ASD Macroeconomic Model of Japan on the Flow of Funds and National Accounts
– Report on its Early Stage Development –

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Abstract

This paper tries to report the early stage development of our ASD (accounting system dynamics) macroeconomic model of Japan. The model incorporates financial sectors to show that demand deposits or credits are created out of nothing or destroyed endogenously under the current fractional reserve banking system. To be specific, 15 macroeconomic sectors are consolidated to the model with more than 1300 variables by incorporating the Flow of Funds Accounts by the Bank of Japan. The difficulty we faced is that inflow and outflow data for financial transactions are not available and we are obliged to reconstruct all financial inflow and outflow transactions by our economic rationale.

Our modeling purpose at this early stage is focused on the macroeconomic system structure that caused Japanese economic recession of two decades long despite of the quantitative easing (QE) policies. From the analysis of imported financial data to the model, we found a dramatic change in the roles of economic players; that is, credit creation roles have shifted from producers and households to the government, followed by accumulating debt crisis.

Finally a partial optimization is successfully performed for the interpolation of real macroeconomic behaviors such as GDP, consumption, investment, price, prime rate, unemployment rate, employed labor, and population. Its success will enable "what-if ?" analysis of macroeconomic behaviors at the next stage development in the future.

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1 Need for Financial Modeling

1.1 Unstable Economic Behaviors

At the international SD conference in Delft, the Netherlands last year, one of the author presented the paper [4, 2014] that shows a transition process from the current debt money system to the public money system by constructing a simple SD macroeconomic model for transition. Then, current debt money system is identified as having system design failures, and proposed to be replaced with more stable system of public money. To be specific, current monetary system has been pointed out to contain two major design failures. First, it causes booms and depressions (and unemployment), or inflation and deflation due to the so-called fractional reserve banking system, which creates credits (or demand deposits) out of nothing and incessantly destroy them, causing unstable money stock (which is defined as the sum of currency outstanding and demand deposits) in the economy.

Second, it causes to accumulate government debt. Under the current debt money system, someone has to borrow money to increase money stock for economic growth. And government has to be the last and the only borrower for a longer period, causing recent debt crises among many countries in the world.

These two system design failures have become the root causes of economic disasters under the current debt money system. The only cure within the system has been to introduce the so-called financial quantitative easing (QE) policy, which has also unfortunately failed to relieve economic difficulties such as recessions and unemployment.

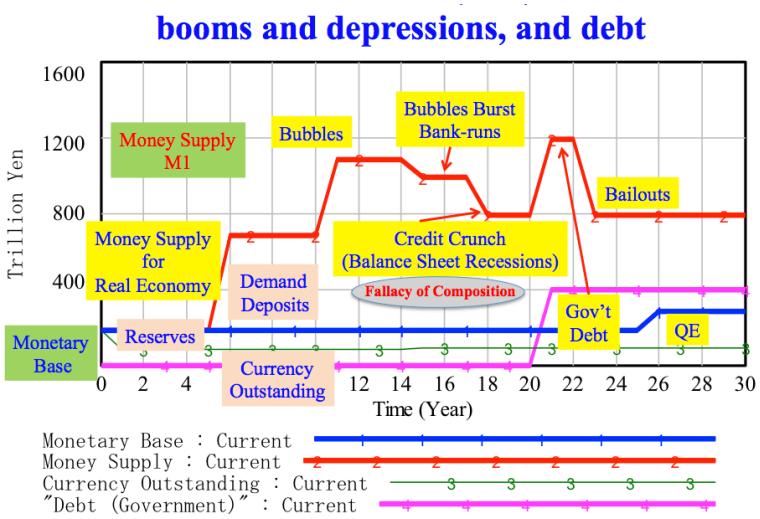

Figure 1: Simple Behaviors of Debt Money System

These structural failures of the current monetary system are very succinctly

described in terms of system behaviors of monetary base and money supply. For this purpose, a simple SD macroeconomic model is developed to illustrate such unstable monetary behaviors as shown in Figure 1. Monetary base is described by the bold blue line 1, which consists of currency outstanding (green line 3) and reserves of commercial banks at the central bank. Money stock (or supply) M_1 is described by the red bold line 2, which indicates unstable behaviors of money stock. The pink bold line 4 illustrates how government debt is forced to be increased.

The financial QE policy mainly consists of the purchase of governmental and commercial securities by the central bank. In exchange, reserves of commercial banks are increased so that banks could expand their credit creation by making loans, thus increasing money stock with a hope that this policy stimulates economic activities out of recession. An increase in monetary base (blue bold line 1) around the year 25 in the above figure indicates the introduction of the QE policy. Yet, this increase in monetary base has failed to increase money stock M_1, which, in turn, has failed to stimulate the economy as expected.

1.2 Failures of Financial QE Policies

To confirm actual behaviors of these monetary movements in relation to money stock by QE policy, real monetary data are taken from the Bank of Japan. Figure 2 illustrates the time-series behaviors of monetary base in Japan since

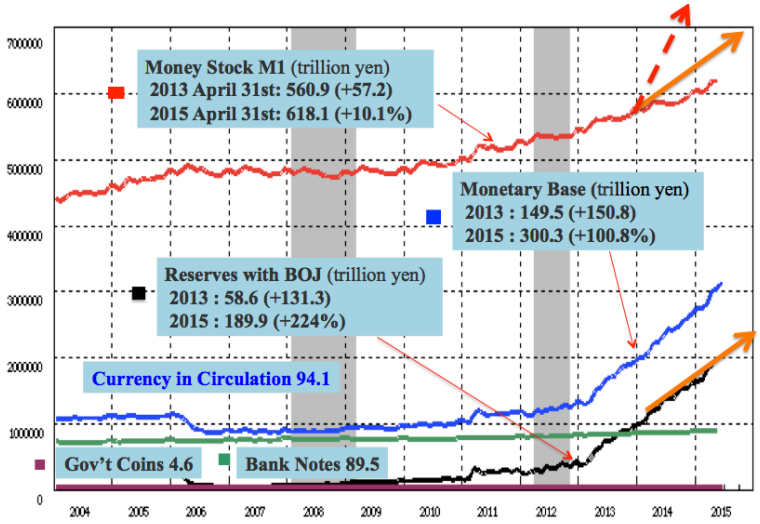

Figure 2: Monetary Base and M1: BOJ Data as of 2015.07

2004 through April of 2015. Specifically, it illustrates how Japanese monetary base has increased since the Bank of Japan began to reintroduce its new QE policy in April of 2013. The BOJ purchased significant amount of government

securities and others to increase its monetary base by 131.3 trillion yen since then through April 2015. Accordingly the monetary base has increased by 150.8 trillion yen during the last two years from 149.5 trillion yen to 300.3 trillion yen. Yet, money stock M_1 only increased by 57.2 trillion yen from 560.9 trillion yen to 618.1 trillion yen. Money multiplier, which is a ratio between money stock and monetary base, was 3.75 two years ago. If it would have stayed stable as most QE policy makers had expected, the increase in monetary base by 150.8 trillion yen could have increased money stock by the amount of 565.5 trillion yen! Yet, it only increased by 57.2 trillion yen, surprisingly smaller than the increase in monetary base itself. In other words, if this increase were to be done as helicopter money, it would have increased money stock at least by the same amount of 150.8 trillion yen. Traditional macroeconomic theory has completely failed to explain this failure.

Concurrently QE policies have been heavily applied to the depressed economies of U.S and EU countries as the last resort of financial policy to stimulate their economies. Unfortunately, they have also failed as in Japan.

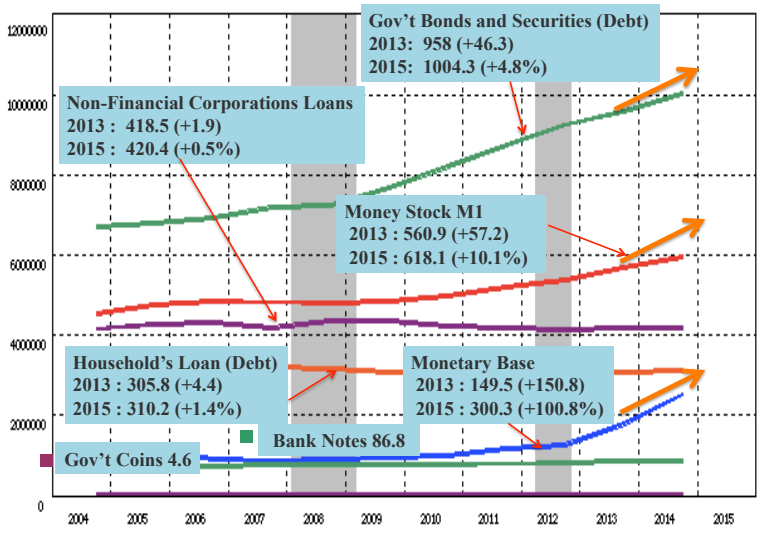

Figure 3: Why QE failed to Stimulate M1

What went wrong, then? Under the current fractional reserve banking system or simply debt money system, money stock (or simply, deposits) can be increased only when someone comes to borrow money from banks. That someone could be producers seeking for investment, households for housing investment, or the government to meet its budget deficits. Figure 3 illustrates to whom commercial banks in Japan made loans since 2004. Specifically, during the last two years when the QE policy was heavily conducted, bank loans to corporations increased only by 1.9 trillion yen (0.5%) from 418.5 trillion yen to 420.4 trillion

yen. This implies that, despite a historically lower interest rate of close to zero and abundance of monetary base made available by the QE policy, non-financial corporations(hereafter called producers) failed to borrow from banks. In addition, bank loans to households (including sole proprietorships) during the same period increased only by 4.4 trillion yen (1.4%) from 305.8 trillion yen to 310.2 trillion yen. Under the recessions, households also didn't expand its borrowings due to their gloomy expectations that their income wages may not increase, or, to be worse they may lose jobs. These concerns of households withheld their borrowings for housing and investment.

Compared with these depressed borrowers, only the government sector is obliged to increase their borrowings due to its budgetary deficit even though it fears to accumulate a huge amount of debts in the near future. In other words, only the government had no choice but to keep borrowing. Accordingly, the increase in monetary base by the QE policy of the BOJ turned out only to monetize the government debt, en route to the borrowings through commercial banks. Hence, the QE policy has essentially become the *debt financing policy* of the government, though it is prohibited by law. How long can the government continue to borrow? And how long can the central bank endure such absurdities? With fears of collapse, quite a few central banks are now trying to find out exits from QE policies to save themselves, not the troubled economies. These exoduses in turn will surely cause the governments and economies to collapse. We are indeed trapped into the dead-end financial system.

1.3 Search for the Causes of QE Failures

With these imminent economic situations we are facing now, the real question we have to be able to answer should be what went wrong with the current economic system structure that has made such QE policy failures. Unfortunately, to the best of our knowledge, no financial models are available to identify structural causes of such failures. The above simple SD model presented at Delft SD conference last year is too simple to better understand the system design failures discussed above. It would be nice, we thought, if we could build a comprehensive SD macroeconomic model, based on the accounting system dynamics method, that integrates financial sectors and real market economic sectors. This has become our main motive to develop the ASD macroeconomic model of Japan in this research.

For this development, the Flow of Funds Accounts (hereafter called the FFA) by the BOJ turned out to be very powerful data source for observing financial transactions in Japan. For the integration of financial sectors with the FFA, the SD macroeconomic model presented in Chapter 9 of the book [3, 2013] turns out to be the best generic modeling framework, because it is built on the accounting system dynamics method, which is close to the FFA approach due to its dependence on the 1993 SNA (System of National Accounts) by the United Nations. So far, however, no such ASD macroeconomic models have been

developed to incorporate the FFA[1]. Since the FFA covers a huge data matrix of the financial transactions in the Japanese economy as explained below, our research is broken down into several stages of development.

Stage 1 Construction of an ASD macroeconomic model that reflects transactions of real and financial economic sectors, and examination of model consistency among all inflow and outflow transactions across all sectors.

Stage 2 Incorporation of real economic and financial data into the model as reference and data variables. Upon its completion, the ASD model could become a prototype for world-wide national models.

When these two stages are done, the model itself could be independently used for understanding inter-sectoral transactions with actual Japanese data at hand.

Stage 3 Partial Optimization of interpolation for real economic behaviors such as GDP, consumption, investment, price, prime rate, unemployment rate, employed labor and other variables with a hypothesis that structural changes are reflected among their exogenous parameters.

Stage 4 Construction of detailed interdependent feedback relations among all sectors in order to make exogenous parameters in Step 3 endogenous as far as possible.

Stage 5 Wholistic simulation analyses to figure out the structural causes of QE policy failures, as well as traditional analyses for the effects of Keynesian fiscal and monetary policies.

Stage 6 Comparative analyses for the workings of debt money and public money systems.

This paper tries to cover the early stages of the ASD model development as far as the stage 3 partially.

2 Revisit of the Macroeconomic Model

For the continuity of model development, let us now revisit the SD macroeconomic model presented in the Chapter 9 of "A Macroeconomic System" in the book [3, 2013]. Its basic framework is illustrated in Figure 4. It shows that the economy consists of five macroeconomic sectors such as producers, consumers, government, banks and central bank.

For the convenience to the reader, let us briefly describe major transactions among these five sectors.

[1]To the best of our knowledge, an applied macroeconomic model based on the chapter 9 is developed to the Croatia macroeconomy by Sinisa Sovilj and Marina Tkalec, which was presented at the Poster session of the 32nd International Conference of the System Dynamics Society, Delft, Netherlands, 2014. It is a simple application of the model in Chapter 9, and no attempt is made to incorporate the Flow of Funds Accounts we are challenging in this research.

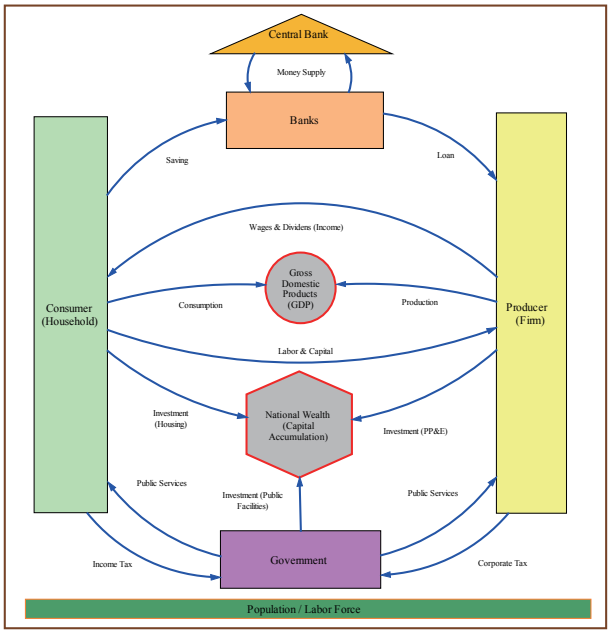

Figure 4: Macroeconomic Overview of Chapter 9

Producers

Major transactions of producers are summarized as follows.

- Producers import goods from overseas and export them to overseas.
- Out of the GDP revenues producers pay excise tax, deduct the amount of depreciation, and pay wages to workers (consumers) and interests to the banks. The remaining revenues become profits before tax.
- They pay corporate tax to the government out of the profits before tax.
- The remaining profits after tax are paid to the owners (that is, consumers) as dividends.
- Producers are thus constantly in a state of cash flow deficits. To continue making new investments, therefore, they have to borrow money from banks and pay interest to the banks.

Consumers (Households)

Major transactions of consumers are summarized as follows.

- Consumers receive wages and dividends from producers.

- Financial assets of consumers consist of bank deposits and government securities, against which they receive financial income of interests from banks and government.
- In addition to the income such as wages, interests, and dividends, consumers receive cash whenever previous securities are partly redeemed annually by the government.
- Out of these cash income as a whole, consumers pay income taxes, and the remaining income becomes their disposal income.
- Out of their disposal income, they spend on consumption. The remaining amount are either spent to purchase government securities or saved.

Government

Major transactions of the government are summarized as follows.

- Government receives, as tax revenues, income taxes from consumers and corporate taxes from producers.
- Government spending consists of government expenditures and payments to the consumers for its partial debt redemption and interests against its securities.
- Government expenditures are assumed to be endogenously determined by either the growth-dependent expenditures or tax revenue-dependent expenditures.
- If spending exceeds tax revenues, government has to borrow cash from consumers by newly issuing government securities.

Banks

Major transactions of banks are summarized as follows.

- Banks receive deposits from consumers, against which they pay interests.
- They are obliged to deposit a portion of the deposits as the required reserves with the central bank.
- Loans are made to producers out of the remaining deposits and banks receive interests for which a prime rate is applied.
- Their retained earnings thus become interest receipts from producers less interest payment to consumers. Positive earnings will be distributed among bank workers as consumers.

Central Bank

Major transactions of the central bank are summarized as follows.

- The central bank issues currencies against the gold deposited by the public.
- It can also issue currency by accepting government securities through open market operation, specifically by purchasing government securities from consumers.
- It can similarly withdraw currencies by selling government securities to the public.
- Banks are required by law to reserve a certain amount of deposits with the central bank. By controlling this required reserve ratio, the central bank can control the monetary base directly.

3 Modeling Processes of Credit Creation

3.1 Stock Approach

ASD macroeconomic models presented in the book [3, 2013], including the one in Chapter 9, differ from the current mainstream macroeconomic models such as neoclassical DSGE (Dynamic, Stochastic General Equilibrium) models and Keynesian econometric models in the sense that (1) ASD models are all based on the accounting system dynamics as its name indicates, (2) demand deposits (credits) are endogenously created in the economy as a part of money stock, and (3) they are disequilibrium models. These different features are made possible by the analytical method of the accounting system dynamics presented in Chapter 3 in [3, 2013].

Under this analytical method, however, two distinct modeling processes of credit creation are shown to exist. Chapter 5 of the book explains these two processes in detail; that is to say, a traditional (or textbook) flow approach and stock approach. In the traditional flow approach of credit creation, banks make loans out of the deposits they receive from households. In the stock approach, on the other hand, banks first make loans with credits given to the borrowers' accounts out of nothing. In case the amount of deposits thus created exceeds the required reserves at the central bank, banks are forced to make adjustments through inter-banking borrowing and lending after the loans are made. This stock approach is closer to the real transactions practiced by commercial banks.

Recently, quite a few economists began to emphasize that the traditional textbook approach is completely inaccurate and that loans are only handled through the stock approach in everyday transactions. Specifically, researchers at the Bank of England have recently emphasized the importance of this stock approach in [2, 2014].

Chapter 5 of the book, however, demonstrates with ASD macroeconomic models that these two approaches to the creation of credits are equivalent at

the macroeconomic level, though the stock approach is more realistic at the microeconomic level of transactions. Accordingly, in our research here we have decided to build the ASD macroeconomic model of Japan by the stock approach of credit creation. This approach would be better for handling real financial transactions among banks on which the FFA data are based.

Major changes in building the ASD model by the stock approach take place in the treatment of money stock. Under the textbook (flow) approach, demand deposits and time deposits are not strictly distinguished and all transactions are assumed to be done through the payment of cash. Accordingly, savings are made out of cash and deposited with banks. Under the stock approach, money stock has to be conceptually distinguished among cash (currency outstanding or in circulation), demand deposits, and time deposits. As a result, major transactions are assumed to be made through demand deposits, and savings as time deposits are made out of demand deposits.

3.2 Two Types of Loans

Following the stock approach, it is observed that there are two different types of loan made in the economy. Loans are usually considered to be made by those who have sufficient amount of money or funds to lend out. Under the fraction reserve banking system, however, loans are made out of nothing. The stock approach is introduced to model the dynamics of such credit creation by banks. Loans thus made by banks increase money stock. However, such type of loans are only a part of loans made in real economy. Accordingly, it becomes absolutely necessary to distinguish the following two types of loans in our model development.

Credit-creating Loans by Banks

This type of loans are made by banks under the fractional reserve banking system out of nothing. It leads to the creation of new credits or demand deposits in the economy, thus directly increasing money stock. This type of loans first creates demand deposits both in the balance sheets of banking sectors and non-banking sectors.[2]

Then, newly created deposits are transferred by producers to the households as wage payments, for example, which will then be used for consumption or financial investment, or end up with households savings. Whenever this type of loans are repaid, credits or demand deposits will be destroyed simultaneously. This is one of the most important economic behaviors under the fractional reserve banking system as repeatedly analyzed by monetary reform economists such as Irving Fisher and others in 1930's and 1940's. See, for instance [1]. Followings are examples of such loans made by banks.

[2]Technically speaking, loans receivable are debited and demand deposits are credited in Bank's balance sheet. At the same time, demand deposits are debited and loans payable are credited in Producer's balance sheet. Most of economic transactions in the ASD macroeconomic model are described in this manner, which is in line with double entry bookkeeping rule. For more details, see Chapter 3 of the book[3, 2013]

- Loans made to producers and government.
- Loans made to other financial institutions.
- Loans made to households and sole proprietors.

Non-Credit-creating Loans by Other Financial Institutions

In addition to the loans explained above, there is another type of loans made by other financial institutions than banks. This type of loans requires such institutions to have sufficient funds beforehand or borrow funds from banks or other lenders to make loans. Contrary to the credit creating loans, this type of loans do not directly affect money stock. Followings are examples of such type of loans.

- Loans made by insurance companies.
- Loans made by pension funds.
- Loans made by other financial intermediaries such as securities investment trusts, nonbanks, public financial institutions, financial dealers and brokers, or government social security funds.

3.3 Another Way of Credit Creation

According to the article by the Bank of England[2, 2014], credit creation occurs in addition to bank loans. For example, banking sector usually buys and holds government bonds as part of their portfolio management of liquid assets on their balance sheets. When banks purchase government bonds from non-bank private sector they credit the seller with bank deposits, leading directly to the increase in money stock. This is another important way in which financial investment by banks creates credits out of nothing.

4 Flow of Funds Accounts

The Bank of Japan provides a large amount of financial transaction data for the use of researchers and financial analysts. It is called "The Flow of Funds Accounts" (hereafter called the FFA). It is explained in the Guide to Japan's Flow of Funds Accounts[3] as follows.

> The FFA is based on the System of National Accounts 1993 (the 1993 SNA), a new international standard for national accounts that includes the FFA and Monetary and Financial Statistics Manual (the IMF Manual), compiled by the IMF, to standardize financial statistics. The 1993 SNA and the IMF Manual set the classification

[3]Guide to Japan's Flow of Funds Accounts is available at https://www.boj.or.jp/en/statistics/outline/exp/exsj01.htm/

> criteria for sectors and transaction items that will be common in various countries, which the FFA has basically embraced. Therefore, the FFA conceptually contributes to part of the macro statistic (the SNA) that records a country' s economic activities, and its basic concept of statistics is consistent with that of the national accounts in Japan (p.3).

4.1 Sectors

The FFA is provided in the matrix format. The columns into which economic entities are classified are known as "sectors." They are broadly divided into six sectors (numbered 1 through 6 in the list below), and these sectors are further broken down into sub-sectors. In total there are 45 sectors[4]

Our research has selected 15 sectors and sub-sectors as essential economic players for describing financial transactions in the macroeconomy of Japan. According to the FFA numbering below, they are 1-1, 1-2-1, 1-2-2, 1-3-1, 1-3-2, 1-4-1, 1-4-2, 1-4-3-1, 1-4-3-2, 1-4-4, 2, 3, 3-3, 4, 6.

1. Financial institutions
   - 1-1 Central Bank
   - 1-2 Depository corporations
     - 1-2-1 Banks
     - 1-2-2 Postal Savings
   - 1-3 Insurance and pension funds
     - 1-3-1 Insurance (called here Insurance Companies)
     - 1-3-2 Pension funds
   - 1-4 Other financial intermediaries
     - 1-4-1 Securities investment trusts
     - 1-4-2 Nonbanks
     - 1-4-3 Public financial institutions
       - 1-4-3-1 Fiscal loan fund
       - 1-4-3-2 Government financial institutions
     - 1-4-4 Financial dealers and brokers
2. Non-financial corporations (called here Producers)
   - 2-1 Private non financial corporations
   - 2-2 Public non financial corporations
3. General government

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

3-1 Central government

3-2 Local government

3-3 Social security funds

4. Households

5. Private nonprofit institutions serving households (neglected in our model)

6. Overseas

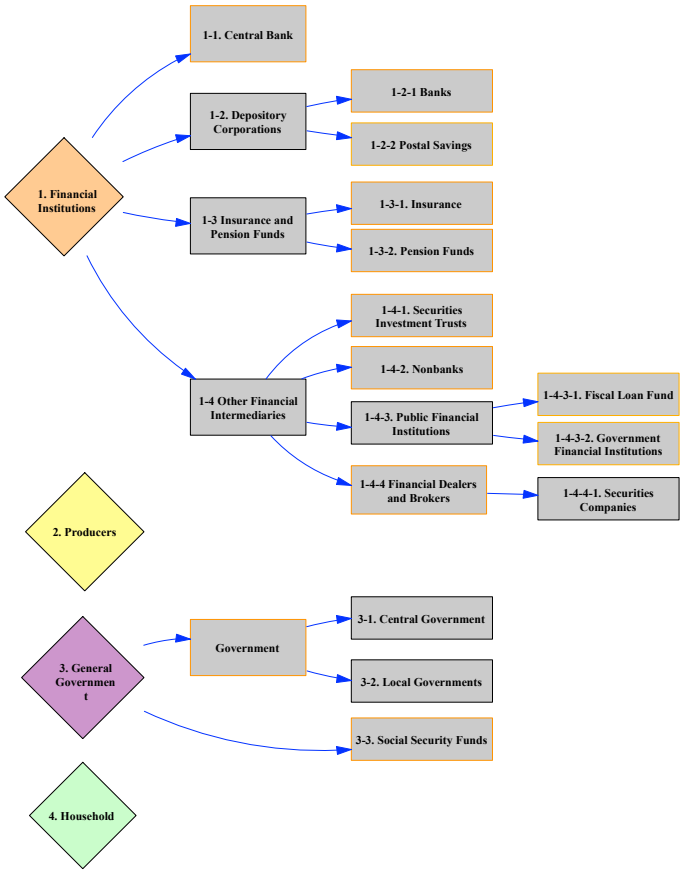

Figure 5: List of Sectors on the Flows of Funds Account

Three remarks may be necessary here. First, a financial sub-sector called "Other financial intermediaries" includes the following in our model: securities investment trusts, nonbanks, fiscal loan fund, government financial institutions, and financial dealers and brokers. Major players of the financial dealers and brokers are securities companies (1-4-4-1). Second, though corporations are

listed above as consisting of private (2-1) and public (2-2) sub-sectors, they are jointly treated as producers (2) in our model. Third, though social security funds(3-3) is part of the general government(3), it is separately treated as an independent sub-sector in the model without losing generality, partly because there are few overlapping transactions with general government(3), and partly because its major sub-sector, known as the Government Pension Investment Fund (GPIF), has been playing an important role recently in the Japanese financial markets. Figure 5 illustrates such financial and government sub-sectors incorporated in the model by orange-shaped boxes.

4.2 Transactions

In the FFA matrix, items in the horizontal lines into which financial instruments (transactions as assets or liabilities) are classified are known as "transaction items." They consist of totaled items such as "A. Currency and deposits", "C. Loans", "D. Securities other than shares", "E. Shares and other equities", and "G. Insurance and pension reserves" etc., and their sub-items.

In total, there are 51 transaction items (matrix rows) in the FFA, among which basic transaction items are 45.

Hence, there are 51 rows (transactions) and 45 columns (sectors) in the FFA matrix, that is, 2,295 matrix cells. Accordingly, time series data from 1980 through 2014 includes total data of 80,325. If it is quarterly data, it contains 321,300 data.

Thus, the Guide to Japan's FFA writes "Such detailed classification allows users to rearrange the classifications in various ways in order to obtain different perspectives of the flow of funds (p. 2)."

To avoid detailed complexities, 23 transaction items are selected as essential for our model. They appear as accounting stock items in assets and liabilities of the balance sheets of the selected 15 sectors. More specifically, they show up under the following names in the balance sheets.

A Currency and deposits

- A-a Currency (renamed here as Cash)
- A-b Deposits with the Bank of Japan (renamed here as Reserves)
- A-c Government deposits
- A-d Transferable deposits (renamed here as Demand deposits)
- A-e Time and Savings deposits (renamed here as Time deposits)

B Deposits with the Fiscal Loan Fund

C Loans

- C-a Bank of Japan loans (renamed here as Central Bank Loan)
- C-d Loans by private financial institutions
  - C-d-a Housing loans

C-d-b Consumer credit

C-d-c Loans to companies and governments

C-e Loans by public financial institutions (of which: C-e-a housing loans)

D Securities other than shares

D-a Treasury discount bills

D-b Central government securities

D-c Local government securities (to be included)

D-d Public corporation securities

D-f Industrial securities

D-i Investment trust beneficiary certificates

E Shares and other equities (renamed here as Capital Stocks)

G Insurance and pension reserves

G-a Insurance reserves

G-b Pension reserves

K Outward direct investment (renamed here as Foreign direct investment Outstanding)

L Outward investment in securities (renamed here as Foreign Financial Investment Outstanding)

So far we have only discussed data in the FFA. For a comprehensive ASD macroeconomic model, of course, more data are called for from government data sources such as national macroeconomic accounts, population as well as labor forces etc. List of various model data sources are presented later in section 7.1.

5 Expanded Financial Transactions

5.1 Financial Transaction of the Original Five Sectors

Integration of additional financial sectors and overseas detailed above has caused expanded financial transactions among the original five sectors of the model (in Chapter 9) to interact one another, simply because all macroeconomic transactions and activities are interrelated one another. Let us briefly describe these transactional changes caused by the integration of financial sectors.

Producers

In the model, imports and exports are treated as exogenously defined flow values. Additionally, following transactions of producers are newly added.

- Producers now raise funds from Financial Dealers and Brokers by selling corporate bonds and issuing new stocks in addition to loans from banks.
- Those newly issued stocks are considered to be traded within sector itself or between different sectors.

Households (previously called Consumers)

Following transactions of households are newly added.

- Households now additionally pay insurance and pensions out of their disposable income.
- They make housing investment for building new houses with loans from banks and other financial institutions.
- They borrow, if necessary, consumer credits from banks and other financial institutions to balance their budgets.
- The remaining incomes after these transactions are saved as time deposits, out of which portfolio investment are made between corporate stocks and treasury securities.
- Retired households also spend on consumption by withdrawing their time deposits.

Government

Following transactions of the government are newly added.

- Government makes public investment in addition to its previous expenditures.
- Government now raises funds by issuing treasury securities and treasury bills to meet its budget.
- In addition to taxes, the government also collects public pensions for social insurance program and pay annuities to households.
- Part of public pension funds all collected from households sector are transferred to social security funds sector.

Banks

Following transactions of banks are newly added.

- Banks now make loans by creating credits (demand deposits) to producers, households (as housing loans, consumer credits loans and loans to companies), financial dealers and brokers, nonbanks, and other financial institutions.
- All transactions with government that are handled by the central bank are now made through excess reserve deposits accounts of banks at the central bank. Some examples of this kind of transaction are, for example, their investment in government securities and treasury bills, and transaction of households when receiving annuities from government.

Central Bank

As already mentioned above, central bank now plays its crucial role in all financial transactions in the economy. That is to say, most of transactions in the model are ultimately processed through central bank. Therefore, central bank works as a financial bridge between private sectors and public sector such as government(3). Accordingly, following transactions are newly added.

- Central bank now handles government transactions, as government's bank, through government's deposit account that is opened at the central bank.
- Central bank now allows "financial dealers and brokers" to open their reserves accounts for their transaction of government securities and so on.
- In addition to its banking functions, central bank also tries to affect interbank rate through changing its policy rate.

The Bank of Japan has historically issued its own stock called "Shussi Shoken" in Japanese, which literally means "Investment Securities" and are similar to corporate capital stocks. They are traded daily in the JASDAQ stock exchange market under the code 8301. This implies that the BOJ is not a government institution. At this stage of our model development, however, their transactions are neglected because the amount of these transactions has no significant effect on our analysis.

5.2 Transactions of Newly Added 10 Sectors

To the original five sectors mentioned above, we have added the following ten more sectors and sub-sectors to our model according to the above FFA classification as follows:

* Postal Savings (1-2-2)
* Insurance Companies (1-3-1)
* Pension Funds(1-3-2)

* Securities Investment Trusts(1-4–1)
* Nonbanks (1-4-2)
* Fiscal Loan Fund (1-4-3-1)
* Government Financial Institutions (1-4-3-2)
* Financial Dealers and Brokers (1-4-4)
* Social Security Funds (3-3)
* Overseas (6)

Postal Savings

Postal Savings sector is listed as part of depository corporations(1-2) in FFA and perhaps a unique sector to Japan. Postal savings refers to the Japan Post Postal Savings Services (former Postal Savings Special Account) that takes in savings deposits and manage investments as postal savings fund. Hence, its basic structure resembles that of banks, though it has more public characteristics. It is reorganized as a private company called the Japan Post Bank in October 2007. Consequently, the data of the "Postal savings" sector are no longer available from the fourth quarter of 2007 due to its sectoral change from Postal Savings to "Financial institutions for small business (1-2-1-4) sub-sector under banks (1-2-1). Major transactions of the postal savings are summarized as follows.

- Postal savings accept savings deposits from households and pay interests accrued.
- Savings are lent out to the Fiscal Loan Fund in the form of entrusted funds or invested in bonds issued by the Fiscal Loan Fund, which are further lent out from the Fiscal Loan Fund to the government financial institutions.
- Postal savings receive interest from the entrusting funds and investment in the Fiscal Loan Fund.

Insurance Companies

Insurance companies sell insurance products and manage investments to wide range of financial products. They are obliged to pay a part of funds as insurance policy. Major transactions of insurance companies are summarized as follows.

- Insurance companies receive insurance policy funds from households, which become asset of households and liability of insurance companies. They are called Insurance reserves.
- These funds are lent out to households and producers, or invested in government securities, corporate bonds, stocks and foreign financial securities.
- Insurance companies receive interest and dividend payments from these financial investments.
- They cover insured policy costs to contractors. At this stage of research, they are assumed to be a constant amount.

Pension Funds

Pension funds are important economic entities in modern economy that invest funds they accumulate from pensions and lump-sum retirement benefits. Examples of this sector includes corporate pensions and other pension funds. It needs to be noted that this pension funds are privately managed funds such as Employees' pension funds and other retirement pension plans, which are different from public social pension funds ultimately administered by the government. Major transactions of pension funds are summarized as follows.

- Pension Funds mainly receive funds from producers who deduct them from their employee incomes. However, in the model, households as employees also make private pension payments to the funds.
- These funds are invested as portfolio investments among government securities, corporate bonds and stocks, foreign financial securities, etc.
- Pension Funds receive interest and dividend payments from these financial investments.
- They pay annuities to the retired households (which are assumed to be a constant value in the model).

Securities Investment Trusts

Securities investment trusts are investment trust management companies that raise funds by issuing investment trust beneficiary certificates. They function as an another type of financial intermediation. Major transactions of securities investment trusts at this stage of research are summarized as follows.

- Securities investment trusts issue investment trust beneficiary certificates and receive funds from investors such as households, insurance companies and pension funds.
- They make investment in foreign financial securities. (At this stage, no revenues are assumed).

Nonbanks

Nonbanks are private institutions that raise funds other than accepting deposits or deposits-like instruments, and make investments through lending. They constitute an important financial sector through which massive amount of liquidity is provided into property markets in Japan (that has led to the formation of property bubble in the 1980's). In the model, their source of funds is through bank loans. Major transactions of nonbank are summarized as follows.

- Nonbanks raise funds by borrowing from banks at interest.
- They lend out these deposits to households in the form of consumer credits and mortgage loans. They also make loans to producers at interest.

- Their main source of income is the interest spreads between bank loans and their lending rate.

Fiscal Loan Fund

Fiscal loan fund raises funds either by issuing Fiscal Investment and Loan Program bonds (FILP bonds) or by accepting entrusted funds from the postal savings and the social security funds (3-3). Specifically, this sector includes the Special Account of Fiscal Investment and Loans Program (Fiscal Loan Program Fund Account). Major transactions of Fiscal Loan Fund are summarized as follows.

- Fiscal Loan Fund issues its bonds and receive funds from the Postal Savings.
- It also receives entrusted funds from the Social Security Funds and Postal Savings at interest (which is not included at this stage).
- It lends out these funds to the Government financial institutions and receive interest. Its interest spreads become its main source of income.

Government Financial Institutions

Government financial institutions are public financial institutions other than the Fiscal Loan Fund. This sector includes, for example, Development Bank of Japan Inc, Japan Finance Corporation and other government-affiliated institutions such as Japan Housing Finance Agency. Major transactions of the government financial institutions are summarized as follows.

- Government financial institutions raise their funds by receiving entrusted fiscal loan funds or by issuing public corporation securities (bonds).
- They lend out these funds to producers and households.
- They receive interest income from these loans.

Financial Dealers and Brokers

According to the above Guide by the BOJ, "Financial dealers and brokers" are defined as institutions that mainly engage in dealing and broking of financial instruments. This sector includes securities companies, money market dealers and Banks' Shareholdings Purchase Corporation. Major transactions of the financial dealers and brokers in the model are summarized as follows.

- Financial dealers underwrite corporate bonds and newly issued stocks, and sell these securities to other sectors.
- They also handle government securities through reserves account at the central bank.

- They receive interests and commissions from the business of these financial securities.
- They borrow from banks in case of the shortage of funds. (At this stage of research, the amount of funds they borrow from banks is assumed to be exogenously determined.)

Social Security Funds

Social security funds receive social insurance such as public pensions collected by the government. They manage a large amount of public pension funds (assumed to be fully collected from households in the model. These funds are then invested as their portfolio management among financial securities. Major transactions of social security fund are summarized as follows.

- Social security funds manage pension funds from households and make investments among treasury securities, corporate stocks, public corporation securities and foreign financial securities.
- They also lend out these funds to the Fiscal Loan Fund.

Overseas

To avoid further complexity of transactions at this stage of research, transactions of overseas are mainly confined to the trades of goods and services, which are exogenously defined in this model. It also needs to be noted that, as a result of foreign direct and financial investment by domestic sectors, a significantly large amount of capital outflows into overseas sector in the model. Transactions of overseas sector are summarized as follows.

- Overseas import and export goods and services from domestic producers.
- They receive funds from domestic sectors as financial investment.

6 Validations of the Model

ASD macroeconomic model at this stage has 179 stocks, 590 Auxiliaries, 44 table functions, 244 data and 374 constants (Total 1431 symbols), many of which are inter-connected through transactions of bank deposits and reserves at the central bank. Accordingly, model validations become crucial before we move to the next stage of development. They are carried out through the following four steps.

Validation 1: Built-in model checks

There are two built-in model checks in Vensim software that is used for this research; that is, Check Model and Check Unit. Our model has cleared these check points.

Validation 2: Balance sheet checks

Throughout the transactions balance sheets of all 15 sectors have to be in balance between total assets, and sum of liabilities and net assets (equities and retained earnings). Our model has cleared these balance sheet (B/S) checks of all sectors.

Validation 3: Flow of funds checks

There are 23 different transaction items in the model. Inter-sectoral sums of these assets and liabilities have to be in balance, transaction by transaction. For example, demand deposits of banks as bank liabilities have to be equal to the sum of all demand deposits among non-bank sectors as their assets. Moreover, reserves of banks at central banks (liabilities) has to be equal to the sum of reserves at banks and reserves of financial dealers and brokers (assets).

As an another example, those newly issued capital stocks, which are treated as net asset item of producers (only producers issue corporate capital stocks in the model) are held by other sectors such as banks, insurance companies and pension funds, etc. at the same time. The sum of all capital stocks being held by them should be in balance with that of capital stocks issued by producers (net asset). (However, only in this case stock market value variation has to be also taken into consideration for the validation).

Our model has cleared all these inter-sectoral flow of funds (FoF) checks.

Validation 4: Model reality checks

Negative values of stocks are tolerated for the model validations discussed above. However, negative values have no real economic senses. Accordingly, our final check is to find out if stocks of asset and liabilities take non-negative values. There are some exceptions, however. For instance, net assets of the government are allowed to take negative values, because it keeps borrowing and its debt level continues to accumulate exponentially. Accordingly, this in turn implies that the government is under the water due to the accumulated debts[5].

Our model has cleared these reality checks.

Remarks on the System Boundary

Our ASD macroeconomic model has 374 constant values. In system dynamics they represent system boundaries of the model. Among those boundaries, the most essential boundary is trades of goods and services with overseas. Real data of imports and exports are used in the model. In addition, quite a few stock data among financial sectors are used as *variable data* at this stage of development.

[5]As a matter of fact, only the government is allowed to run under water, because it has to be the last borrower to provide the enough money stock under the current fractional reserve banking system. This causes a fundamental inconsistencies of system design of our current debt money system.

These boundaries will be removed one by one as our model construction proceeds in the future.

7 Getting Data into the Model

7.1 Data Inconsistencies

Our second stage of this research is to get macroeconomic data as reference data and/or variable data not only from the FFA but also from the SNA macroeconomic database as well as population data from the government statistics office. Various data sources utilized in this research are listed as follows:

- Flow of Funds Accounts developed by Bank of Japan
  (http://www.boj.or.jp/statistics/sj/index.htm/)
- Annual Report on National Accounts by Cabinet Office, Government of Japan
  (http://www.esri.cao.go.jp/jp/sna/data/)
- Economic data released by Ministry of Finance
  (http://www.mof.go.jp/statistics/)
- Population data available from Ministry of Internal Affairs and Communications
  (http://www.stat.go.jp/data/jinsui/)

The ASD model has to utilize various economic and social data discussed above. It tuned out that there are no complete sets of macro economic data of sectoral balance sheets that have both financial and real stock values in a uniformed framework.

Accordingly, it becomes necessary to integrate financial date from the Flow of Funds Accounts, real economic data from the National Accounts consisting of major macroeconomic data such as GDP, detailed Social Transfers, as well as government statistics data including debts data from the Ministry of Finance Statistics.

As a result, we have encountered difficulties of data inconsistencies. An example of such data inconsistencies has appeared from the data on Capital (PP & E) when we tried to estimate macroeconomic production function. Capital stock data from the SNA accounts differed between 2000 base and 2005 base, as well as the capital stock data we have calculated by their flow (investment) data from the same SNA data. In this case, we have decided to use the capital stock data based on our integration of their flow data.

The other example of data inconsistencies occurred among the money stock data by the BOJ. Original time series data available from BOJ consists of 3 different periods. Thus we have combined those original data into one continuous money stock data.

7.2 Limitations of Net Flow of Funds

The Flow of Funds data by the Bank of Japan provides us with important economic information for our research. Yet, there are serious limitations when applied to our modeling approach. Specifically, data for financial transactions are provided as stock values and their net flows, simply because net flows are calculated as the differences between this year's stock values and those of previous year.

This method of calculation result in two difficulties in constructing the ASD model. First, exactly the same stock values can be produced by the same net flows, but by the different combinations of inflows and outflows. For instance, in Figure 6, the same net flows of revenues (lines 3) are shown to produce the same convex-shaped stock values of retained earnings that increase first, then decrease later (lines 4). These same stock behaviors, however, can be caused either by decreasing inflow of revenues (line 1) with constant outflows of costs (line 2) in the left-hand diagram, or by constant inflow of revenues (line 1) and increasing outflow of costs (line 2) in the right-hand diagram.

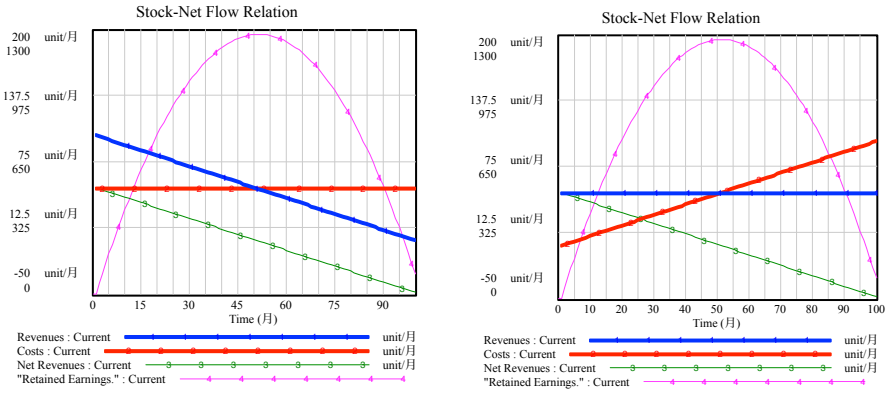

Figure 6: Limitations of Net Flow Analysis

Accordingly, if these net flows are calculated from the same stock values, they become exactly the same, and it becomes impossible to identify the real causes of the increasing-then-decrease behaviors of the retained earnings (stock values) just by observing the same net flow values of data per se. Without knowing real causes that produce the convex shape of retained earnings, no effective policies can be suggested to prevent the decrease in the retained earnings; that is, whether to stop decreasing revenues or to stop increasing costs.

Second, stock values in the FFA are calculated from financial statements or balance sheets of all related sectors. According to this nature of data calculation, no data of inflows and outflows of each financial transactions are difficult to be identified. Moreover, it is almost impossible from publicly available data to identify where transaction funds come from as inflows and where to go out as

outflows. For instance, bank loans are made to several sectors and repaid by several sectors. Each sector has different historical behaviors in terms of inflow and outflow. Thus, stock and net flow data on the bank loans are insufficient to identify sectoral inflows of loans and those of outflows.

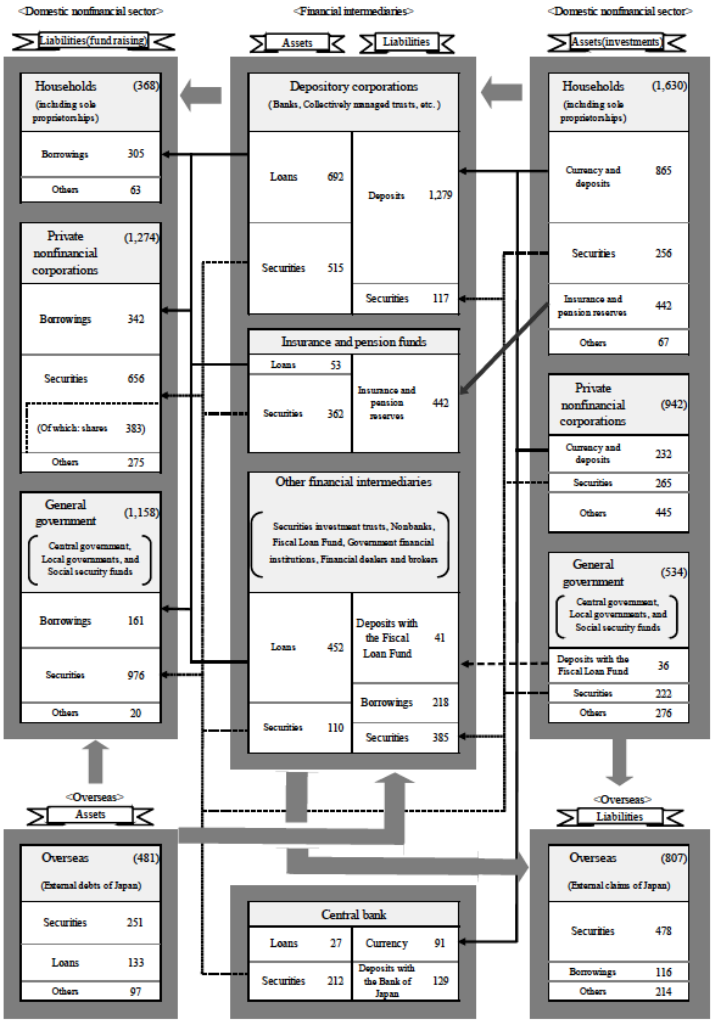

Figure 7: Financial Assets and Liabilities by Sector, p.5 (March 2014), BOJ

Figure 7 from the Guide of the FFA demonstrates how the Bank of Japan struggles to illustrate the flow of funds among major sectors and sub-sectors by using sectoral balance sheets of assets and liabilities. It reveals the limitation of the FFA data for explaining inflows and outflows of funds among sectors.

These limitations have become serious obstacles for modeling financial trans-

actions with stock and flow structure of system dynamics. Therefore, it has been a very painful process for our research to overcome these limitations and connect all inflows and outflows of transactions among 15 sectors. We have tried to connect them according to our rational reasoning and behavioral assumptions of economic sectors. These connections have successfully completed the second stage of our model development.

7.3 Hidden Manipulation of Special Taxes Revealed

Whenever government budget is discussed in Japan, it usually refers to the general government budget publicized by the Ministry of Finance. For instance, tax revenues in 2014 were 54.6 trillion yen, and government expenditures were 72.6 trillion yen, resulting in the primary balance deficit of 18 trillion yen. Accordingly, the government is forced to borrow 41.3 trillion yen, including debt repayment and interest. These figures on government budget are the ones repeatedly covered by media and macroeconomic textbook.

Yet, in reality the government levies more taxes under the name of Special Taxes, which has been cunningly hidden from the public eyes and budgetary discussions on the Diet. For instance, in addition to the income and consumptions taxes that show up in the general budget, Japanese households have been forced to pay special taxes such as automobile taxes, airport taxes, highway taxes, etc.

In fact, according to the data from the Ministry of Finance, government revenues in 2012 were 376 trillion yen, while its expenditures were 332 trillion yen, attaining 44 trillion yen surplus. These data have been hidden from the above government's general income reports . Accordingly, special taxes have never been examined and debated openly on the Diet, nor paid attention by the public. In other words, those taxes have been privatized by the government' bureaucrats as if they are special budgets for their own private use.

Among the developed OECD countries, Japan is the only country, to the best of our knowledge, which adopts such a dual taxation and budget system. This hidden tax system which has accumulated hidden surplus has been deceiving the public as if the government is suffering from deficit every year. From the system's points of view, such dual tax system has to be either abolished or reformed drastically to attain the efficiencies and openness of public policies in Japan.

It turned out that the ASD macroeconomic model cannot attain data consistencies of the macroeconomic behaviors unless it integrates both general and special taxes. Without bringing the role of these hidden special taxes to the surface, data consistencies of our model has never been attained. In this sense, the ASD model has revealed the hidden role of special taxes at the macroeconomic level. It advocates the integrated and more effective use of budgets by the government. The government will no longer be allowed to hide special tax revenues behind the screen in the face of the accumulating debts.

8 Behaviors of Data as System Design Failures

8.1 Five System Design Failures

With the imported data in our model, we are now in a position to observe macroeconomic behaviors such as GDP (line)1, M_0 (line 2), M_1 (line 3) and debts by banks (line 4), by producers (line 5) and by government (line 6), as illustrated in Figure 8, with an expectation that these data analyses may help understand why Japanese economy has been trapped into the so-called "Lost Two Decades" since early 1990s.

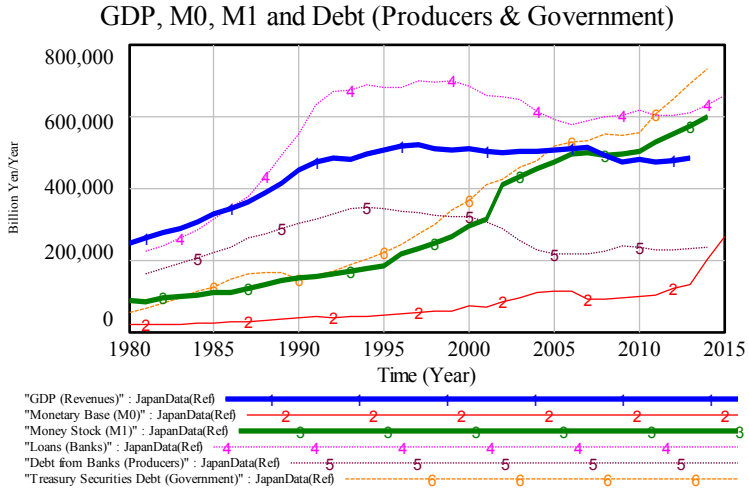

Figure 8: Japanese Bubble and Burst followed by Lost Two Decades

From the observation of these data, we have identified five abnormal macroeconomic behaviors of Japanese economy as system design failures of the current debt money. In section 1, we have already pointed out two fundamental system design failures, that is, monetary instability and government debts, caused by the current debt money system. They are the ones originally indicated by Fisher [1], etc. in 1930s after the Great Depression in 1929.

These five system design failures are illustrated in Figure 9, out of which two of them numbered (1) and (3) may overlap the two fundamental system design failures pointed out by Fisher, etc. The remaining failures supplement them. Let us now discuss them one by one.

8.2 System Design Failure 1: Bank Loans $\rightsquigarrow M_1$

The first system design failure claims that the current debt money system triggers economic bubbles and bursts repeatedly, as briefly discussed in Figure 1. Bubbles are caused by excessive loans (credits out of nothing) by banks, fol-

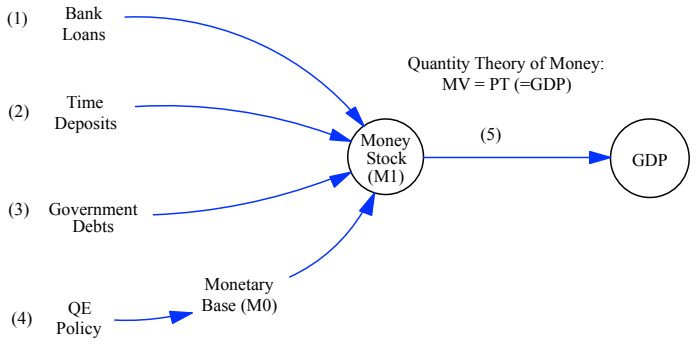

Figure 9: Five System Design Failures

lowed by an increase in money stock M_1. Their bursts destroy M1 due to the forced repayment of loans (credits), causing economic recessions. Having faced with the Great Depressions in 1929, Irving Fisher [1] demonstrated that these economic booms and recessions are caused by the fractional reserve banking system.

Line 4 in Figure 8 represents total amount of loans (or credits) by banks, while line 5 represents debts of producers from banks. They began to increase swiftly in late 80s and suddenly stop in early 90s, then collapse in late 90s. They illustrates how quickly bank loans have contracted during the middle of 1990s just after the bubbles burst. Even today, Japanese economy is suffering from these collapses.

Meanwhile, money stock M_1 is illustrated by bold line 3[6]. It has been constantly increasing. If Fisher's above observation were correct, money stock M_1 in Japan would have also collapsed after the bubbles burst, causing rapid decline in GDP.

The relations between bank loans, producer debts and money stock M_1 are illustrated as phase diagrams in Figure 10. Under the debt money system, money stock is created out of nothing when banks make loans, and destroyed when loans are repaid. This instability of M_1 has been the root cause of economic booms and recessions as pointed out by Fisher, etc. In the above phase diagrams, these relations are represented by the upward-sloping lines. That is to say, whenever banks make loans by creating credits out of nothing, M_1 increases simultaneously, and vise versa. This instability of M_1 caused by bank loans is itself the most serious system design failure under the debt money system.

However, when bubbles in Japan popped in early 1990s, and bank loans and producer debts began to collapse, M_1 didn't decline as expected by the monetary

[6]A sudden increase in M_1 around 2004 shows that some discrepancies of monetary data have been adjusted around that time mainly due to the privatization of Japan Postal Savings as explained in section 5.2.

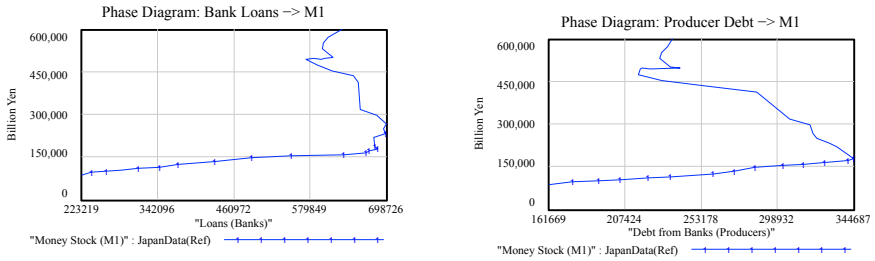

Figure 10: Phase Diagrams of Bank Loans and Producer Debt vs M_1

instability of Fisher, etc. Instead, it began to increase as the downward-sloping lines in Figure 10 indicate. These abnormalities are unexpected behaviors. Why didn't M_1 decrease along the upward-sloping lines as bank loans and producer debts continue to collapse?

8.3 System Design Failure 2: Time Deposits $\rightsquigarrow$ M_1

The answer for increasing M_1 against the decrease in bank loans could be partially found in the behaviors of time deposits. Figure 11 is produced by replacing lines 5 and 6 in Figure 8 with time deposits by banks (line 5)[7] and money stock M_3 (line 6). M_3 is defined as the sum of M_1 and time deposits.

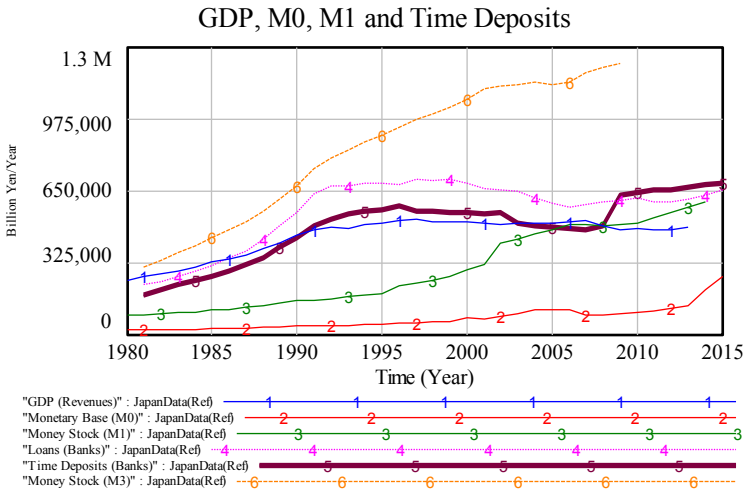

Figure 11: Monetary Base, Money Stock and Time Deposits

[7] A sudden increase in time deposits around 2007 indicates their amalgamation with Japan Postal Savings due to its privatization

In the figure bank loans (line 4) and time deposits (line 5) move in the same direction. This implies that whenever bank loans soar, money stock M_1 also grows, causing households to increase time deposits simultaneously during the normal period.

When bubbles burst, depositors try to withdraw their time deposits to compensate for their lost demand deposits due to the decline in bank loans. This is why time deposits continues to decrease (line 5) along with the collapse of bank loans (line 4). It is additionally observed that total amount of money stock M_3 continues to grow or sustain its level throughout economic depressions.

The relation between time deposits and M_1 can be better presented by the left-hand phase diagram in Figure 12.

During the normal time, this relation is shown as an upward-sloping line. That is, time deposits increases along with the increase in M_1; that is, households save more as more money stock becomes available, and vice versa.

On the other hand, as a steep downward-sloping line implies, households are forced to withdraw their time deposits in order to increase their demand deposits and meet economic difficulties during the recessions after the bubbles popped. Hence, the steep downward-sloping line indicates that, along with the collapse of bank loans, a large amount of time deposits held by banks (mainly by households) were transferred to demand deposits[8]. Withdrawals of time deposits from higher savings in Japan could be indeed said to have contributed to the increase in M_1, which in turn sustained GDP. This abnormal behavior of households in Japan explains why M_1 didn't decrease even though bank loans were repaid and credit crunch is concurrently triggered. In this sense, due to the higher savings the instability of M_1 caused by time deposits, the second system design failure, worked positively in Japan during the abnormal period of economic recessions.

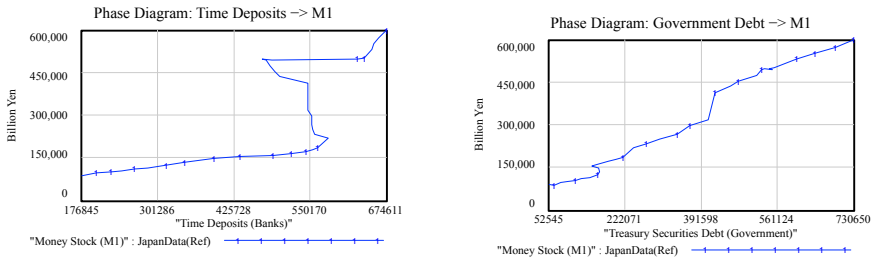

Figure 12: Phase Diagrams of Time Deposits and Government Debt vs M_1

[8] A sudden jump of time deposits after 2008 in data indicates the integration of time deposits by banks sector with the Postal Savings which was privatized by that year.

8.4 System Design Failure 3: Government Debt $\rightsquigarrow M_1$

The withdrawal of time deposits only explain a part of the increase in M_1 against the collapse of bank loans (credits). The main reason for the increase in M_1 could be explained by the increase in government debt. In fact, it has continually increased from 53 trillion yen in 1980 to 730 trillion yen in 2014. According to our simple calculation, it increased by 32.5% annually between 1970 and 1979, by 8.3% between 1980 and 1999, and by 3.3% between 2000 and 2014.

Accordingly, as explained in Figure 1, government debt increases M_1. The relation between treasury securities debt and M_1 can be better illustrated by the upward-sloping line in the right-hand phase diagram in Figure 12. This makes a big difference of monetary behaviors between the Great Depression in 1929 and the Lehman Shock (called the Second Great Depression) in 2008. As a price of this incessant borrowings, government is now facing serious debt crisis. In fact, government debt surpassed GDP in 2005 (Debt-GDP ratio becomes more than 100%), and continues to accumulate at an unstoppable rate. Yet, it failed to stimulate GDP. Accumulation of government debt constitutes the third system design failure in the debt money system.

8.5 System Design Failure 4: $M_0 \rightsquigarrow M_1$

Under the current fractional reserve banking system, someone has to keep borrowing to sustain money stock. Someone could be producers, households or government. As Figure 3 above indicates, producers and households stopped borrowing when bubbles burst. In fact, in the middle of 1990's, loans made by financial institutions to producers began to decrease. Therefore, the government must be the last and the only borrower to sustain the collapsing money stock and economy.

In this way, due to the accumulating borrowing by the government, money stock managed to increase as discussed above, which in turn prevented a decrease in GDP. In comparison, during the Great Depression in early 1930's, money stock shrank rapidly so as to reduce GDP by more than 30% in the US. Without the increasing government debt, GDP in Japan would also have plummeted drastically.

Yet, an increase in M_1 has not been large enough to drive GDP to grow as to be explained below. To increase M_1 furthermore, QE policy of expanding M_0 has been intensively introduced as discussed in section 1. Left-hand phase diagram in Figure 13 shows the relation between monetary base (M_0) and money stock (M_1). Under a normal economic condition, it has an upward-sloping relation as illustrated in the left part of the line. After the bubbles burst, however, the rapid increase in M_0, due to the re-activated QE policy by the Bank of Japan during the last two years from 2013 to the present day, failed to stimulate M_1, This abnormal behavior demonstrates the fourth system design failure in our debt money system.

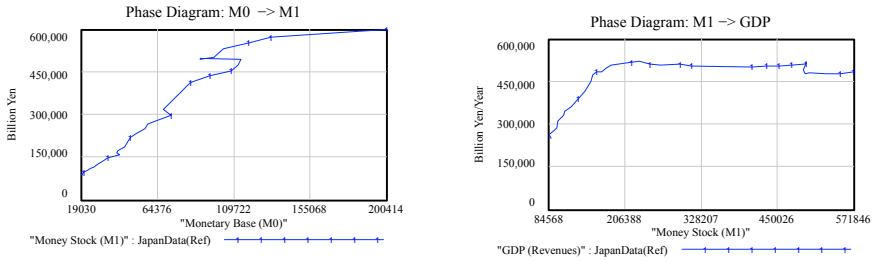

Figure 13: Phase Diagrams of M_0 vs M_1, and M_1 vs GDP

8.6 System Design Failure 5: $M_1 \rightsquigarrow$ GDP

The above QE allegation that the increased M_0 will in due course expand M_1 and stimulate GDP has overlooked a decisive fact shown in Figure 8 that GDP (line 1) stopped growing despite of the increase in M_1 since around 1995. This relation can be better illustrated by the right-hand phase diagram in Figure 13, in which the relation between M_1 and GDP is shown to be upward-sloping for a while, then it becomes flat all of a sudden, though it never got plummeted furthermore under the collapse of credit crunch.

This constitutes the fifth system design failure in the current debt money system. How can the increase in M_1 stimulate GDP, then ?

9 Real Macroeconomic Behaviors

So far our analyses are based on the behaviors of the imported monetary and economic data. Now we are in a position to challenge the question raised above: how can the increase in M_1 stimulate GDP? To answer the question, however, we have to understand system structure of Japanese macroeconomy that relates behaviors of M_1 and GDP. More specifically we have to explore the interdependent relations that affect them, and challenge the related questions posed in section 1. Why did producers stop borrowing even though interest rate (and capital costs) is close to zero? Why did QE policy fail to increase corporate borrowing as well as money stock? These questions continue endlessly toward better solutions by running simulations.

This leads us to the third stage of development; that is, a process of model optimization with real economic data. Figures presented below show some of our successful optimization results. They are obtained by partial optimization processes of data interpolation. By partial optimization it is meant that only directly related parameters for interpolation variables are picked up to obtain optimum values. Control parameters we have used for optimization are the ones already presented in the generic models in the book [3, 2013]. This may show the robustness of the generic models in the book as base macroeconomic models

of actual economies.

By observing data behaviors of the model, we have realized that our partial optimization could be effectively performed if a structural change in Japanese economy is considered. Accordingly, we have created two categories of parameter values for two structural changes; that is, bubbles and their bursts. Eight figures below show our optimization results for such variables as nominal and real GDPs, price, prime rate, consumption, private investment, population, employed labor and unemployed labor.

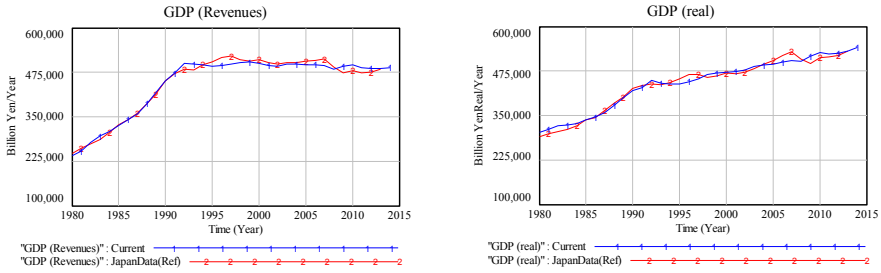

Figure 14: Nominal and Real GDP

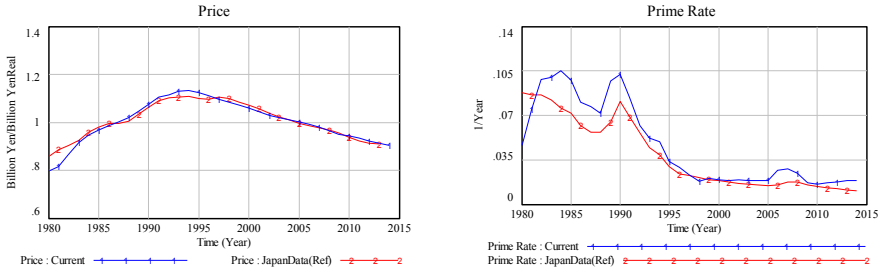

Figure 15: Price and Prime Rate

From these optimization processes, we have found interesting behavioral changes among producers, households and government before and after bubbles burst. Behavioral changes of private investment took place in the year 1990.42, those of consumption took place in the year 1991.75, and finally those of government spending took place in the year 1999.87. Producers are affected first by the burst of bubbles, followed by households about two years later. Finally government is forced to change its spending policy 10 years later after the burst of bubbles. In short, it is observed that there exist some delays among economic sectors for their behavioral changes against the burst of bubbles.

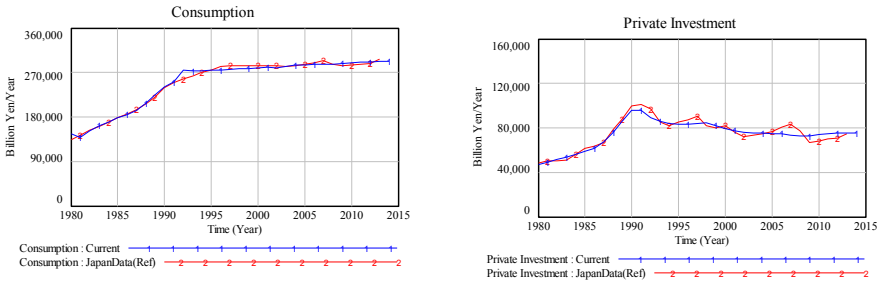

Figure 16: Consumption and Private Investment

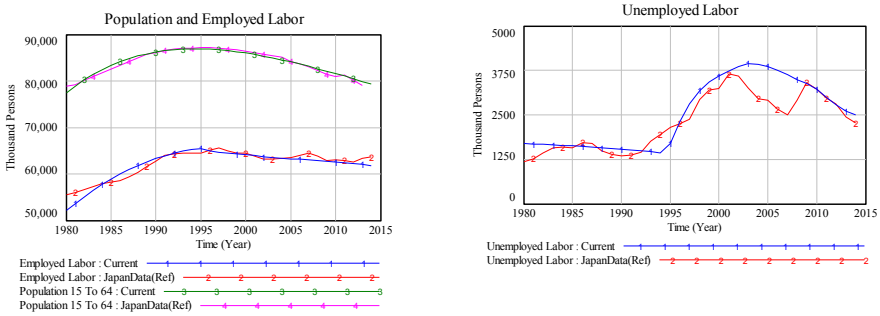

Figure 17: Population, Employed and Unemployed Labor

10 "What if ?" Macroeconomic Behaviors

Sustained Investment and Economic Growth

The ASD macroeconomic model of Japan, if completed, will be able to answer the "What if ?" macroeconomic behavioral questions that have been so far considered impossible in social science. For instance, what would have happened with GDP if the private investment were sustained by the same behaviors of investment activities before the bubbles burst? Line 3 of the left-hand diagram in Figure 18 illustrates such a situation in which private investment levels of producers were sustained. Line 3 in the right-hand diagram then shows how nominal GDP would have increased to about 900 trillion yen, or 80% increase, if producers would have maintained their investment behaviors.

If so, the next question would be, then, "How such investment levels could be sustained? These are challenges we will tackle at our next stage of development.

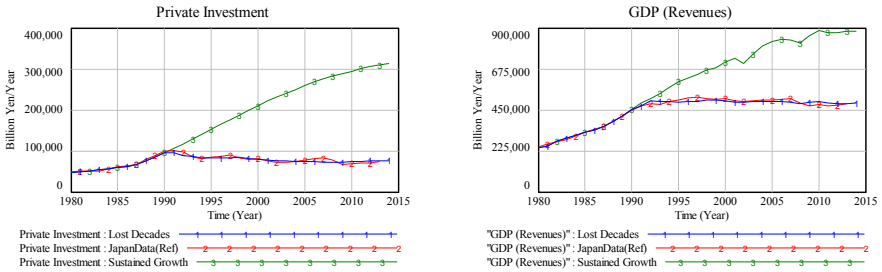

Figure 18: What if? Simulations for Investment and GDP

11 Conclusion

The purpose of this research is to develop a comprehensive ASD macroeconomic model of Japan that incorporates both real and financial sectors. Since this is a huge model-building project, it is broken down into 6 stages. This paper reports its early stage of development from the stage 1 through 3 partially. At the first stage of research, we have developed a basic framework of the model on the basis of accounting system dynamics approach. As a base model, the generic macroeconomic model used in Chapter 9 in the book [3, 2013] is revisited. It has 5 economic sectors. Then, it is extended to 15 sectors with 23 transaction items. Along with these model extensions, four model validation checks are performed

At the second stage, a large amount of data from various sources are imported to the model. Various economic and social data are collected from the Flow of Funds Accounts by the Bank of Japan, SNA data by the government and Ministry of Finance. At this stage we have faced some difficulties caused by data inconsistencies and the nature of flow data as net flows. Then, with the imported data, we have observed macroeconomic behaviors of data and identified five system design failures in our current debt money system.

At the third stage, partial optimization processes are successfully performed for the interpolation of various real macroeconomic variables such as nominal and real GDPs, price, prime rate, consumption, private investment, population, employed labor and unemployed labor.

This paper tries to report our early stage development of ASD macroeconomic model of Japan by focusing on the recent QE policies as an example of system design failures, with a hope that the model, when completed, will reveal our macroeconomic system structures that have caused design failures so that we could draw a better macroeconomic system design.

References

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[3] Kaoru Yamaguchi. *Money and Macroeconomic Dynamics – Accounting System Dynamics Approach*. Japan Futures Research Center, Awaji Island, 2013.

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Appendix: Major Sector Models Illustrated

In this appendix, GDP determination and original 5 sectors are illustrated such as Producers, Households, Government, Banks and Central Bank. And the remaining 10 sectors are not presented here due to the limited page spaces. Readers are referred to the model in the book [3, 2013] to compare how the ASD macroeconomic model of Japan has extended the transactions of the original 5 macroeconomic sectors.

To avoid the complicated spaghetti diagram of crossing flow arrows, in the figures below we have tried to use as many shadow variable as possible and hidden some inessential arrows into the lower depth.

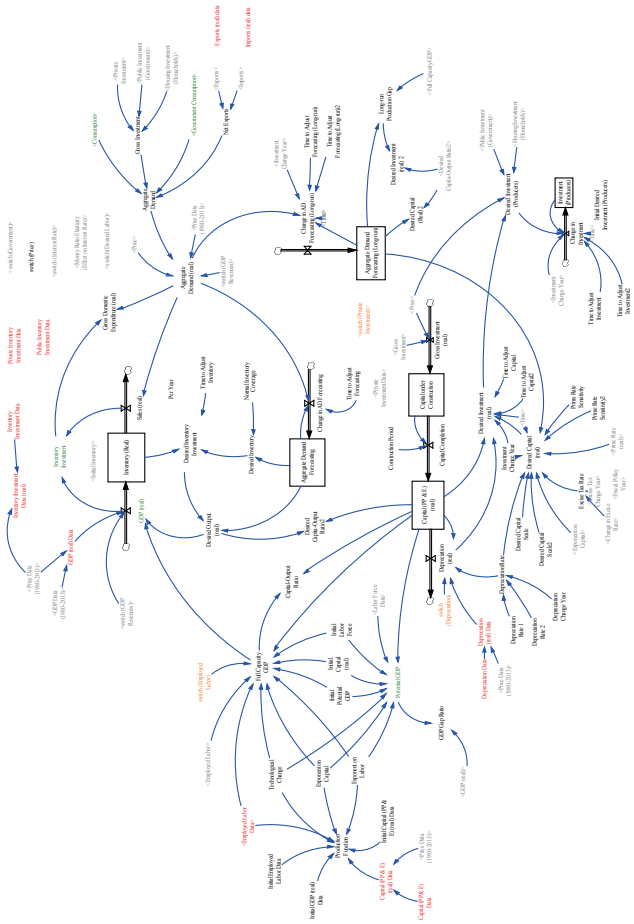

Figure 19: Determination of GDP

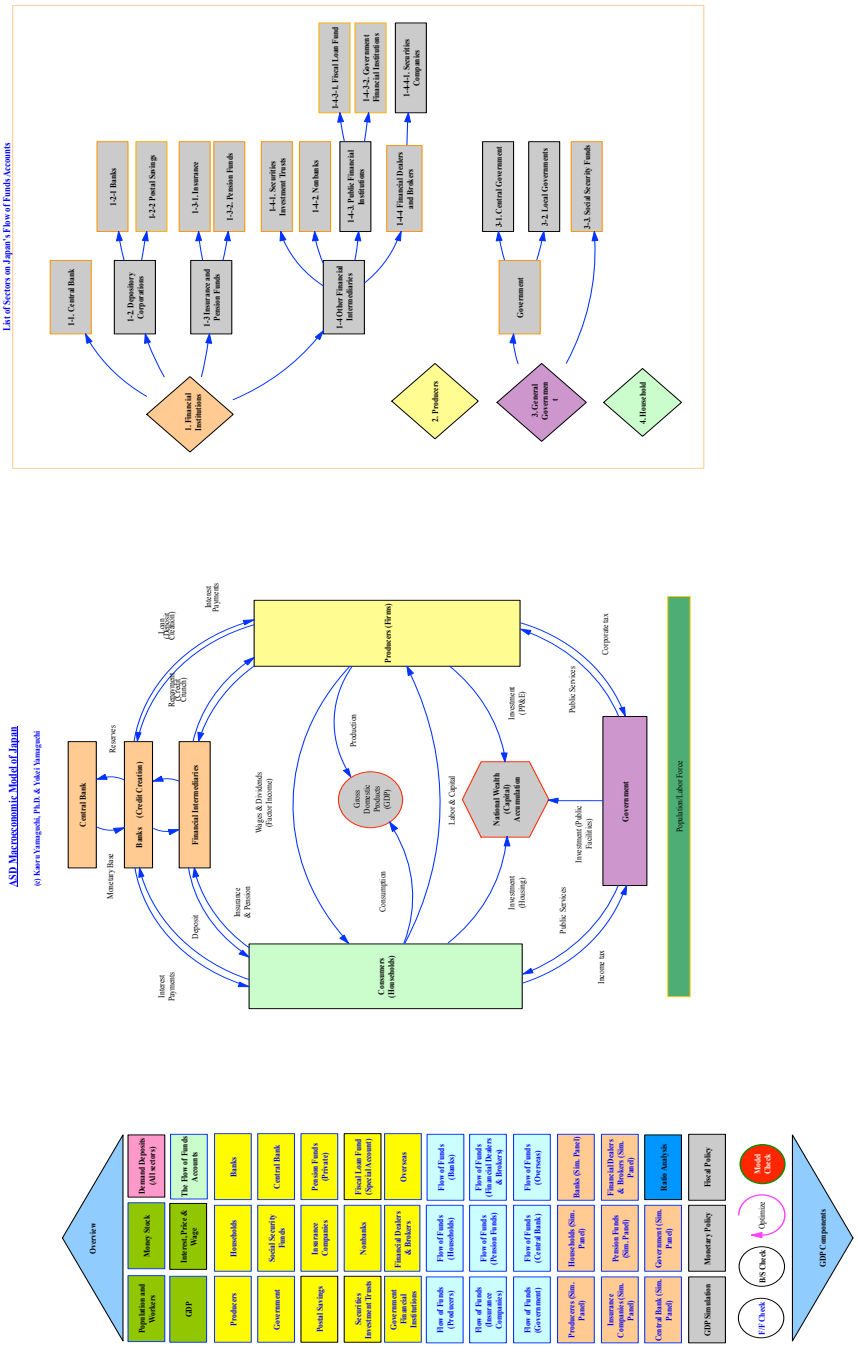

Figure 20: ASD Macroeconomic model of Japan

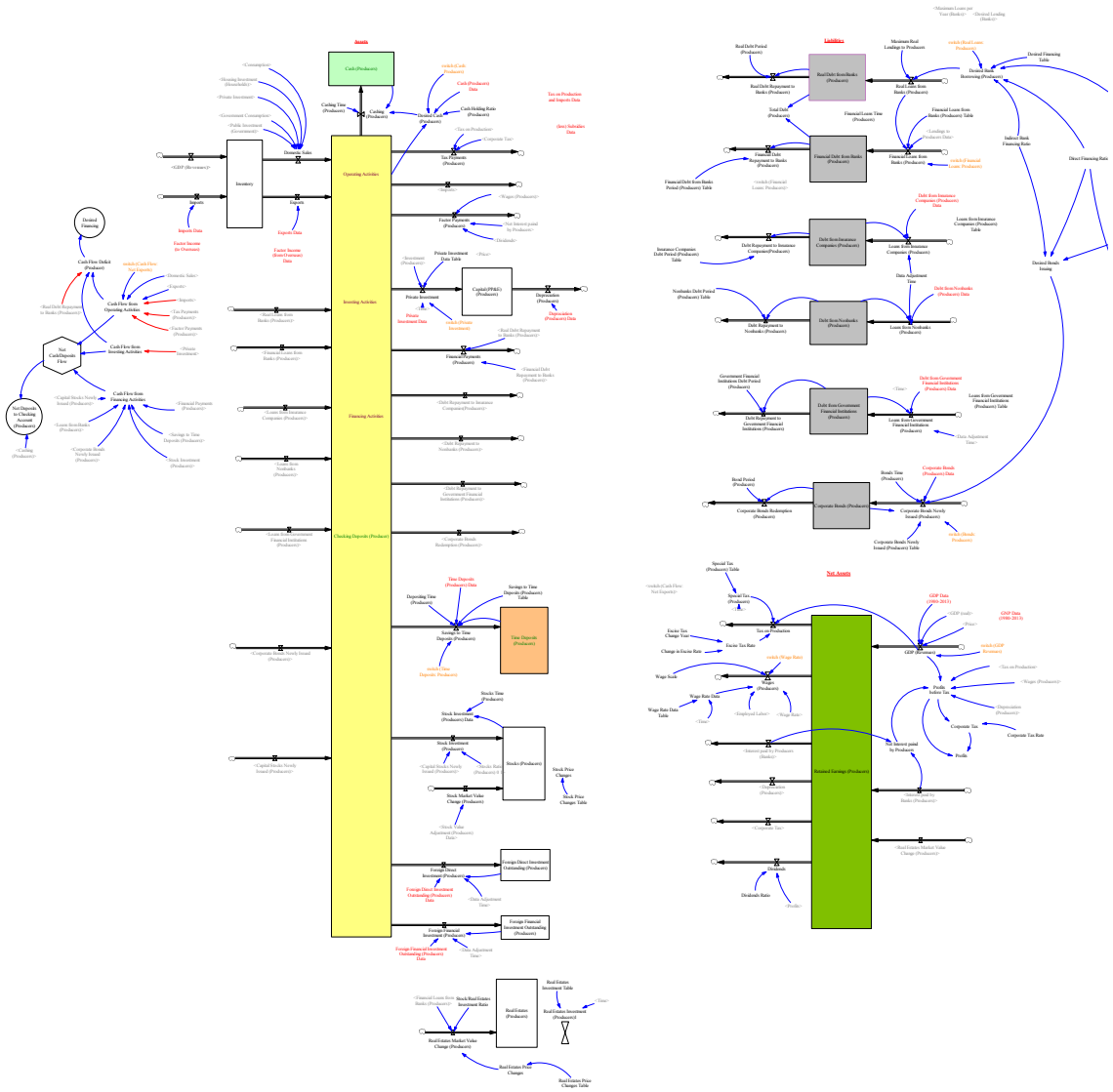

Figure 21: Extended Transactions of Producers

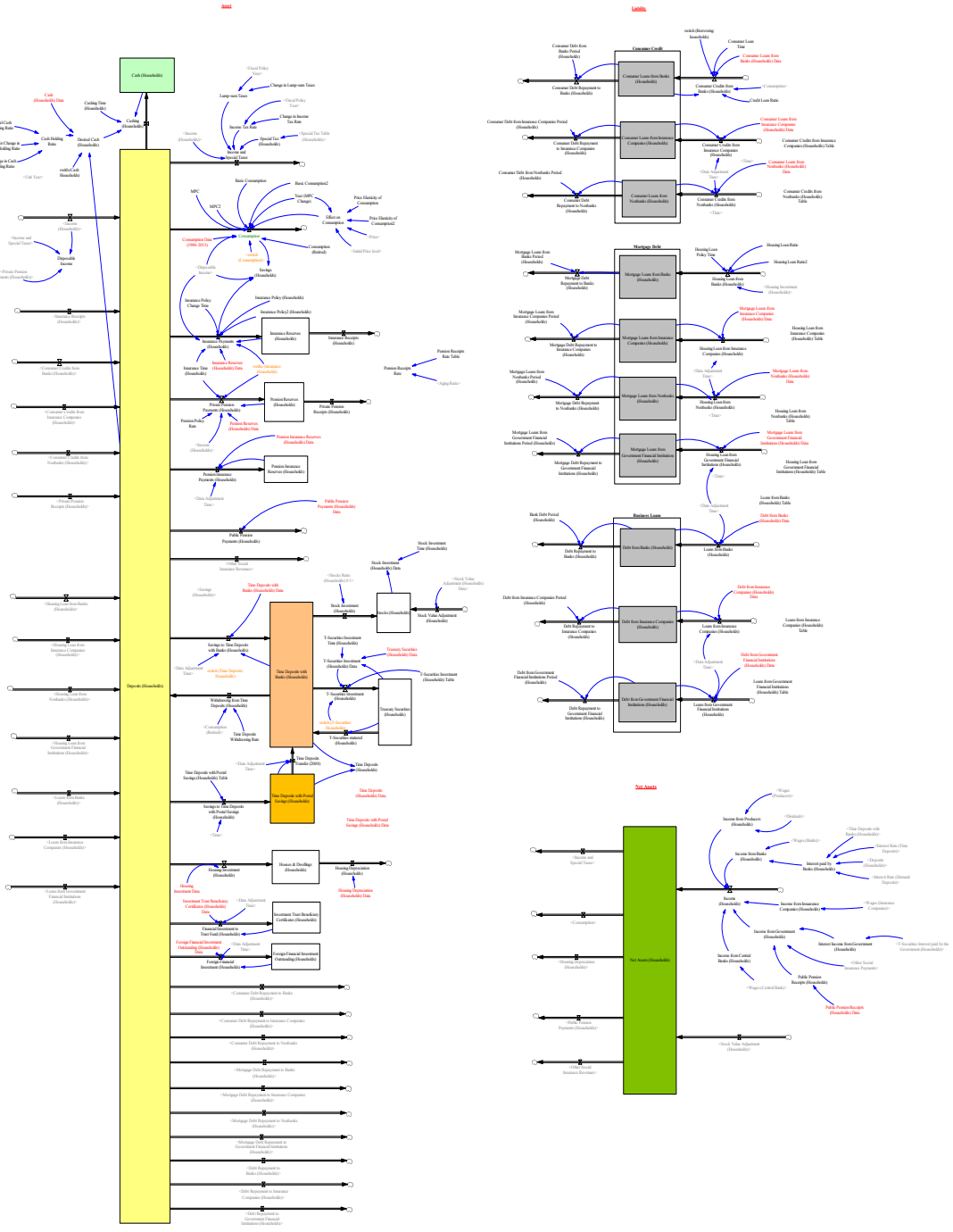

Figure 22: Extended Transactions of Households

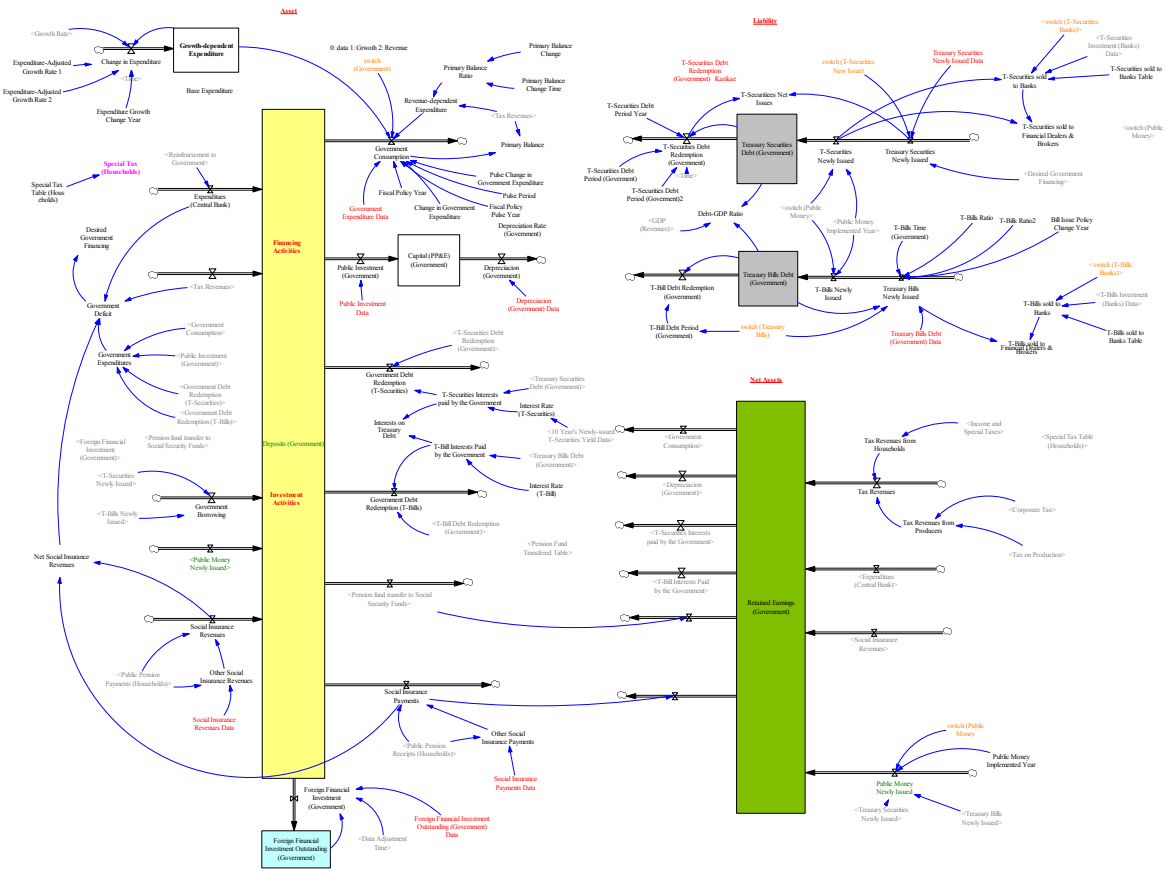

Figure 23: Extended Transactions of Government

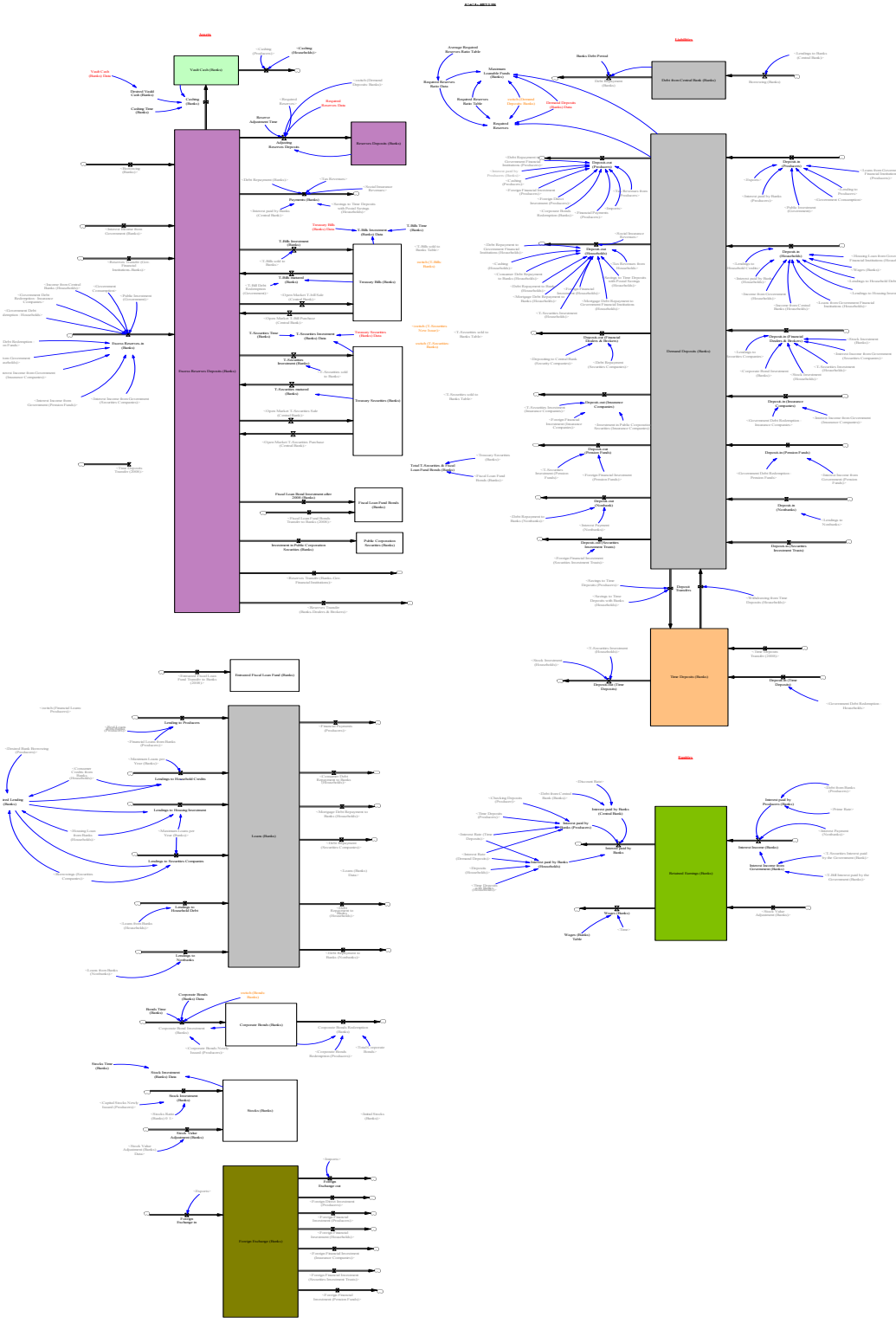

Figure 24: Extended Transactions of Banks

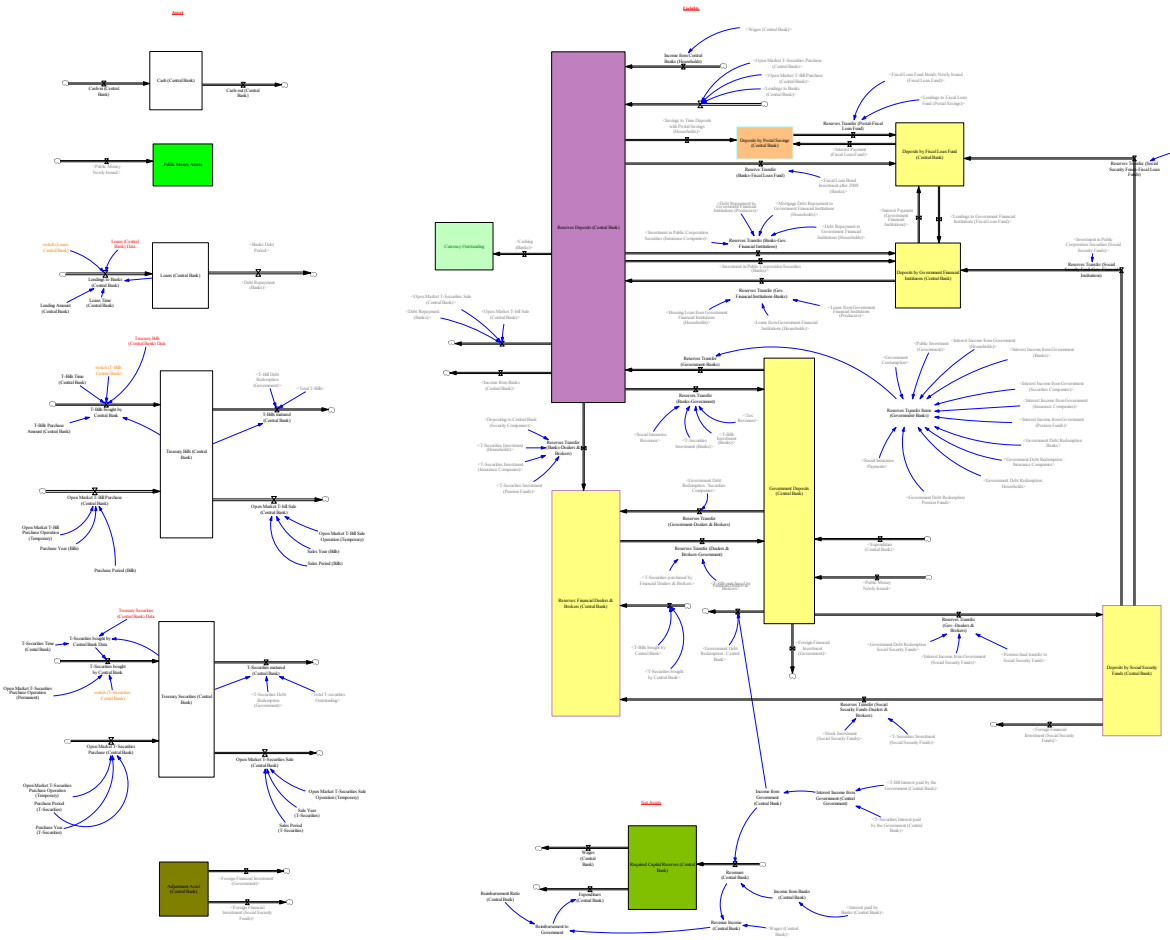

Figure 25: Extended Transactions of Central Bank