash assets in the model as shown in top left balance sheet of Banks in Table 5.6. In other words, banks increase their loan assets to gain interest revenues by

Banks		Non-Banking Public Sector	
Debit (Assets)	Credit (Assets)	Debit (Assets)	Credit (Liabilities)
Loan (+)	Cash (-)	Cash (+)	Debt (+)
Debit (Assets)	Credit (Liabilities)	Debit (Assets)	Credit (Assets)
Cash (+)	Deposits (+)	Commodity (+)	Cash (-)

Table 5.6: Journal Entries of Flow Approach in (2) and (3)

giving up their own cash assets. This transaction seems fair and reasonable as a profit-seeking management out of their cash assets.

Where does that cash come from, then? Surely it is tied with deposits as shown in the bottom left balance sheet of Banks. When cash accounts are cancelled out in this balance sheet, bank loan (debit of assets) can be said to be balanced by deposits (credit of liabilities)[15]. Under the situation, can the

[15] Whenever transactions are traced back in this way, balance sheet of flow approach becomes

banks, then, make loans out of these deposits at their disposal? If deposits are time deposits entrusted with banks by savers for better financial management, then the answer is surely "Yes, they can". But if deposits are demand deposits for transactional purposes, then the answer should be "No, they cannot", because banks are obliged to hold them anytime to meet withdrawal requests from depositors.

Accordingly, it becomes fraudulent to make loans out of demand deposits. Yet, Irving Fisher once pointed out:

> When money is deposited in a checking account (i.e. demand deposits), the depositor still thinks of the money as his, though *legally it is the bank's* (italicized by the author). [12, p.12, 1935].

Hence, deposits are legally owned by banks and they can make loans out of depositors' money[16]. In this way, fraudulent-looking loans out of depositors' money have been made legitimate under the fractional reserve banking system.

Hence, in the flow approach deposits (credit) creation process out of nothing is masqueraded behind the double-entry bookkeeping practice of making loans out of cash. That is why this flow approach of banking practice has been deliberately supported so that many economists as well as ordinary people have been enticed to believe that banks are not creating money out of nothing, but merely intermediating money between lenders and borrowers (this point will be discussed more in detail below).

When cash keeps being loaned out in circulation as explained above, deposits simultaneously gets accumulated as well. These accumulated deposits are used for transactions in the non-banking public sector, though they are not legal tender, as if they are functional-money (or convertible to money) as illustrated in Figure 5.4. In other words, cash and deposits gets interchangeably used for transactions; that is, buyers and sellers keep their transactions as recorded in Table 5.7. In reality, transactions through deposits occupy a large portion of economic activities.

Buyers		Sellers	
Debit (A)	Credit (A)	Debit (A)	Credit (A)
Commodity (+)	Cash (-)	Cash (+)	Commodity (-)
Commodity (+)	Deposits (-)	Deposits (+)	Commodity (-)

Table 5.7: Transactions of Non-Banking Sectors: Flow Approach

Surely these deposits are created out of nothing through fraudulent practice of loans out of depositors' money under the fractional reserve banking system.

structurally the same as that of stock approach as shown in Table 5.8 below. In the flow approach, loans are made out of deposits (Deposits→Loan), while in the stock approach, deposits are made out of loans (Loan→Deposits).

[16]In Japan this practice is guaranteed by Article 590, Civil Code.

5.4 Stock Approach of Functional-Money Creation

5.4.1 A *Fractional Reserve* Banking: Stock Approach

Flow approach to the fractional reserve banking system is based on the flow analysis in the sense that inflows of deposits with banks are made out of currency in circulation, out of which banks make loans after reserving a required amount with the central bank. This has been standard explanation adopted by almost all textbooks on macroeconomics and many economists, including Nobel laureates in economics.

However, this approach blurs the role of banks as deposit (credit) creators out of nothing, because the flow analysis gives us an impression that banks are nothing but mere intermediaries of money, and can only make loans out of the deposits they receive. This has caused confusions among students in economics as well as experts.

Irving Fisher once explained the essence of the current fractional reserve system of deposit (credit) creation in a very succinct way as follows:

> Under our present system, the banks create and destroy check-book money by granting, or calling, loans. When a bank grants me a $1,000 loan, and so adds $1,000 to my checking deposit, that $1,000 of "money I have in the bank" is new. It was freshly manufactured by the bank out of my loan and written by pen and ink on the stub of my check book and on the books of the bank.
>
> As already noted, except for these pen and ink records, this "money" has no real physical existence. When later I repay the bank that $1,000, I take it out of my checking deposit, and that much circulating medium is destroyed on the stub of my check book and on the books of the bank. That is, it disappears altogether. [12, p.7, 1935, 2011]

In this way, banks can easily create "functional-money" or deposits in our deposit account by hitting keyboard. This banking practice looks very different from that of the flow approach. Hence, it is called stock approach to the fractional reserve banking in this chapter.

Let us now explore the stock approach of lending practice of banks as illustrated in conceptual Figure 5.12. The itemized numbers below are the same as those indicated in the Figure.

(1) Whenever banks collect deposits, they reserve the entire amount of deposits with the central bank[17].

[17] In the stock approach model, deposits are assumed to go directly into "Reserves (Banks)". In practice, when customers put deposits at the bank, they are first debited as "Cash (Banks)" instead of "Reserves (Banks)" as in the flow approach. Deposits of cash in the stock approach are assumed to be directly debited as Reserves, and the amount of Vault Cash is later adjusted according to liquidity demand by non-banking sector.

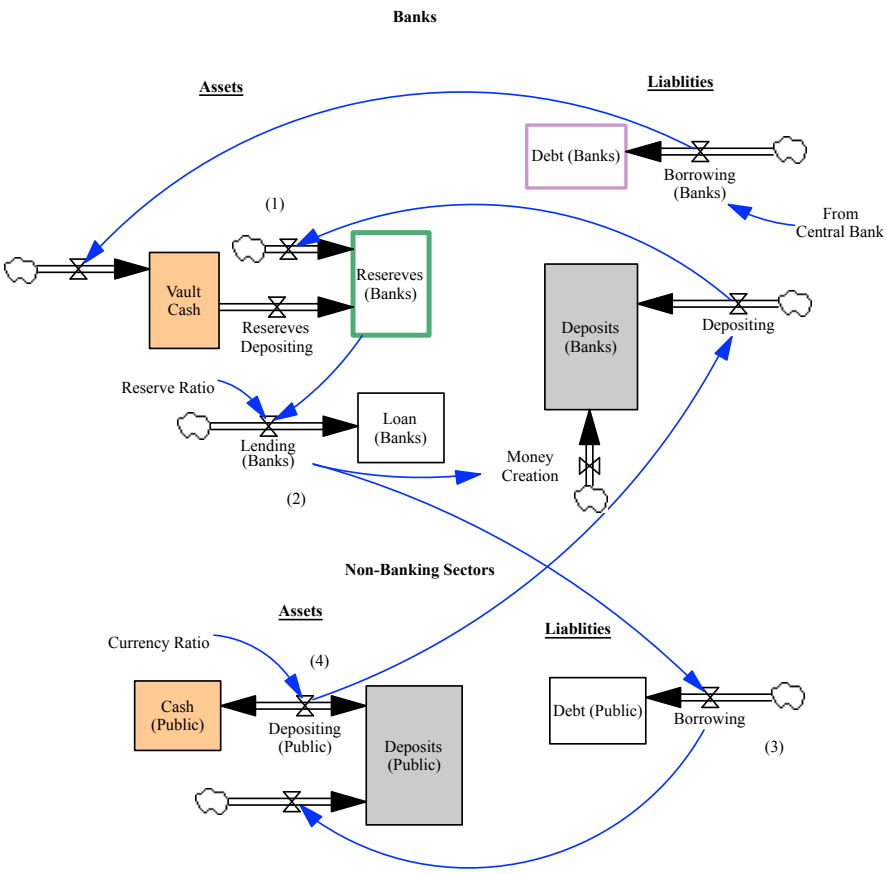

Figure 5.12: Stock Approach of Money Creation

(2) Under the fractional reserve banking system, banks try to lend maximum loanable funds according to the following formula[18]:

$$\begin{aligned}
&\text{Maximum Loanable Funds (Banks)} \\
&= \frac{\text{Reserves (Banks)}}{\text{Required Reserve Ratio}} - \text{Deposits (Banks)} \\
&= \frac{1-\beta}{\beta}\ \text{Reserves (Banks)} \qquad (5.23)
\end{aligned}$$

[18]The last equation holds only when bank's deposits are fully reserved with the central bank; that is, Deposits(Banks) = Reserves(Banks).

(3) Banks enter this amount of loans as deposits with borrower's deposits account. This lending practice of loans differs from the flow approach in which borrows receive real cash instead of deposits as digital number in their account. In this way, banks can create $\frac{1-\beta}{\beta}$ factors of functional-money out of nothing for a unit increase in deposits, or, vice versa, they can destroy $\frac{1-\beta}{\beta}$ factors of functional-money for a unit decrease in deposits. For example, a consumer's withdrawal of \$1 destroys \$9 of functional-money when $\beta = 0.1$, and vice versa. Irving Fisher called this magnified behavior of money stock "the chief cause of both booms and depressions, namely, the instability of demand deposits, tied as they are now, to bank loans" [12, p.xviii, 1935][19].

(4) Borrowers withdraw cash out of their deposits account according to the currency ratio(α), then the remaining amount is deposited again.

5.4.2 Accounting Presentation of Stock Approach

Banking practice of this stock approach is now described according to the double-entry bookkeeping rule in Table 5.8.

Banks	
Debit (Assets)	Credit (Liabilities)
Loan (+)	Deposits (+)

Non-Banking Public Sector	
Debit (Assets)	Credit (Liabilities)
Deposits (+)	Debt (+)

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

Table 5.8: Journal Entries of Stock Approach in (2) and (3)

It may be worthwhile at this stage to explain the difference between flow and stock approaches in terms to accounting principle. In the flow approach, banks' loan (+) (debit assets) is increased at the cost of cash (-) (credit assets), while in the stock approach, banks' loan (+) (debit assets) is increased simultaneously with the deposits (+) (credit liabilities). In other words, in the flow approach assets of banks are cancelled out, while in the stock approach without sacrificing the cash assets banks can increase loan assets by increasing deposits as liabilities out of nothing, and increase their interest revenues in an unearned fashion.

Is this *free-lunch* practice of bookkeeping acceptable? In the open letter to FASB, IASB, and IFAC[20], Michael Schemmann, publisher of the reprint of Irving Fisher's "100% Money [12, 2011]" pointed out:

> The creation of units of account by MFIs (monetary financial institutions) that are masquerading as demand deposits defined by the

[19] This issue will be discussed in Chapter 14.

[20] FASB = Financial Accounting Standards Board, IASB = International Accounting Standards Board, IFAC = International Federation of Accountants

> FASB's ASC 305-10-20 as "cash in bank" do not comply with GAAP (Generally Accepted Accounting Principles) or IFRS (International Financial Reporting Standards). [67, p.2, 1st May 2013].

In other words, "demand deposits are created *bank-internally* and therefore in violation of **self-dealing** (p.2)"; that is to say, free-lunch is fraudulent and against economic principle of transactions! Accordingly, he continues, "Such internally created units of account are not transferable among banks because they are unique to the MFI that created the units of account in their books of account, and can only be offset in what MFIs call their payment clearing" (p.3)". This implies that deposits are not "legal tender", supporting the quoted statement in Section 5.1.5 by the former governor of the Bank of Japan that "deposits are functioning as money".

Moreover, deposits thus created are not literally liabilities to the banks. As Irving Fisher pointed out in the previous section, "*legally it is the bank's*". Therefore, deposits are legally not liabilities or obligations to the banks. Stock approach unquestionably reveals the free-lunch nature of Loan→Deposits out of nothing, tied with the increase in unearned interest revenues. To hide away this inconvenient fact, flow approach has been favorably used in the textbooks, instead of stock approach, so that banks can pretend to be intermediaries.

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

Table 5.9: Transactions of Non-Banking Sector: Stock Approach

As long as deposits function as money, deposits and cash are convertibly used in actual transactions as exhibited in Table 5.9. For buyers and sellers in the non-banking public sector, flow and stock approaches turn out to be indistinguishable in their balance sheets in the sense that cash and deposits are practically booked under the same Cash/Deposits account of assets[21].

5.4.3 Masqueraded Economists for Flow Approach

Facing repeated financial crises after the so-called second Great Depression triggered by the bankruptcy of Lehman Brothers in 2008, some monetary economists began to throw serious suspicion against the standard textbook view on the role of banks as intermediaries (flow approach), and tend to argue that the view of banks as credit creators out of nothing (stock approach) is more accurate in

[21] In fact, cash and deposits items in many balance sheets are integrated as an inseparable Cash/Deposits asset.

consideration of banking practices in real economy. In short, according to their arguments, flow approach is incorrect, and stock approach is correct.

For instance, Richard Werner [84, 2015] classifies the flow approach further into two theories; *the financial intermediation theory of banking* and t*he fractional reserve theory of banking*, while the stock approach as *the credit creation theory of banking*. In the working paper of the Bank of England, Jakab and Kumphof [43, 2015] classifies the flow approach as *the intermediation of loanable funds* (ILF), while the stock approach as *financing through money creation* (FMC). Another well-cited "Bank of England" paper [57, 2015] criticizes the flow approach by arguing that "one common misconception is that banks act simply as intermediaries, lending out the deposits that savers place with them."

Having classified the process of money creation in these ways, these authors, then, put themselves all in a supporting position of the stock approach by criticizing the view of banks as intermediaries. Accordingly it may be worth while, following Richard Werner, to show how economists have been confused for more than a century among these two or three theories when modeling the magical process of credit creation.

Flow Approach. This approach is further broken down into two theories. Examples of *the financial intermediation theory* of banking include some well-kmown economists. They are[22] : Keynes(1936); Gurley and Show (1955); Tobin (1963, 1969); Sealey and Lindley (1977); Balernsperger (1980); Mises(1980); Diamond and Dybvin (1983); Diamond (1984, 1991, 1997); Bernanke and Blinder(1988); Eatwell, Milgate and Newman (1989); Gorton and Pennacchi (1990); Bencivenga and Smith (1991); Bernanke and Gertler (1995); Rajan (1998); Myers and Rajan (1998); Allen and Gale (2004); Allen an Santomero (2001); Diamond and Rajan (2001); Kashyap, Rajan and Stein (2002); Mattews and Thompson (2005); Casu and Girardone (2006); Dewatripont et a. (2010); Gertler and Kiyotaki (2011); Stein (2014); Carney(2014) and Krugman (2015).

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

Stock Approach: Examples of *the credit creation theory* are: Macleod(1856); Wicksell (1989); Withers(1909, 1916); Schumpeter (1912); Cassel (1918); Hahn (1920) Hawtrey (1919); Howe(1915); Gustav Cassel(1923); Macmillan Committee(1931); Fisher(1935); Rochon and Rossi(2003); Werner(2005); Bank of England [57, 2014]; Jakob and Kumhof [43, 2015].

It is interesting to observe from these lists of economists that Nobel laureate economists such as Samuelson, Tobin, Krugman and Stiglitz all belong to the flow approach group, while the stock approach group disappeared entirely since Irving Fisher [12, 1935] till quite recently as if it has been *a taboo subject* for economists (Adair Turner [80, p.31, 2013]).

[22]References of these economists quoted here under flow and stock approaches are not listed in the references of this book. Please refer to the original Werner paper [84, 2015] for detailed references.

Our system dynamics approach of modeling "money and its creation" has revealed here that either flow approach or stock approach of modeling money is equally feasible. Yet, in a long history of economic analysis, most economists have favored to describe banks as mere intermediaries of transactional money and concealed the fact that bank deposits (or credits) are indeed created out of nothing. That is to say, they have masqueraded, until recently, as supporters of the flow approach of money creation. This chapter unmasks them to the effect that banks create functional-money (credits) out of nothing even under the flow approach. In contrast, stock approach unquestionably reveals that banks are not intermediaries, but actually creating credits out of nothing.

Accordingly from now on let us show, with the SD models of flow and stock approaches, that both flow and stock approaches are indeed identical as if they are heads and tails of the same coin, bringing century-long masquerades of economists to an end.

5.5 Functional-Money Creation under Gold Standard

5.5.1 Flow Approach Simulations

To examine a dynamic process of money and functional-money creation, let us construct a simple money creation model of flow approach [Companion model: 1 Money(Gold).vpm]. Without losing generality it is assumed from now on that excess reserve ratio is zero, $\beta_e = 0$ so that reserve ratio β becomes equal to the required reserve ratio β_r. Vault cash of commercial banks in the model could be interpreted as excess reserves. The model is then built by assuming that the only currency available in our macroeconomic system is gold, or gold certificates (convertibles) issued by the central bank against the amount of gold. In short, it is constructed under gold standard. By doing so, we could avoid complicated transactions of discount loans by the central bank and government securities among three sectors, and focus on the essential feature of money stock per se. This assumption will be dropped later and discount loans and government securities will be introduced into the model.

Figures 5.13 illustrates our simple money creation model under gold standard. In the model, currency outstanding in the central bank and currency in circulation in non-financial sector are illustrated as two different stocks. Thus, they need not be identically equal as most macroeconomics textbooks treat so. This is one of the features that system dynamics modeling can precisely differentiate itself from traditional macroeconomic modeling. It is interesting to observe how these two differentiated stocks of currency and three expressions of money stock derived from them will behave in the economy.

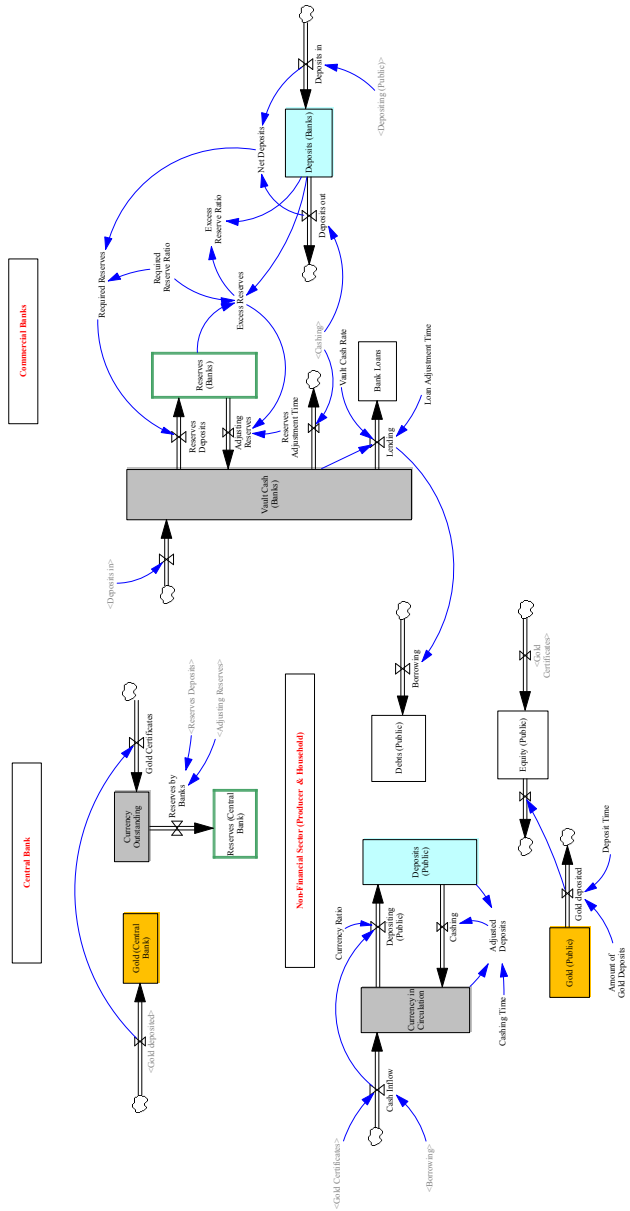

Figure 5.13: Money Creation Model under Gold Standard: Flow Approach

Base Money vs High-Powered Money

Let us run the model and see how it works. In the model, currency ratio and required reserve ratio are set to be $(\alpha, \beta) = (0.2,\ 0.1)$. Hence, money multiplier becomes $m = (0.2 + 1)/(0.2 + 0.1) = 4$. Meanwhile, from the balance sheet of the central bank base money under gold standard is always equal to the fixed amount of gold, the only assets held by the central bank, which is here set to be equal to 200 dollars. This amount of gold is also equal to the gold assets by the public. In other words, the central bank is assumed to be trusted to start its banking business with the gold owned by the public and issue gold certificates as banknotes against it.

From the equation (5.20), money stock (base) can be easily calculated as 800 (= 4 * 200) dollars without running the model. Meanwhile, true money stock based on high-powered money in equation (5.19) cannot be obtained without running a simulation.

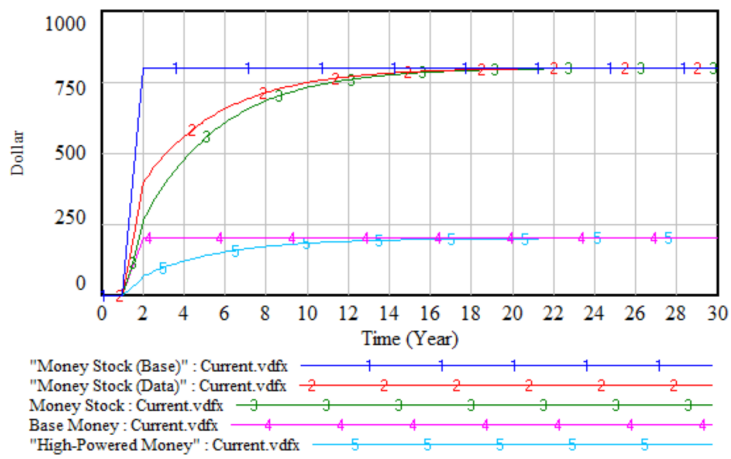

Figure 5.14: Money Stock under Gold Standard

Figure 5.14 illustrates our simulation result in which money stock (base), money stock (data), and money stock are represented by the lines numbered 1, 2 and 3, respectively. Base money and high-powered money are illustrated by the lines 4 and 5.

Two features are easily observed from the Figure. First, three expressions of money stock appear to have the following orderly relation.

$$\text{Money Stock (Base)} > \text{Money Stock (Data)} > \text{Money Stock} \tag{5.24}$$

Latter part of the inequality implies that actual money stock (data) overestimates true money stock. Since money stock (data) is the only figure actually obtained by using real data of the currency outstanding (liabilities of the central

bank) and deposits (liabilities of commercial banks), the overestimation of true money stock might mislead economic activities in the real economy.

Second, base money turns out to be greater than high-powered money.

$$\text{Base Money} > \text{High-Powered Money}, \tag{5.25}$$

which then leads to the following inequality from the definitions in equations (5.19) and (5.20):

$$\text{Money Stock (Base)} > \text{Money Stock}. \tag{5.26}$$

It also leads to

$$\text{Currency Outstanding} > \text{Currency in Circulation}, \tag{5.27}$$

which in turn implies

$$\text{Money Stock (Data)} > \text{Money Stock}. \tag{5.28}$$

In other words, actual money stock (data) (line 2) calculated by the central bank always overestimates true money stock (line 3) available in the economy, which, however, tends to approach to the money stock (data) eventually.

Furthermore, under the equation (5.25) it is easily proved that

$$\text{Money Stock (Base)} > \text{Money Stock (Data)}^{23}. \tag{5.29}$$

Hence, the orderly equation (5.24) is proven. All three expressions of money stock are shown to converge as long as vault cash tends to diminish, and overestimation of money stock will be eventually corrected. Furthermore, it is shown as well that the above orderly relation is reversed when the order in equation (5.25) is reversed. This reversed order can be observed in Figures 5.18 and 5.19 below.

To understand the above orderly features from the simulation, specifically the difference between currency outstanding and currency in circulation, let us consider the amount of currency that exists outside the central bank. From the money creation model, it is the sum of cash in circulation among the non-financial sectors such as producers and households and cash held in the vaults of all commercial banks. Hence, the following relation holds:

[23] Money multiplier m in equation (5.18) is rewritted as $m = \frac{C+D}{C+R}$. Then we have

$$\frac{dm}{dC} = \frac{R-D}{(C+R)^2} < 0.$$

Accordingly, under the condition: Currency Outstanding (O) > Currency in Circulation (C), it is easily shown that

$$\text{Money Stock (Base)} = \frac{C+D}{C+R} * (O+R) > O + D = \text{Money Stock (Data)}.$$

$$\text{Cash outside Central Bank} = \text{Currency in Circulation} + \text{Vault Cash(Banks)} \tag{5.30}$$

Furthermore, cash outside the central bank should be equal to cash outstanding in the balance sheet of the central bank; that is, the amount of cash that the central bank owes to its outside world (non-financial sector and commercial banks).

$$\text{Currency Outstanding} = \text{Cash outside Central Bank} \tag{5.31}$$

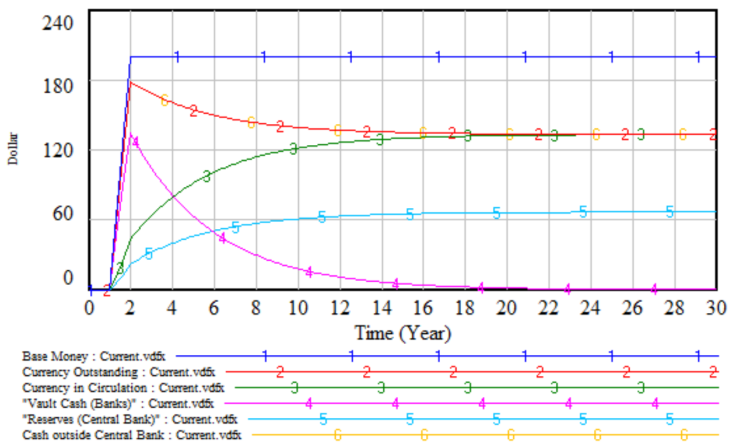

Figure 5.15: Currency Outstanding and Cash outside the Central Bank

Figure 5.15 confirms that currency outstanding (line 2) is equal to the cash outside the central bank (line 6). Hence, we have correctly arrived at the equation:

$$\begin{aligned}\text{Vault Cash(Banks)} \\ &= \text{Currency Outstanding} - \text{Currency in Circulation} \\ &= \text{Base Money} - \text{High-Powered Money} > 0 \end{aligned} \tag{5.32}$$

which in turn leads to the above inequality relations of equation (5.25) so long as vault cash is positive.

Ingredients of Functional-Money Creation

Since currency ratio of 0.2 cannot be controlled, money multiplier can take the range of $6 \geq m \geq 1$. When base money is \$200 in our example, this implies that money stock can take the range between \$1,200 and \$200. Accordingly, let us discuss how money stocks get affected between the range by several ingredients in the money creation processes.

Loan Adjustment Time

There is a case in which a convergence to the money stock (data) becomes very slow and overestimation of money stock remains. In Figure 5.16 loan adjustment

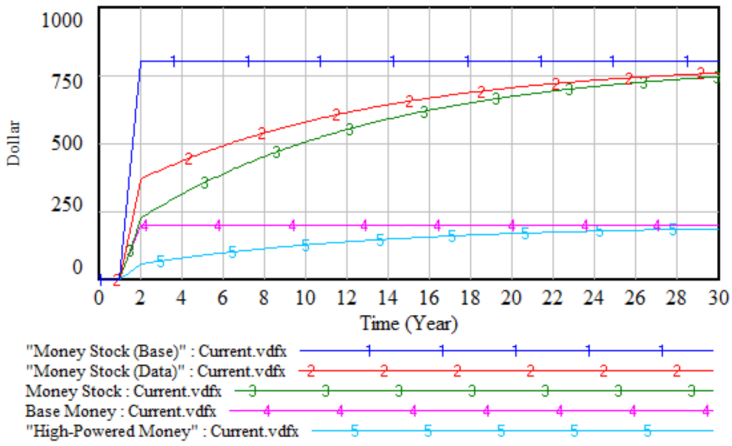

Figure 5.16: Money Stock when Loan Adjustment Time triples.

time is assumed to triple and become 3 periods. This is a situation in which a speed of bank loans becomes slower, or commercial banks become reluctant to make loans. Accordingly, money stock might converge to money stock (data), but extremely slow. In other words, money stock will not converge to the money stock (data) for a foreseeable future and overestimation of money stock remains. Specifically, money stock (data) (line 2) is always greater than money stock (line 3) during the simulation of 24 periods.

Excess Reserves / Vault Cash

How can the amount of money stock be changed or controlled by the central bank? Under the gold standard, base money is always fixed, and the central bank can only influence money stock by changing a required reserve ratio. Even so, money stock may not be under the control of the central bank in a real economy. It could be affected by the following two situations. First, commercial banks may be forced to hold excess reserves in addition to the required reserves due to a reduced opportunity of making loans. Second, depositors in the non-financial sector may prefer to hold cash or liquidity due to a reduced attractiveness of financial market caused by lower interest rates. Money stock will be reduced under these situations.

Let us consider the situation of excess reserves first. In our model excess reserves are stored as vault cash in the asset of commercial banks. Excess reserves are needed to an imminent demand for liquidity. Thus, commercial banks may additionally need to keep excess reserves as vault cash in their vaults.

To see how excess reserves affect money stock, let us increase a vault cash rate to 0.5 from zero, so that 50% of available vault cash is constantly reserved.

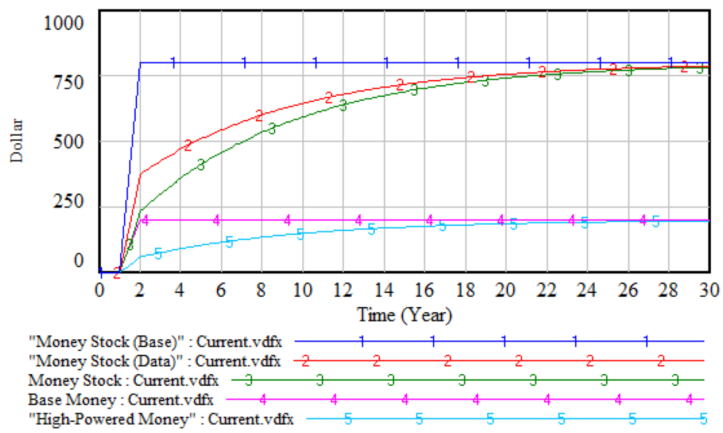

Figure 5.17: Money Stock when Vault Cash Rate is 0.5.

As Figure 5.17 illustrates, the effect of keeping a portion of vault cash is similar to the above case of loan adjustment time. That is, three expressions of money stock converges eventually as the amount of vault cash diminishes.

Currency Ratio

Let us now consider the second situation in which non-financial sector prefers to hold more liquidity. To analyze its effect on money stock, let us assume that at t = 8 consumers suddenly wish to withhold cash by doubling currency rate from 0.2 to 0.4. Money multiplier is now calculated as $m = (0.4+1)/(0.4+0.1) = 2.8$ and money stock (base) becomes 560 dollars (= 2.8 * 200).

Figure 5.18 illustrates how money stock is reduced due to a sudden increase in liquidity preference in the non-financial sector. Three expressions of money stock tend to converge again.

Let us emphasize at this early stage of analysis that money stock can be in this way easily crunched under the fractional reserve banking system. This becomes the main cause of monetary and financial instability as pointed out by Irving Fisher [12, 1935]. We'll discuss monetary stability issues in Chapter 14.

Assets, Equity and Money as Debts

When functional-money is created *out of nothing*, non-financial sector's assets also increase from the original equity (or gold assets) of $200 to $800; that is, assets is increased by $600. Does this mean that non-financial sector becomes wealthy out of the process of money creation under the *fractional reserve* banking system? Apparently, if 100% fractional reserve is required at t=8; that is,

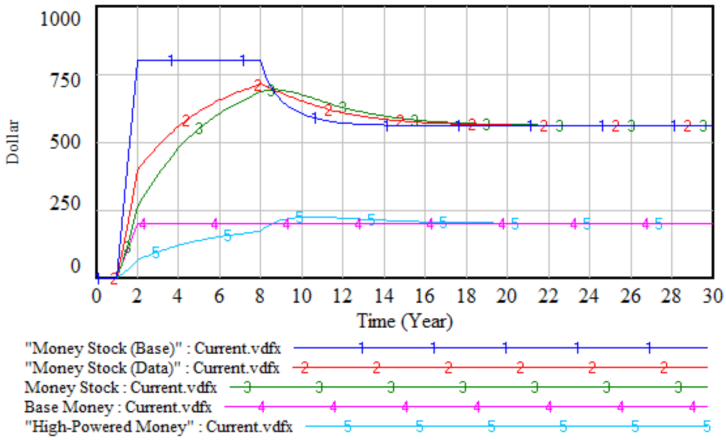

Figure 5.18: Money Stock when Currency Ratio doubles at t = 8

$\beta = 1$, commercial banks have to keep the same amount of deposits as deposited by the non-financial sector. Accordingly, money stock remains the same as the original gold certificates of \$200. Thus, equity, assets and money stock remain the same amount as Figure 5.19 illustrates.

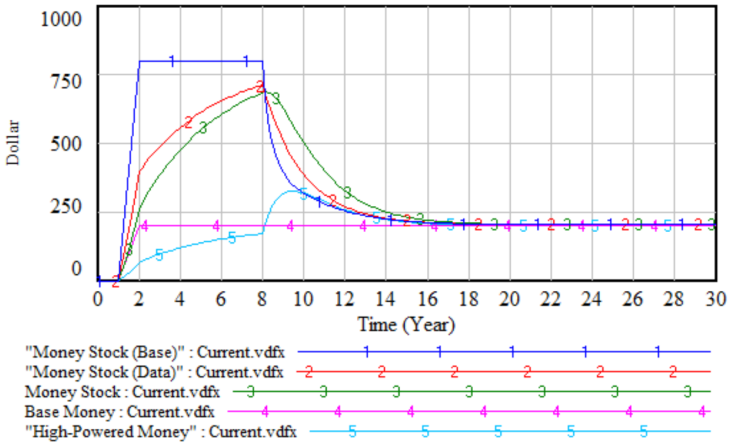

Figure 5.19: 100% Fractional Reserve at t=8

Where does the money of \$600 come from when a required reserve ratio is $\beta = 0.1$, then? There is no magic. Nothing cannot be created *out of nothing!* It comes from the non-financial public sector's debt, Debt (Public) of \$600, as line 3 of Figure 5.20 indicates, which also becomes equal to Functonal-Money (line 4).

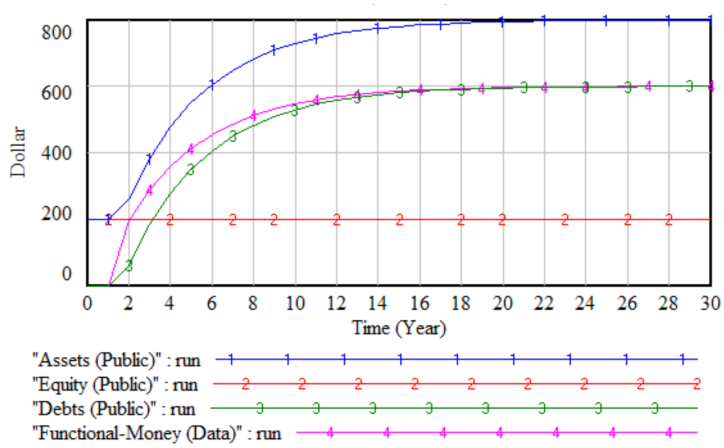

Figure 5.20: Money Stock, Assets, Equity and Debt

In other words, source of functional-money becomes debts, without which no functional-money creation takes place. Non-financial sector's *wealth* remains the same as its equity of gold assets of $200. It has never been increased through this process of functional-money creation under the fractional reserve banking system.

5.5.2 Stock Approach Simulations

Let us now construct stock approach model of Gold Standard according to the conceptual Figure 5.12. According to the stock approach banking practice, banks first calculate the maximum amount of demand deposits they can create from the amount of reserves, then create "functional-money or deposits" by hitting keyboard and writing digital numbers, as a flow amount of Deposits Creation, into the borrower's Deposits account. This stock approach of money creation [Companion model: 1a Money(Gold-S)] is illustrated in Figure 5.21.

How are money stocks created under stock approach, then? Compared with diversified behaviors of money stocks in Figure 5.14, money stock (base), money stock (data), and money stock now coincide as indicated by lines 1, 2 and 3 in Figure 5.22, because banks are assumed not to hold vault cash under the stock approach here[24]. Accordingly, base money and high-powered money become the same (lines 4 and 5). In other words, orderly relations disclosed in equations (5.24) and (5.25) no longer emerge. The behaviors of money stock become simplified. Yet similar behaviors of various money stocks as in the flow approach will be obtained under the stock approach model if vault cash is held by banks.

[24]By increasing the value of Vault Cash Ratio, the reader can confirm that lines 1,2 and 3 begin to diverge as in the flow approach. Under stock approach, this ratio becomes a banking policy variable of commercial banks.

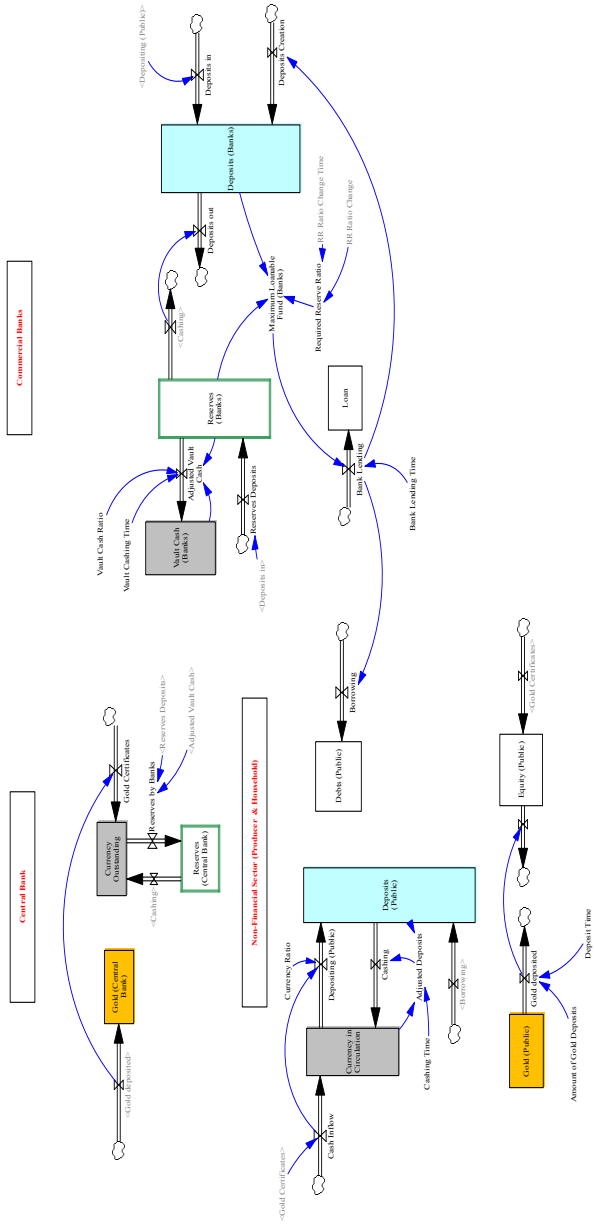

Figure 5.21: Money Creation Model under Gold Standard: Stock Approach

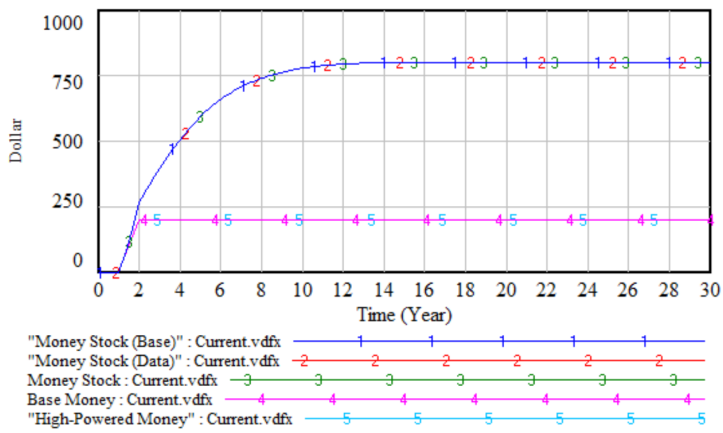

Figure 5.22: Money Stock under Gold Standard: Stock Approach

Functional-Money = Debts (by Non-Financial Sector)

This stock approach reveals a true nature of functional-money creation under the fractional reserve banking system more vividly as illustrated in Figure 5.23. It is extended to the 60th year. In the year 1, currency outstanding of $200 is put into circulation as base money (bold line 1), part of which is held by non-financial public sector as currency in circulation (line 2) according to a currency ratio (=0.2) and the remaining will be deposited (line 3) directly as reserves of the banks with the central bank (line 3). Money Stock (Data) is presented by bold line 4; that is, $800 at t=30.

Functional-money (bold line 5) is obtained as the amount of money stock that is not backed up by base money as legal tender; that is, the difference between money stock and base money (= $800 - $200 = $600 at t=30). Total debts by the public, Debts (Public), shown by line 6 becomes exactly equal to functional-money (bold line 5). As pointed out in the above flow approach subsection, debts become the source of functional money under the stock approach as well. Hence, the functional-money constitutes a newly created amount of money stock which has "no real physical existence" as pointed out above by Fisher [12, p.7, 1935]. The nature of functional-money created out of nothing as public debts is in this way clearly revealed by the stock approach.

According to the flow-approach textbook definition of money stock, equation (5.21), money stock in a real economy (here $800) is calculated as a sum of currency outstanding (here $133.33) and deposits (here $666.67). Consequently the fact that most deposits are newly created out of nothing (that is, $600) is entirely hidden in the flow approach of a fractional reserve banking analyses. Our new introduction of functional money M_f as debts by non-financial sector (producers and households) has revealed this fact. This could be the main reason why almost all macroeconomics textbooks have adopted the flow approach

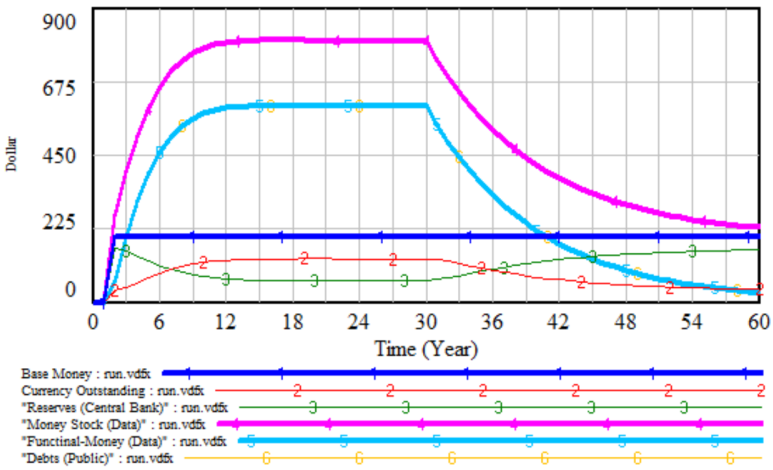

Figure 5.23: Base Money, Deposits and Money Stock: 100% Reserve at t=30

without introducing M_f, and many economists, including Nobel laureates, have flocked to the flow approach and disguised as if banks are mere intermediaries for the benefits of banking industry.

When a required reserve ratio is increased to 100% at the year 30, functional-money, as well as public debts, begins to shrink to zero as illustrated by lines 5 and 6 in Figure 5.23, and money stock tends to become the original amount of base money ($200). In other words, money stock tends to approach to base money; that is, 100% money. Fluctuations of a currency ratio, say, caused by the withdrawal of deposits due to recessions, only affect functional-money and loans, but do not affect the base money as the reader can easily confirm by running the companion model. This is the main reason why Irving Fisher advocated that 100% money attains monetary and financial stability in [12, 1935]. This issue will be further investigated in Chapter 14.

5.5.3 Limit to the Gold Standard System

If base money backed by gold is fixed under gold standard, how can we increase money stock to meet the need for increasing transactions as our economy continues to grow? Let us ask differently. What's the maximum amount of money stock the gold standard system can provide?

From the equation (5.20), under the fixed amount of base money, only money multiplier can change the money stock (base), and money stock accordingly. Since currency ratio is not under the direct control of the central bank, the only discretionary policy the central bank can exercise is a change in the required reserve ratio, as already shown above. Hence, money multiplier could be maximized if the required reserve ratio is set to be zero (!), and commercial banks are

allowed to fully make loans out of all deposits. In this case, money multiplier becomes $m = (0.2 + 1)/0.2 = 6$ and the maximum money stock (base) increases from 800 to 1,200.

Historically, base money backed by gold had been increased in two different ways: (i) gold mining and (ii) devaluation of gold.

(i) Gold mining. Well-known story is the California Gold Rush (1848 - 1855). On January 24, 1848 gold was found by James W. Marshall at Sutter's Mill in Coloma, California, which brought approximately 300,000 people to California the rest of the US and abroad. Private banking business flourished in California and the West where commercial banks began to issue their own coins and banknotes backed by newly mined gold, like Miners Bank of San Francisco in1849, and Bank of D. O. Mills, Sacramento, California, in 1853.

(ii) Gold devaluation. A de facto gold standard was adopted by England in 1717 when the Master of the Mint, Sir Isaac Newton (a founder of differential equations), produced a report "On the State of the Gold and Silver Coin" and fixed the value of the guinea (approximately one-quarter ounce of gold) at twenty-one shillings. A century later in 1819 the gold standard was formally adopted. In 1834 the United States, formally under a bimetallic (gold and silver) standard, switched to gold de facto, and fixed the price of gold at $20.67 per ounce.

This rate was maintained for a century long until 1933 when, after the Great Depressions in 1929, the newly-elected President Franklin D. Roosevelt closed the banks to stop bank runs on the gold reserves at the Federal Reserves Bank of New York. That is, FDR increased the price of gold from $20.67 to $35 per ounce according to the Gold Reserve Act (established on January 30, 1934) that authorized him to devalue the gold dollar by 40%, As a result, the government's gold reserves increased in value from $4,033 billion to $7,348 billion; 82% increase in gold reserves. In our simulation models above, this is the same as to appreciate the value of gold certificates from $200 to $364, increasing money stock from $800 to $1,456.

To maintain the gold standard, the Bretton Woods agreement was created in 1944 by all of the Allied nations during the World War II in Bretton Woods, New Hampshire. In those days, the United States held the majority of the world's gold and it was set by the dollar exchange; that is, $35 per ounce. Under this agreement, its member countries are obliged to convert their currencies into gold only through dollars indirectly at their pegged currency values to dollar. In this sense, this is not a genuine gold standard but a gold-dollar standard. Yet, the pressure of gold devaluation continued due to the growing demand for gold, because U.S. balance-of-payments deficits steadily reduced U.S. gold reserves, and confidence of redeeming gold by the US was declining. On August 15, 1971, President Richard M. Nixon announced that the United States would no longer redeem currency for gold. In those days, the United States didn't have political and economic power to devalue gold once again as FDR did in 1934, say from $35 to $70 per ounce, against the growing demand for gold as a means of payments. The final step in abandoning the gold standard historically took place in 1971.

How can central banks, then, increase money stocks under a fractional reserve banking by abandoning the historical gold standard system? Our analysis of debt money system continues.

5.6 Functional-Money Creation out of Discount Loans to Banks

5.6.1 Discount Loans: Flow Approach Simulations

Let us assume that a growing economy has to meet an increasing demand for money from non-financial sector (producers and households). Under the circumstances without gold standard, commercial banks are now entitled to freely borrow from central bank at a discount (lower) interest rate. Then they make loans to a non-financial sector at a higher interest rate to make arbitrage profits.

This process of money creation is easily modeled as an expansion to the gold standard model by adding a stock of discount loan in the assets account of the central bank, and that of debts in the liabilities account of commercial banks, as illustrated in Figure 5.24 [Companion model: 2 Money(Loan).vpm].

Under the gold standard in the above model, the maximum amount of money stock to be created is limited to \$800 when $\beta = 0.1$. Suppose the demand for money from the economic activities is \$1,200. To meet this additional demand for money of \$400, the amount of \$100 worth of gold is further needed under the gold standard, since the economy's money multiplier is 4. Line 1 and 2 in Figure 5.25 illustrates how money stock is increased by the increase in the amount of gold by \$100; that is, the amount of gold deposited increases to \$300 from \$200.

Due to the limitation of gold standard, it eventually becomes impossible to meet a growing demand for money by increasing more gold to the gold standard system. In this way, historically, gold standard has been repeatedly suspended in 1930s and finally abandoned in 1971 as briefly discussed above.

Instead of increasing gold, the central bank now just prints its banknotes (legal tender) worth of \$100 and make loans to commercial banks, which in turn make loans to non-financial sector. Line 3 in Figure 5.25 illustrates how money stock is increased to \$1,200 when the central bank makes discount loans of \$100 at the period of 6. Vice versa, money stock is contracted when the central bank retrieves discount loans from commercial banks.

Thanks to this increase in money stock, non-financial sector's assets also increases to \$1,200, as illustrated by line 1 in in Figure 5.26. Yet its equity or wealth remains the same as the initial Gold Certificates; that is, \$200 (line 2). As already examined under the gold standard, the increased amount of \$1,000 is made available by the same amount of increase in debts by \$1,000 (line 3) in non-financial public sector. In other words, the increase in money stock is always followed by the increase in debts. This point will be further examined in the next chapter.

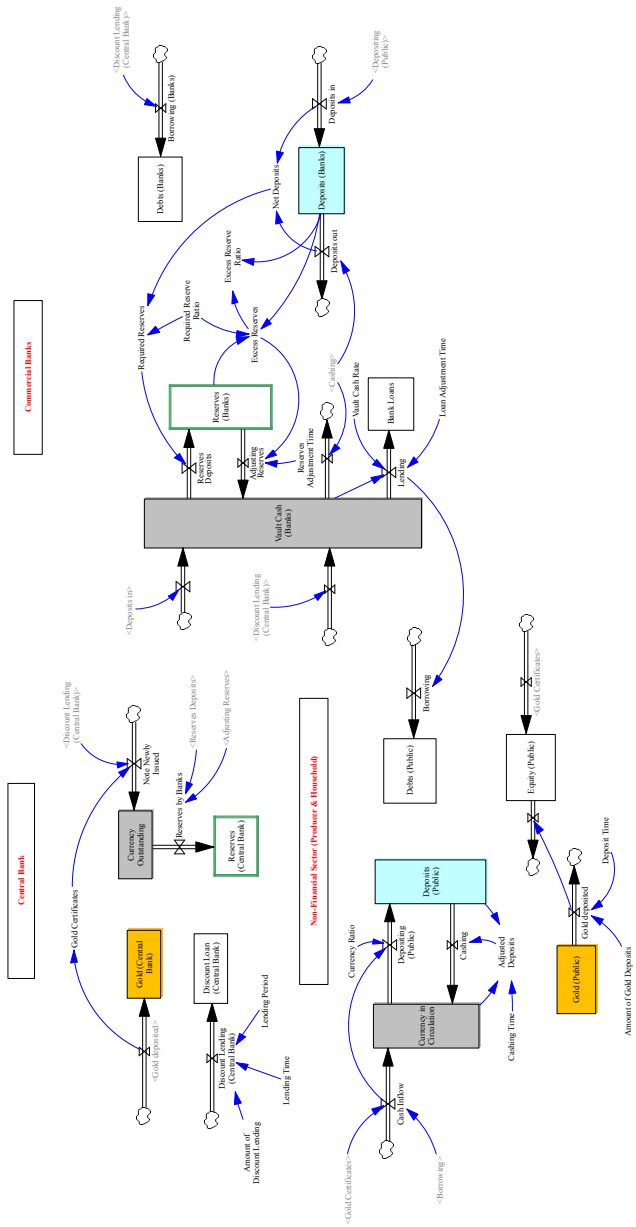

Figure 5.24: Money Creation Model out of Discount Loans to Banks

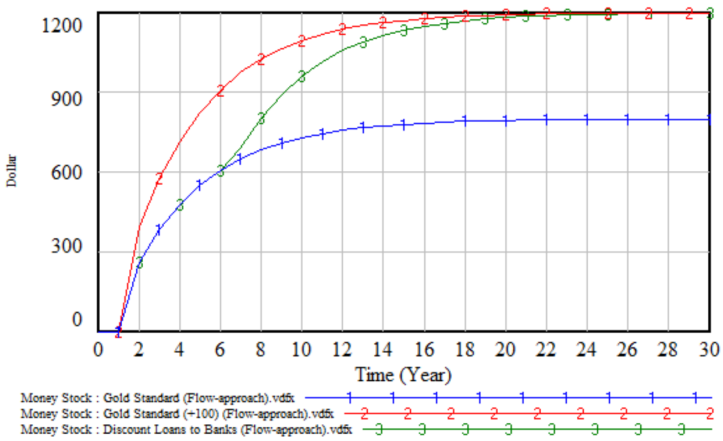

Figure 5.25: Money Stock Creation out of Discount Loans to Banks

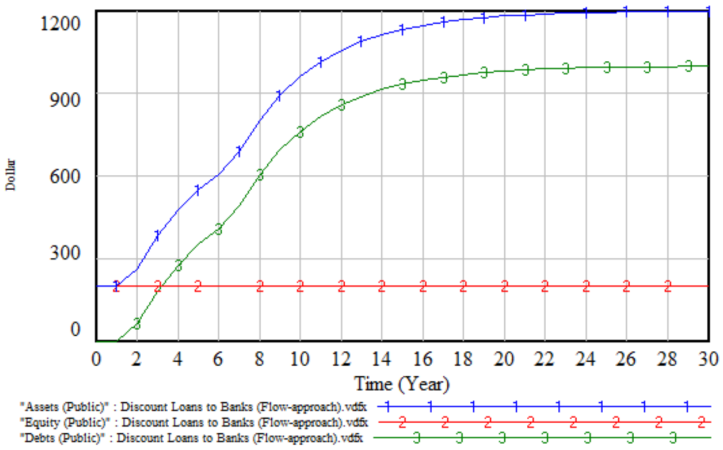

Figure 5.26: Assets, Equity and Debts

By abandoning the gold standard, central bank can exercise its almighty power to create money by just making discount loans to commercial banks; a process of functional-money creation as debts by commercial banks. According to Richard A. Werner [82, 2003], for instance, the Bank of Japan used to exercise the so-called *window guidance* - a hidden monetary policy, through which previous governors of the BoJ intentionally assigned discount loans to the commercial banks according to their own preferences. Moreover, functional-money thus created by commercial banks can buy anything such as military weapons, economic hit men, drugs, and information of media for controlling political and economic activities in favor for those who control money stock. That is, a free-

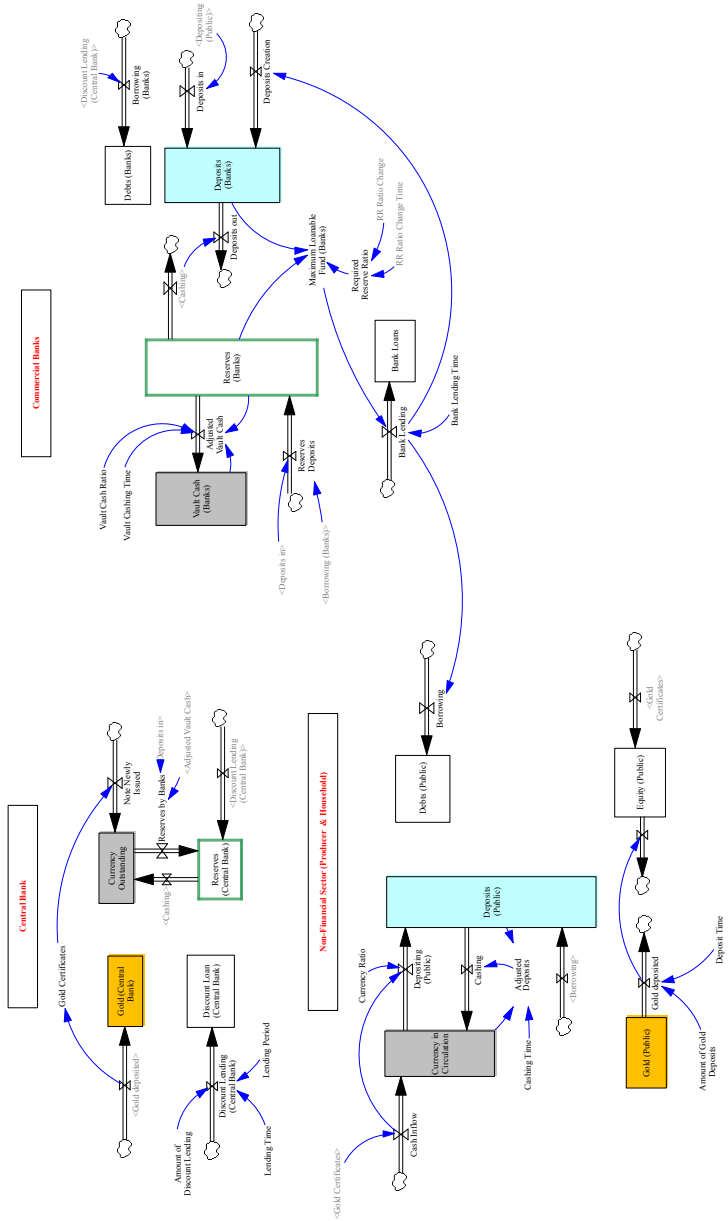

Figure 5.27: Money Creation Model out of Loan to Banks: Stock Approach

hand control of the economy is endowed to the central bank through the power of issuing its banknotes out of nothing. To restrict its power, central bank has to be, indeed, placed under the management of democratic government and people.

5.6.2 Discount Loans: Stock Approach Simulations

Stock approach to the money creation model out of discount loans to banks is easily built by applying a similar method to the stock approach as in the gold standard model. Figure 5.27 is the stock approach model, thus built, of the fractional reserve banking [Companion model: 2a Money(Loan-S).vpm].

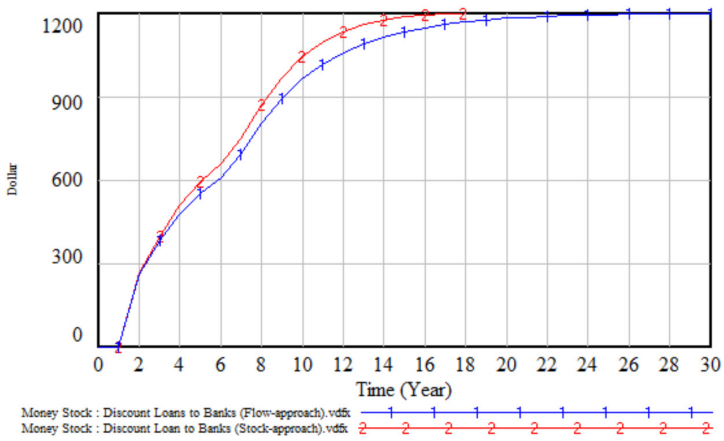

Figure 5.28: Money Stock Creation out of Loans to Banks: Comparison

Figure 5.28 compares how money stock behaves between flow and stock approaches when commercial banks borrow the amount of $100 from central bank. Line 1 indicates money stock under flow approach and line 2 under stock approach. Money stock under stock approach converges to the equilibrium level slightly faster than that under flow approach. Except these, two approaches behave in a similar fashion.

5.7 Functional-Money Creation out of Loans to Government

5.7.1 A Complete Money Creation Model: Flow Approach

Let us now expand our money creation model to a further complete model of money creation in which government securities are introduced and central bank can purchase them as assets and issue its banknotes for their payments as liabilities [Companion model: 3 Money(Flow-approach).vpm]. The model

consists of four sectors such as non-financial sector (producers and households), government, commercial banks and central bank. With the introduction of government securities, our expanded money creation model becomes a little bit complicated. To avoid a further complication the model is explained as four sub-models.

Non-Financial Sector (Producers and Households)

Non-financial sector consists of producers and households (non-banking financials are excluded here). It is called public sector. With the introduction of government, a stock of government securities (public) is newly added as assets. A balance sheet of non-financial sector is illustrated in Figure 5.29.

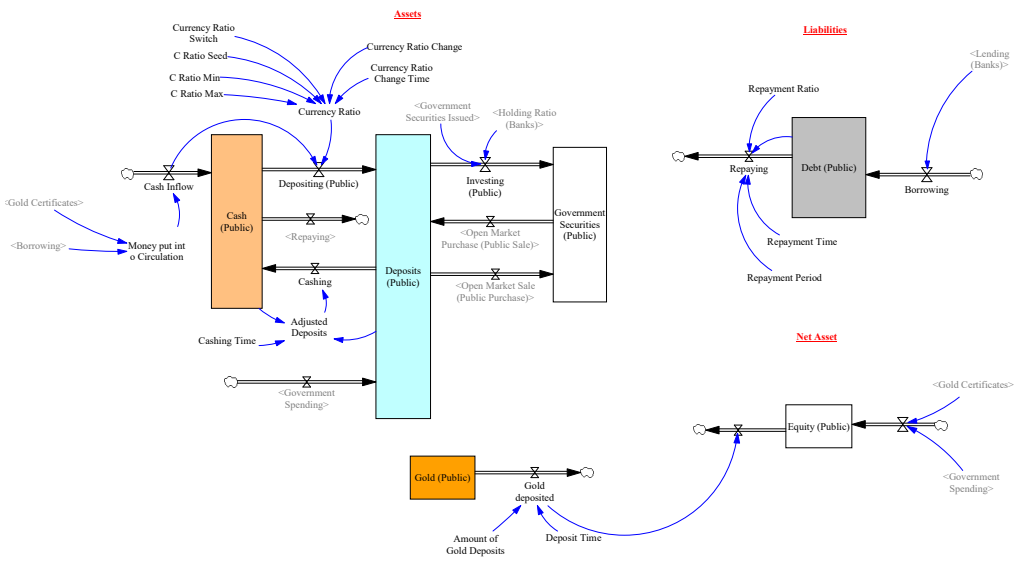

Figure 5.29: A Complete Money Creation Model: Non-Financial Sector

Government

Figure 5.30 illustrates a balance sheet of government, in which a stock of government deposit is added to the assets side, and stocks of its debts and its equity are added to its liabilities and net asset side, respectively.

Apparently money stock is not affected by the introduction of government securities so long as they are purchased by consumers and producers and government spends the amount it borrowed within the non-financial sector, as shown below.

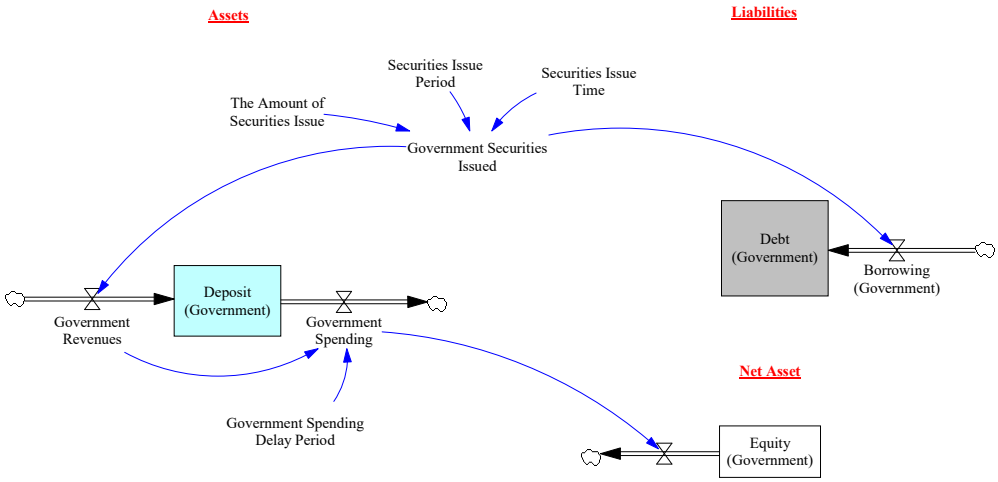

Figure 5.30: Non-Financial Sector (Government)

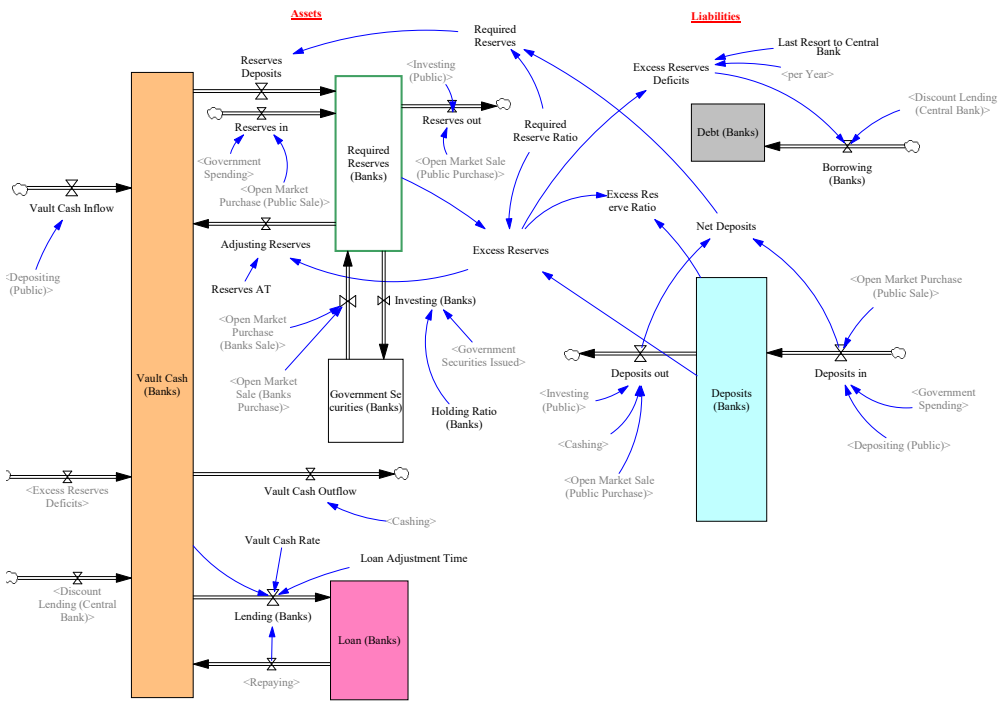

Figure 5.31: A Complete Money Creation Model: Commercial Banks

Commercial Banks

A stock of government securities held by commercial banks has to be newly added to the assets side of the balance sheet of commercial banks. Now commercial banks have a portfolio choice of investment between loans and investment on government securities. Government securities are paid out of reserves account of commercial banks with the central bank. Figure 5.31 illustrates the sector of commercial banks.

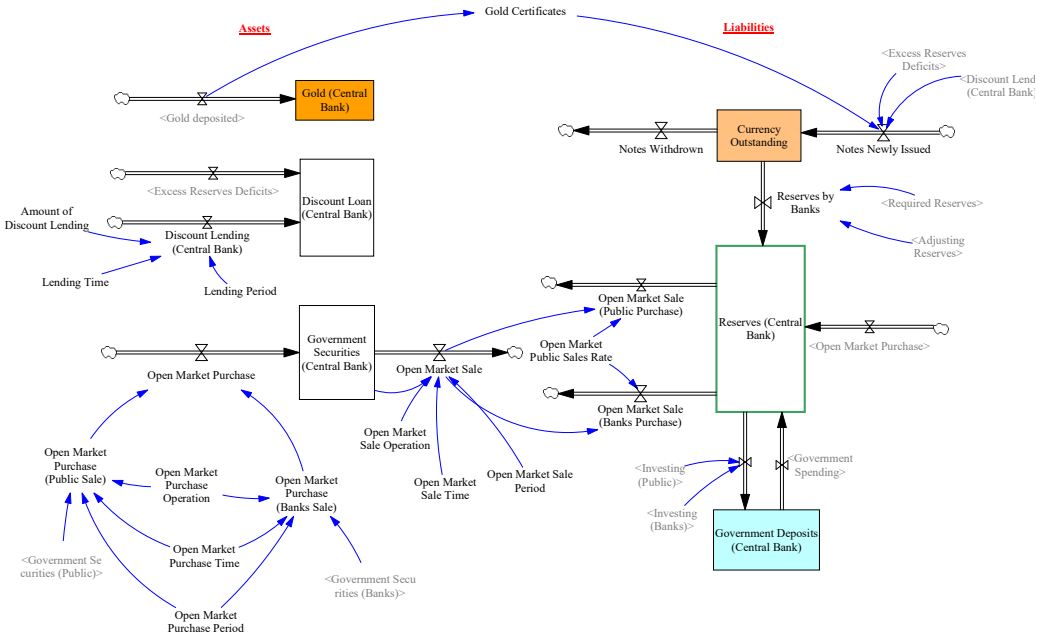

Figure 5.32: A Complete Money Creation Model: Central Bank

Central Bank

A stock of government securities held by the central bank has to be newly added to the assets side of the balance sheet of the central bank. In addition, the central bank opens deposits account of government, and plays a role of government's bank. Now, the central bank can purchase government securities, and their payments are handled through reserves account of commercial banks[25]. These

[25]Direct purchase of government securities, or direct loans to government by the central bank is prohibited in Japan. Therefore, such purchases has to be indirectly performed through markets.

transactions increase the same amount of the central bank's liabilities such as reserves, and accordingly base money.

If the central bank sells government securities to the non-financial sector and commercial banks, these payments are withdrawn from reserves account of commercial banks, decreasing reserves of commercial banks by the same amount, and hence base money as a whole. Purchases and sales of government securities by the central bank are known as open market operations.[26] Figure 5.32 illustrates these operations of the central bank. In this way, with the introduction of government securities, the central bank has a discretionary control of base money, which, however, does not imply its direct control over money stock as generally assumed in the textbooks.

Open Market Operations: Flow Approach

Let us explore how our complete functional-money creation model works. It includes the functional-money creation structures of the previous two models; that is, gold standard and discount loans to banks. Accordingly, the reader can easily confirm the previous behaviors of functional-money creation with this integrated model.

It is assumed here that government issues securities (and borrow money) of 100 dollars at the period t = 8, 70% of which are assumed to be purchased by commercial banks and 30% by the public (households and producers). Yet, this only interrupts money stock temporarily, which tends to converge eventually to 800 dollars as before as illustrated by lines 1, 2 & 3 in Figure 5.33. Temporal

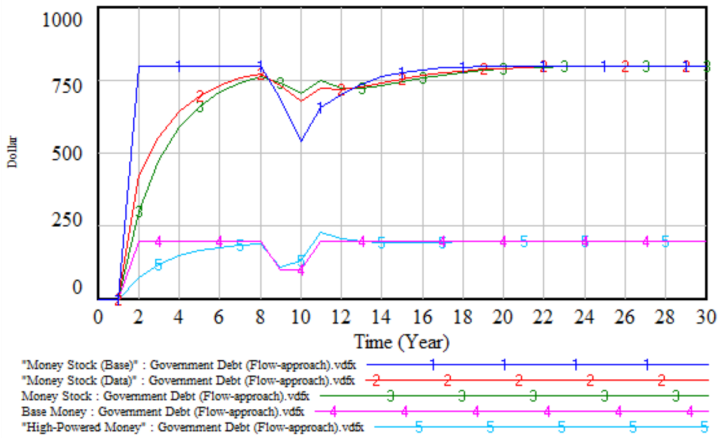

Figure 5.33: Simulation of Government Securities (Debt)

drops of money stocks at time 8 are caused by a time lag of borrowing and

[26] Recently, purchases of government securities and private bonds held by commercial banks and non-banking financials are known as *quantitative easing (QE)* policies

spending by government. Therefore, it is essential to understand at this stage

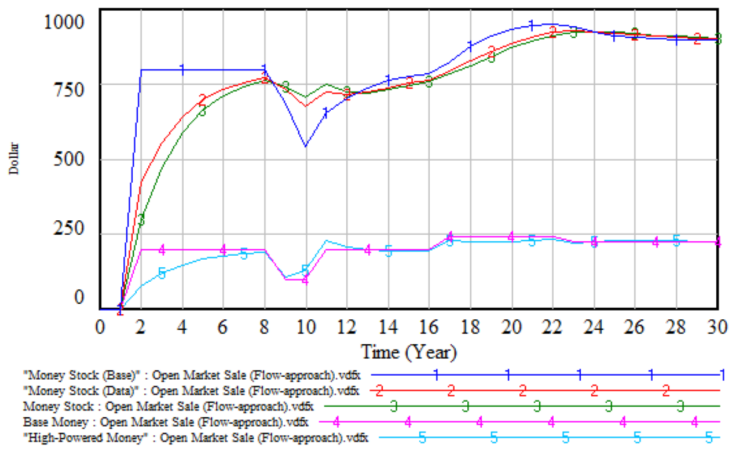

Figure 5.34: Simulation of Open Market Purchase and Sale Operations

that money stock cannot be increased at all by the government debt, contrary to the general belief that government borrowing is a root cause of inflation.

Figure 5.34 illustrates how open market operations affect the behavior of money stock. At the period t = 16 the central bank purchases 50% of government securities held by the public and commercial banks through open market purchase operation. Accordingly, base money (line 4) is now increased from the original 200 dollars to 240 dollars. Money stock (base) (line 1) begins to increase from 785.6(t=16) to 950.8 (t=22), while money stock (data) and money stock (lines 2 & 3) also continue to increase toward the same level.

At the period t = 22 the central bank sells 50% of the government securities it holds, and base money decreases to 2224 dollars next year. Money stock (base) (line 1) begins to decrease from 950.8 (t=22) to 897.5 dollars (t=30). Eventually three expressions of money stock converge to this level as shown in Figure 5.34.

In this way, the central bank can increase or decrease money stock by its discretionary monetary policy of open market operations so long as commercial banks make maximum loans, as assumed in this model, under the fractional banking practice. In this way, theoretically there exists no ceiling or upper boundary of money stock to be created under the current debt money system.

Even so, there is a case in which the central bank cannot control money stock. Figure 5.35 illustrates the case in which a currency ratio is additionally doubled from 0.2 to 0.4 at t = 24, due to the economic recessions, followed by the increase in liquidity preferences. Money stock (base) tends to decrease from 922.4 (t=24) to 631.5 dollars (t=30); a reduction of money stock by 290.9 dollars. Three expressions of money stock all converge to this reduced amount.

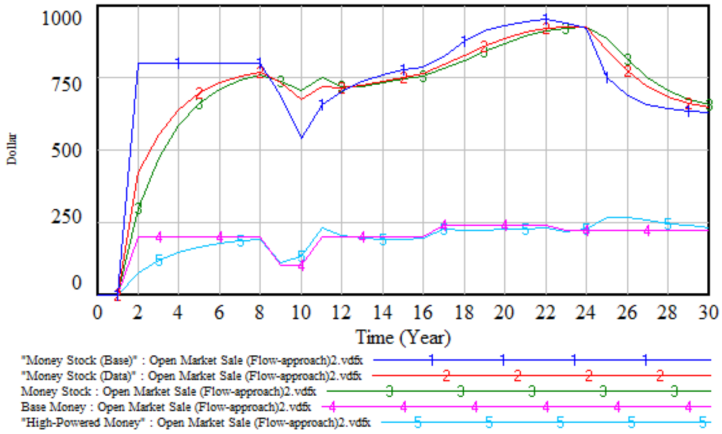

Figure 5.35: Open Market Operation with Currency Ratio Doubled

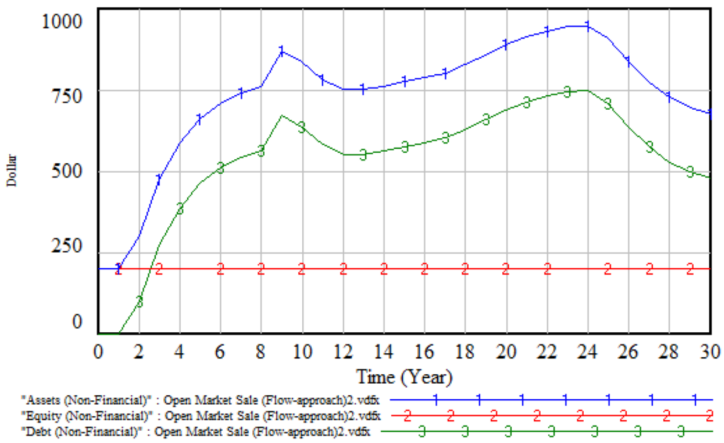

Figure 5.36: Assets, Equity and Debt of Non-Financial Sector (Public)

Finally, let us examine how the above open market operations and a change in currency ratio affect assets (line 1), equity (line 2) and debt (line 3) of non-financial sector (public). As expected from the above analyses, it is again confirmed that the equity or wealth of non-financial sector is not affected at all as illustrated in Figure 5.36. All changes in assets are balanced by debt.

5.7.2 A Complete Money Creation Model: Stock Approach

A complete money creation model by stock approach is demonstrated in Figure 5.37 [Companion model: 3a Money(Stock-approach).vpm]. With this model,

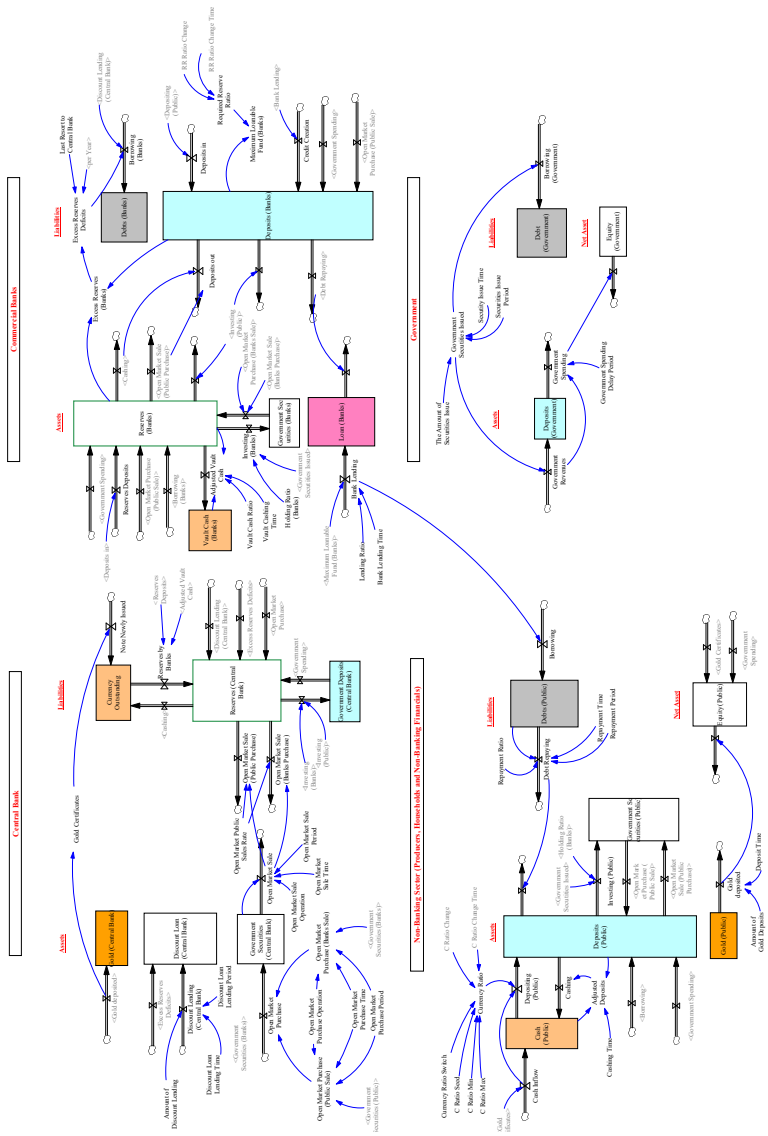

Figure 5.37: A Complete Money Creation Model: Stock Approach

the reader can run similar simulations as in the above flow approach to confirm the similar results.

Open Market Operations: Stock Approach

Specifically, similar open market behaviors of stock approach are confirmed in Figure 5.38 under the same parametric conditions, as in the open market behaviors of flow approach illustrated in Figure 5.34. The only difference is that here three different behaviors of money stock (base), money stock (data) and money stock are all merged. Furthermore, for comparison money stock behavior of flow approach is added as dotted line 6. Obviously money stocks of both approaches (line 3 and line 6) behaves similarly to converge at t-30. Now

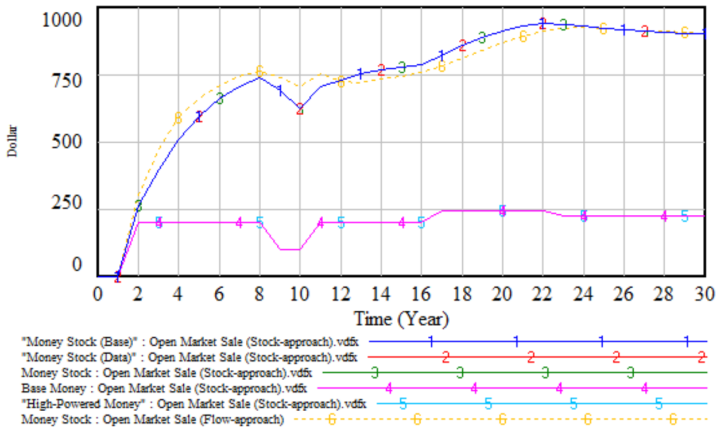

Figure 5.38: Simulation of Open Market Operation

we have completed the comparative analyses of flow and the stock approaches of money stock.

Can Government Debt increase Money Stock?

The above analysis of government debt may needs some remarks. Recently due to the influence of MMT (Modern Money Theory) such as [88, 2012], misperception spreads such that whenever government borrows and spends money stock is increases simply because government transfers the borrowed money to the deposits account of the public, which by definition increases money stock M_1. This argument is inappropriate. Money stock can only be increased so long as base money M_0 is increased as our simulations above have demonstrated. Let us consider the following three cases.

Case 1 When government borrows money directly from the public (households and producers), its debt moves from the deposits account of the public to

the government account, then goes back to the public account. In this case money stock does not increase. This is a well-known case of mainstream theory which causes *crowing-out* effect, causing only interest rate to go up.

Case 2 When government borrows money directly from commercial banks, its debt is paid out of the banks' reserve accounts, which in turn forces to reduce their loans to the public and deposits of the public, cancelling out the increase of government's spending into the public deposits. The reader can easily examine this case by running either the flow or stock approach model.

Case 3 Only when government borrows money directly from commercial banks which can pay out of their excess reserves, its debt increases money stock. The existence of excess reserves implies that banks are not making full amount of loans available under a fractional reserve banking. Hence, government debt plays a role to fill in this gap of loans. MMT inaccurately seems to assume only this recessionary case.

5.8 Identical Creations of Functional-Money

So far we have observed, step by step, how money stocks are increased in response to the increases in base money due to the discount loans to banks and loans to the government (security purchase). Our simulation results have indicated that both flow and stock approaches of functional-money creation entail similar behaviors of money creation. We are now in a position to compare flow and stock approaches simultaneously in terms of base money and money stock according to the following simulations.

(1) Gold Standard: \$200 by default.

(2) Discount Loans to Banks: \$100 at t=6.

(3) Government Debt: \$100 at t=8.[27]

(4) Open Market Purchase: 50% purchase of existing Gov Securities at t=16.

(5) Open Market Sale: 50% sale of Gov Securities held by Central Bank at t=22.

Figure 5.39 illustrates the flow approach behaviors of Base Money (left-hand diagram) and Money Stock (Data) (right-hand diagram) under five different simulations; gold standard (line 1), discount loans to commercial banks (line 2), government debt (loans to the government) (line 3), open market purchase of government securities (line 4), and open market sale of government securities (line 5).

[27]Here government is assumed to issue its securities of \$100, instead of \$50 issued in our analysis above.

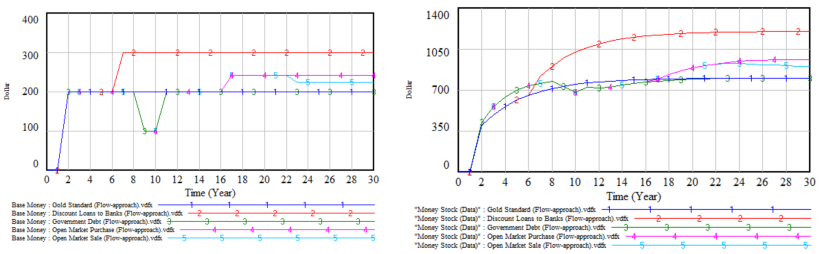

Figure 5.39: Behaviors of Base Money and Money Stock: Flow Approach

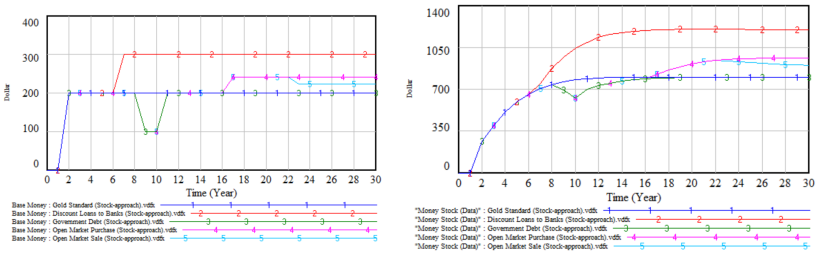

Figure 5.40: Behaviors of Base Money and Money Stock: Stock Approach

To be more specific, first, base money of 200 dollars is assumed under the gold standard. Second, discount loans to banks is made with 100 dollars at t=6, which increases money stock to 1,200 dollars. Third, government borrows 100 dollars (by issuing securities of 100 dollars) at t=8, which, however, does not affect money stock; that is, a temporal drop of money stock eventually converges to the same level of previous 800 dollars. Fourth, central bank exercises open market purchase of 50% of outstanding securities (50 dollars) at t=16, which surely increases money stock to a new level of 960 dollars at t=30. Fifth, central bank exercises open market sale of 50% of its holding securities at t=22, which decreases money stock to 901 at t=30.

Figure 5.40 illustrates the stock approach behaviors of Base Money and Money Stock (Data) under the same simulations as in the flow approach. To be more specific, first, base money of 200 dollars is assumed under the gold standard. Second, discount loans to banks is made with 100 dollars at t=6, which increases money stock to 1,200 dollars. Third, government borrows 100 dollars (by issuing securities of 100 dollars) at t=8, which, however, does not affect money stock; that is, a temporal drop of money stock eventually converges to the same level of previous 800 dollars. Fourth, central bank exercises open market purchase of 50% of outstanding securities (50 dollars) at t=16, which surely increases money stock to a new level of 962 dollars at t=30. Fifth, central bank exercises open market sale of 50% of its holding securities at t=22, which

decreases money stock to 900 at t=30.

Except minor differences of money stock for open market purchase and sale operations, flow approach and stock approach indeed indicate similar behaviors. Consequently, the comparison of these two figures confirms that the behaviors of flow and stock approaches are almost identical, as if they are heads and tails of the identical coin. This is our mail conclusion on the flow and stock approaches of money creation in this chapter. Our simulation results here may put an end to century-long disputes among economists on the creation of money.

Inseparable Heads and Tails in Banking Practices

If flow and stock approaches are identical, which one of modeling should be used for the analysis of economic behaviors? For the macroeconomic analysis of aggregate banking sector, either approach works well.

At the microeconomic level of individual banks, however, the answer depends on the target sectors of economic analysis. In the non-financial public sector, producers and non-banking financial institutions are constantly in a state of liquidity deficiency and need to borrow from banks, while consumers tend to make deposits.

Under the circumstances, if consumers are main clients of banks, these banks tend to hold excess reserves, out of which loans are made first to derive arbitrage interest incomes between deposits and loans. Hence, for the analysis of such banking practices, the flow approach of banks (say, the heads of the coin) that masquerade as intermediaries may be appropriate.

If producers and non-banking financial institutions are main clients of banks, the stock approach of functional-money creation (say, the tails of the coin) may be appropriate for analyzing their banking practices. These banks make large amount of loans first, then adjust to their reserve requirements later through interbank call-money market, etc. Hence, the selection between flow and stock approaches depends on target sector of analysis so long as the analysis objectives are at a microeconomic level.

In real banking transactions at the microeconomic level, however, both practices of flow and stock approach coexist and become impractical to distinguish one from another. This coexistence might have confusingly misled economists into either or tails camp, or "three main theories of banking" according to the classification of Werner [84, 2015], as already discussed above. Under these confusions, bankers who wish to hide away their practice of functional-money (or deposits) creation out of nothing tended laboriously to support flow approach of "banks as intermediaries".

Our ASD macroeconomic modeling analyses have successfully revealed the equivalence of flow and stock approaches as the heads and tails of the identical coin. Even so, it's worth drawing attention to the reader that significant differences in banking practices exist at the individual banking level.

Under the circumstances, we have decided to follow the traditional flow approach of money stock in the following chapters that analyze macroeconomic

dynamic behaviors. Accordingly, leaving further macroeconomic analyses by stock approach to the reader, let us continue our journey.

Conclusion

We have started this chapter by defining money as legal tender according to the definition by the Greek philosopher Aristotle. Under the current debt money system legal tender is created by the privately-owned central bank as base money. Commercial banks then create deposits as functional-money out of nothing under the fractional reserve banking. Deposits thus created only function as money so long as they are accepted for transactions.

Concerning this functional-money creation process, two or three different theories have been presented in the history of economics. They are called flow and stock approaches in this chapter according to our accounting system dynamics modeling method.

For the analysis of functional-money creation, six sectors in the previous chapter are rearranged to three sectors: central bank, commercial banks and non-financial sector. This modeling process inevitably requires a distinction between currency in circulation and currency outstanding, and accordingly high-powered money and base money that have been traditionally treated equivalently in macroeconomics. These distinctions lead to three different concepts of money stock; that is, money stock (base), money stock (data) and money stock.

Our comparative analysis is carried out first under gold standard. It is shown that, in the flow approach, money stock (data) obtained from actual economic data tends to overestimate true money stock based on high-powered money. It is also shown that three expressions of money stock tend to converge one another as long as vault cash held by commercial banks diminishes. It turned out that these different behaviors of money stock are fully merged in the stock approach.

These comparative analyses continue to the models in which functional-money is created out of loans to commercial banks and government by introducing the central bank's discount loans and purchase of government securities. Then we have obtained that behaviors of money stock are approximately identical between the flow and stock approaches as if they are the heads and tails of the same coin.

Throughout the functional-money creation processes, it is also demonstrated that the increased assets in non-financial sector due to functional-money creation are always balanced by the same increased amount of debts. In consequence, the equity or wealth of non-financial sector is not affected, and remains the same under three models such as gold standard, discount loans to commercial banks and loans to the government.

Our simulation results of functional-money creation may put an end to century-long disputes among economists on the creation of money.

Questions for Deeper Understanding

1. When people claim that money is created out of nothing or thin air, what kind of money are they referring to? Explain it by using definitions of money and Table 5.2 (Classification of Money).

2. Discuss how the money you analyzed above is indeed created out of nothing, or thin air under the following four cases by running flow-approach models:

Case 1 Central bank issues gold certificates of 100 (million) dollars against the gold deposited by the public (Run *1 Money(Gold).vpm*).

Case 2 Central bank makes loans of 100 (million) dollars by newly issuing its banknotes to commercial banks, which in turn use them to make loans to the public, that is, non-financial sectors such as producers and households (Run *2 Money(Loan).vpm*).

Case 3 Government newly issues its bonds of 100 (million) dollars, and commercial banks purchase them by borrowing money from the central bank. In other words, both government and commercial banks borrow. Additionally discuss how the balance sheet accounts of the central bank and commercial banks are affected by these transactions. Moreover discuss how debts and equity accounts of the government are affected by them (Run *3 Money(Flow-approach).vpm*).

Case 4 Under the situation of the above case 3, the central bank now purchases 50% of the government bonds trough Open Market Purchase Operations (Run *3 Money(Flow-approach).vpm*).

3. In a history of economic thoughts, two different approaches to the money creation process out of nothing have been provided. The stock approach was dominant till 1935, then this approach completely disappeared, as if it is a taboo subject, from the economic teaching till around 2014. On the other hand, flow approach has dominated since Hayek (1929) and Keynes (1936) till recently, simply because this approach misguides banks as mere intermediaries of money in circulation. These two approaches are fully discussed in this chapter. Considering a recent popularity of stock approach of money creation, it is essential to fully comprehend the nature of money with the model of stock approach.

   Run the comprehensive money creation model of stock approach: *3a Money(Stock-approach).vpm*. Then, perform the following simulations:

   (1) Gold Standard: $200 by default.

   (2) Discount Loan to Banks: $100 at t=6.

   (3) Government Debt: $100 at t=8.

   (4) Open Market Purchase: 50% purchase of existing Gov Securities at t=16.

(5) Open Market Sale: 50% sale of Gov Securities held by Central Bank at t=22.

Save these simulation results and answer the following questions.

(a) Draw a diagram that compares how Money Stock gets increased or decreased under these simulations.

(b) Draw a diagram that compares how Assets and Debts of non-financial public sector get affected under these simulations.

(c) Draw a diagram that compares Base Money and Money Stock, and discuss the relations among Base Money, Money Stock and Money Multiplier.

(d) Discuss how government debt (by issuing securities) affects Money Stock.

4. Creation of functional-money or credits (a source of control) depends on the fractional reserve banking; that is, a reserve ratio between $0 \leq \beta \leq 1$. If $\beta = 1$, what will happen?

5. It will also be affected by a change in currency ratio α. Discuss why the fractional reserve banking system becomes "the chief cause of both booms and depressions (Irving Fisher [12, p.xviii, 1935])."

6. Who owns the central bank in your country?

7. Do we really need the central bank to manage money stock and run the economies? Without the central bank, what problems will arise?

8. If the central bank is owned by the government, what alternative policies could be available against current monetary policies of open market operations etc. by the central bank?

9. (**Challenge**) Table 5.5 presents a complete classification of money stock in Japan. For deeper understanding of the nature of contemporary debt money, the reader is encouraged to create a similar classification table of money stock in his/her country.