

## Chapter 11

# Open Macroeconomies as A Closed System

This chapter<sup>1</sup> expands the comprehensive macroeconomic model in chapter 9 to the open macroeconomies on the basis of the framework developed in the previous chapter. It provides a complete generic model of open macroeconomies as a closed system, consisting of two economies such that a foreign economy becomes an image of a domestic economy. As a demonstration of its analytical capability, a case of credit crunch is examined to show how domestic macroeconomic behaviors influence foreign macroeconomy through trade and financial capital flows.

### 11.1 Open Macroeconomic System Overview

This chapter finalizes our series of macroeconomic modeling on the basis of the principle of accounting system dynamics. Chapters 5 and 6 constructed a model of money supply and its creation process, followed by the introduction of interest rate to the model. Chapter 7 modeled dynamic determination processes of GDP, interest rate and price level. For its analysis four sectors of macroeconomy were introduced such as producers, consumers, banks and government. Chapter 8 and 9 integrated real and monetary sectors that had been analyzed separately in chapters 5, 6 and 7, by adding the central bank, then labor market. Chapter 10 built a model of a dynamic determination of foreign exchange rate in open macroeconomies in which goods and services are freely traded and financial capital flows efficiently for higher returns. For this purpose a new method is applied, contrary to the standard method of dealing with a foreign sector as being adjunct to the domestic macroeconomy; that is, an introduction of another whole macroeconomy as a foreign sector.

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<sup>1</sup>It is based on the paper: Open Macroeconomies as A Closed Economic System – SD Macroeconomic Modeling Completed, which was presented at the 26th International Conference of the System Dynamics Society, Athens, Greece, July 20-24, 2008.

In this chapter, the integrated macroeconomy in chapter 9 is opened to foreign economy through trade and financial capital flows according to the framework developed in the previous chapter. In other words, a complete mirror economy is created as a foreign economy as illustrated in Figure 11.1.

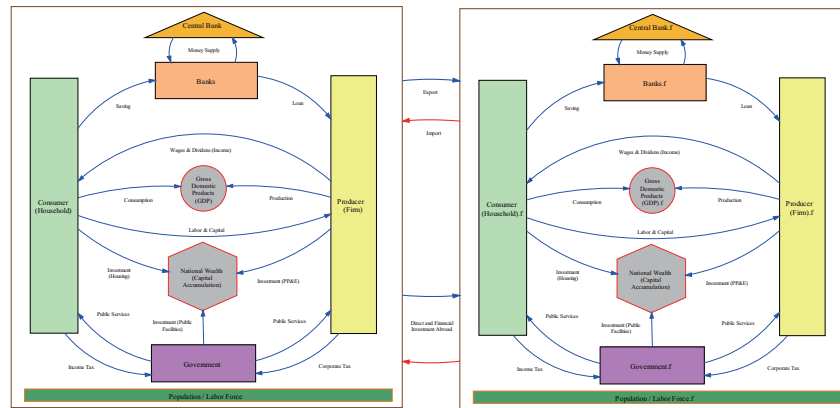


Figure 11.1: Open Macroeconomic System Overview

The only exception is the banking sectors such as commercial and central banks. Specifically, it is assumed that all foreign exchange transactions are done through domestic banks to meet the demand for foreign exchange services by consumers and producers.

## 11.2 Transactions in Open Macroeconomies

We are now in a position to open our integrated macroeconomy to foreign trade and direct and financial investment abroad [Companion Model: MacroDynamics2-5.vpm]. According to our method in the previous chapter, this is nothing but a process of creating another macroeconomy as the image economy of the domestic macroeconomy. All variables of the foreign economy are thus renamed with a suffix of .f; for instance, the foreign GDP is written as GDP.f.

To avoid analytical complication, we have picked up the existing currency units of yen and dollar, among which dollar is assumed to play a role of key currency. We have further assumed that a domestic economy has yen currency, and a foreign economy has dollar currency.

Nominal foreign exchange rate FE (merely called foreign exchange rate here) is now the amount of yen in exchange for one unit of foreign currency; that is, dollar as assumed above, and has a unit of *Yen/Dollar*. At this stage of building a generic open macroeconomy, the initial foreign exchange rate is assumed to be one; that is, one yen is exchanged for one dollar. Foreign exchange rate thus defined does not by all means reflect the ongoing current exchange rate in the real world economy.

Real foreign exchange rate (RFE) is the amount of real goods worth per unit of the equivalent foreign real goods such that

$$RFE = \frac{FE * P_f}{P} \quad (11.1)$$

which has a unit of *YenReal/DollarReal*.

Let us now describe main transactions of the open macroeconomies by producers, consumers, government, banks and the central bank.

### Producers

Main transactions of producers are summarized as follows. They are also illustrated in Figure 11.6 in which stocks of gray color are newly added for open economies.

- 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, including dividends abroad. However, a small portion of profits is allowed to be held as retained earnings.
- Producers are thus constantly in a state of cash flow deficits. To make new investment, therefore, they have to borrow money from banks and pay interest to the banks.
- Producers imports goods and services according to their economic activities, the amount of which is assumed to be a portion of GDP in our model, though actual imports are also assumed to be affected by their demand curves.
- Similarly, their exports are determined by the economic activities of a foreign economy, the amount of which is also assumed to be a portion of foreign GDP.
- Producers are also allowed to make direct investment abroad as a portion of their investment. Investment income from these investment abroad are paid by foreign producers as dividends directly to consumers as owners of assets abroad. Meanwhile, producers are required to pay foreign investment income (returns) as dividends to foreign investors (consumers) according to their foreign financial liabilities.
- Foreign producers are assumed to behave in a similar fashion as a mirror image of domestic producers

## Consumers

Main transactions of consumers are summarized as follows. They are also illustrated in Figure 11.7 in which stocks of gray color are newly added for open economies.

- Sources of consumers' income are their labor supply, financial assets they hold such as bank deposits, shares (including direct assets abroad), and deposits abroad. Hence, consumers receive wages and dividends from producers, interest from banks and government, and direct and financial investment income from abroad.
- 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 disposable income, they spend on consumption. The remaining amount is either spent to purchase government securities or saved.
- Consumers are now allowed to make financial investment abroad out of their financial assets consisting of stocks, bonds and cash. For simplicity, however, their financial investment are assumed to be a portion out of their deposits. Hence, returns from financial investment are uniformly evaluated in terms of deposit returns.
- Consumers now receive direct and financial investment income. Similar investment income are paid to foreign investors by producers and banks. The difference between receipt and payment of those investment income is called income balance. When this amount is added to the GDP revenues, GNP (Gross National Product) is calculated. If capital depreciation is further deducted, the remaining amount is called NNP (Net National Product).
- NNP thus obtained is completely paid out to consumers, consisting of workers and shareholders, as wages to workers and dividends to shareholders, including foreign shareholders.
- Foreign consumers are assumed to behave in a similar fashion as a mirror image of domestic consumers.

## Government

Transactions of the government are illustrated in Figure 11.8, some of which 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 and banks by newly issuing government securities.
- Foreign government is assumed to behave in a similar fashion as a mirror image of domestic government.

## Banks

Main transactions of banks are summarized as follows. They are also illustrated in Figure 11.9 in which stocks of gray color are newly added for open economies.

- Banks receive deposits from consumers and consumers abroad as foreign investors, against which they pay interests.
- They are obliged to deposit a portion of the deposits as the required reserves with the central bank.
- Out of the remaining deposits, loans are made to producers and banks receive interests to which a prime rate is applied.
- If loanable fund is not enough, banks can borrow from the central bank to which discount rate is applied.
- Their retained earnings thus become interest receipts from producers less interest payment to consumers and to the central bank. Positive earnings will be distributed among bank workers as consumers.
- Banks buy and sell foreign exchange at the request of producers, consumers and the central bank.
- Their foreign exchange are held as bank reserves and evaluated in terms of book value. In other words, foreign exchange reserves are not deposited with foreign banks. Thus net gains realized by the changes in foreign exchange rate become part of their retained earnings (or losses).

- Foreign currency (dollars in our model) is assumed to play a role of *key* currency or *vehicle* currency. Accordingly foreign banks need not set up foreign exchange account. This is a point where a mirror image of open macroeconomic symmetry breaks down.

## Central Bank

Main transactions of the central bank are summarized as follows. They are also illustrated in Figure 11.10 in which stocks of gray color are newly added for open economies.

- 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 the public (consumers) and banks. Moreover, it can issue currency by making credit loans to commercial banks. (These activities are sometimes called *money out of nothing*.)
- It can similarly withdraw currencies by selling government securities to the public (consumers) and banks, and through debt redemption by banks.
- 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.
- The central bank can additionally control the amount of money supply through monetary policies such as open market operations and discount rate.
- Another powerful but hidden control method is through its direct influence over the amount of credit loans to banks (known as *window guidance* in Japan.)
- The central bank is allowed to intervene foreign exchange market; that is, it can buy and sell foreign exchange to keep a foreign exchange ratio stable (though this intervention is actually exerted by the Ministry of Finance in Japan, it is regarded as a part of policy by the central bank in our model).
- Foreign exchange reserves held by the central bank is usually reinvested with foreign deposits and foreign government securities, which are, however, not assumed here as inessential.

## Missing Loops Fixed

In the previous chapter five loops below are pointed out as missing. To repeat,

- Imports and exports are assumed to be determined by the economic activities of GDPs, which are in turn affected by the size of trade balance. Yet, they are missing.

- Foreign exchange intervention by the central bank (and the government) such as the purchase or sale of foreign exchange surely changes the amount of currency outstanding and money supply, which in turn must affect an interest rate and a price level. Yet, they are being fixed.
- A change in interest rates affects investment, which in turn determines the level of GDP. Yet, investment is not playing such a role.
- A change in price level must also affect consumption spending and hence real GDP. Yet, these loops are missing.
- Official intervention must influence speculations and estimations on foreign exchange and investment returns among international financial investors. Yet, these fluctuations are only given by outside random normal distribution.

Our open macroeconomies have now successfully augmented these missing feedback loops except the last loop of speculation. Figure 11.2 illustrates newly fixed feedback loops.

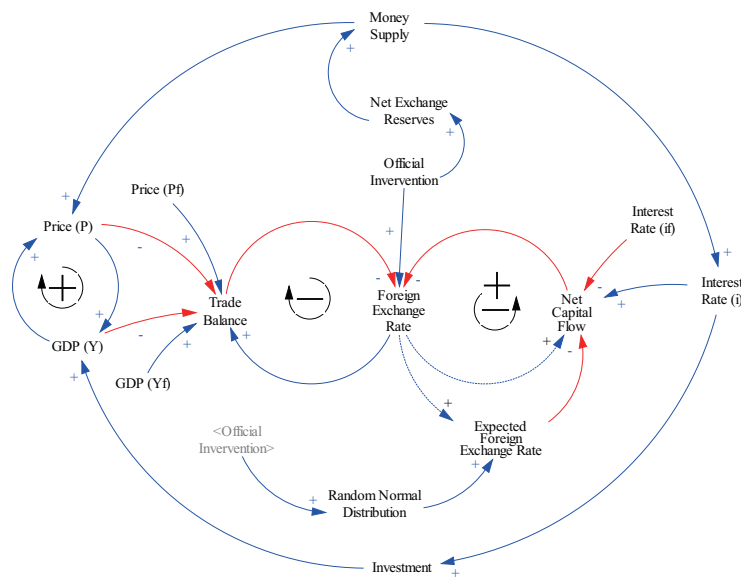


Figure 11.2: Fixed Missing Loops in the Foreign Exchange Dynamics Model

We are now in a position to present our complete open macroeconomic model. Due to the limited spaces, only domestic economic sectors are shown below.

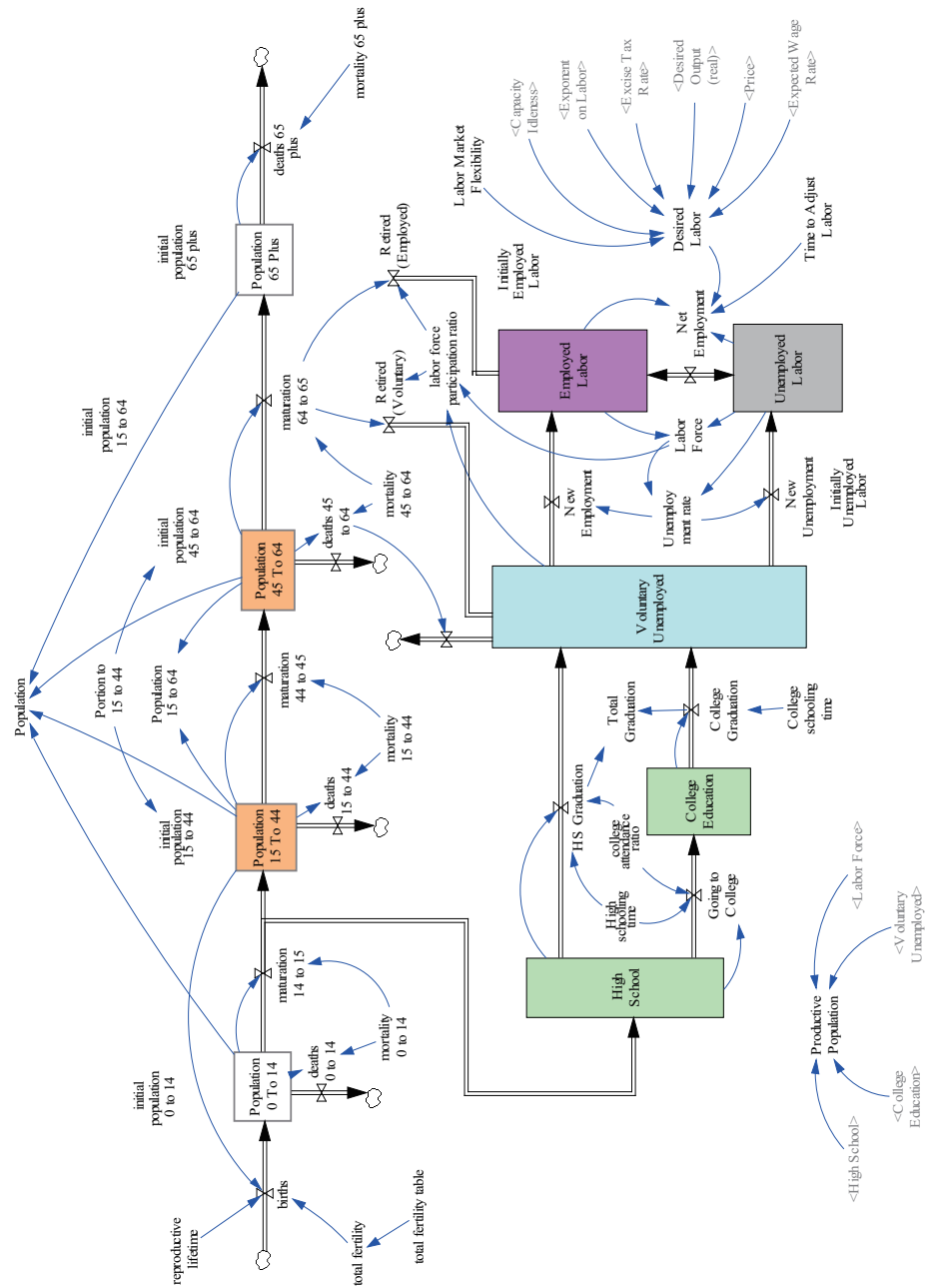


Figure 11.3: Population and Labor Force



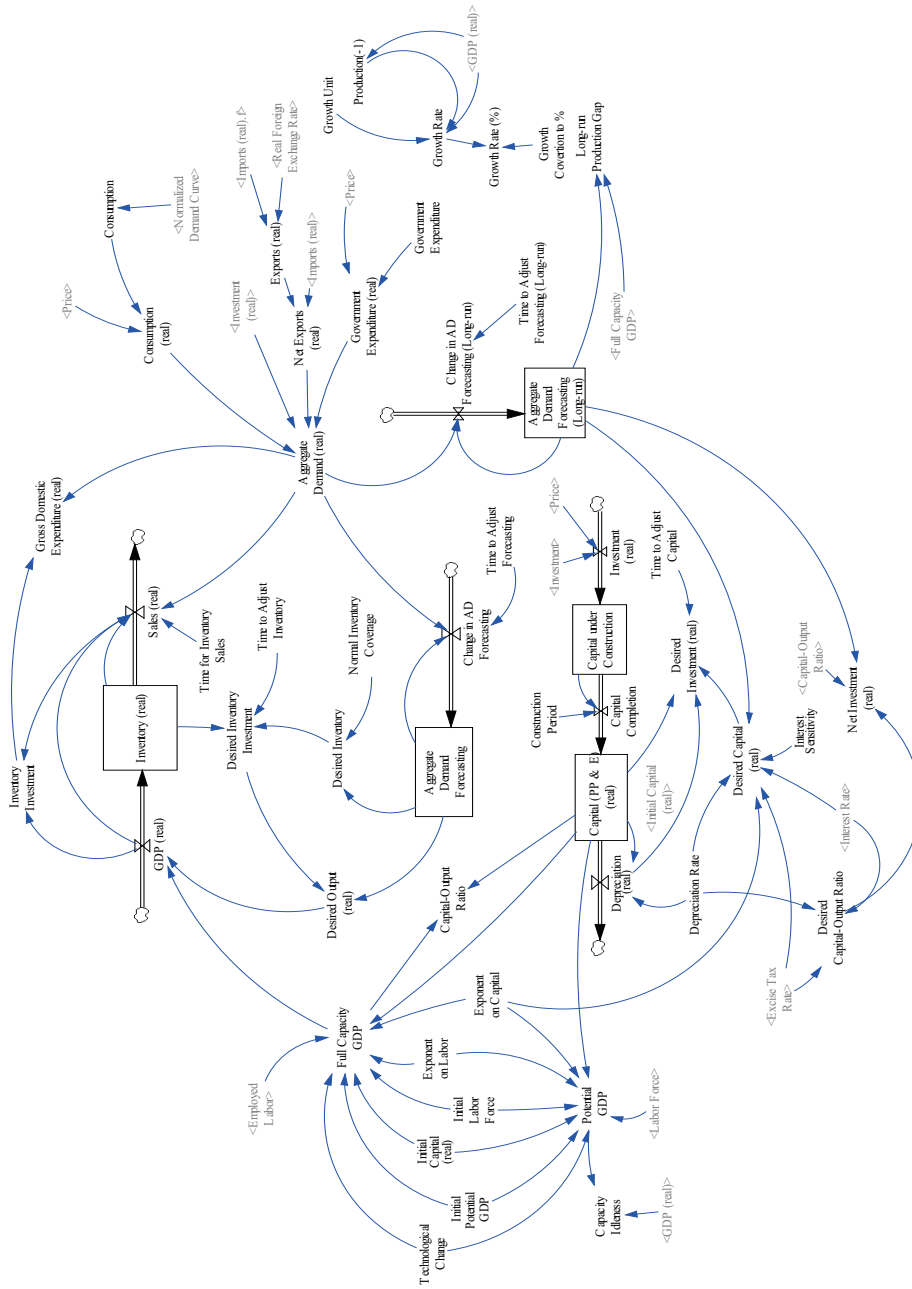


Figure 11.4: GDP Determination

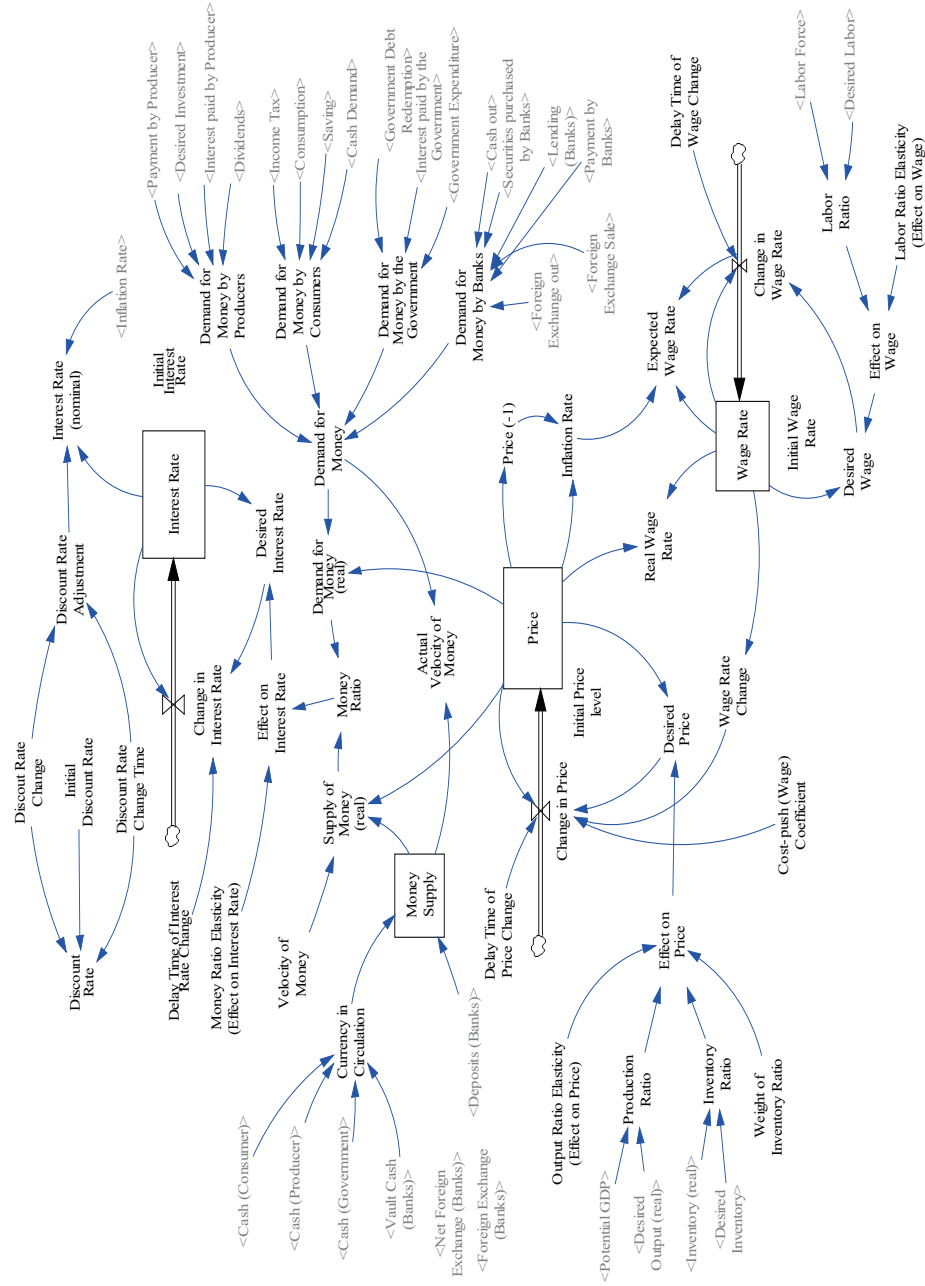


Figure 11.5: Interest Rate, Price and Wage Rate

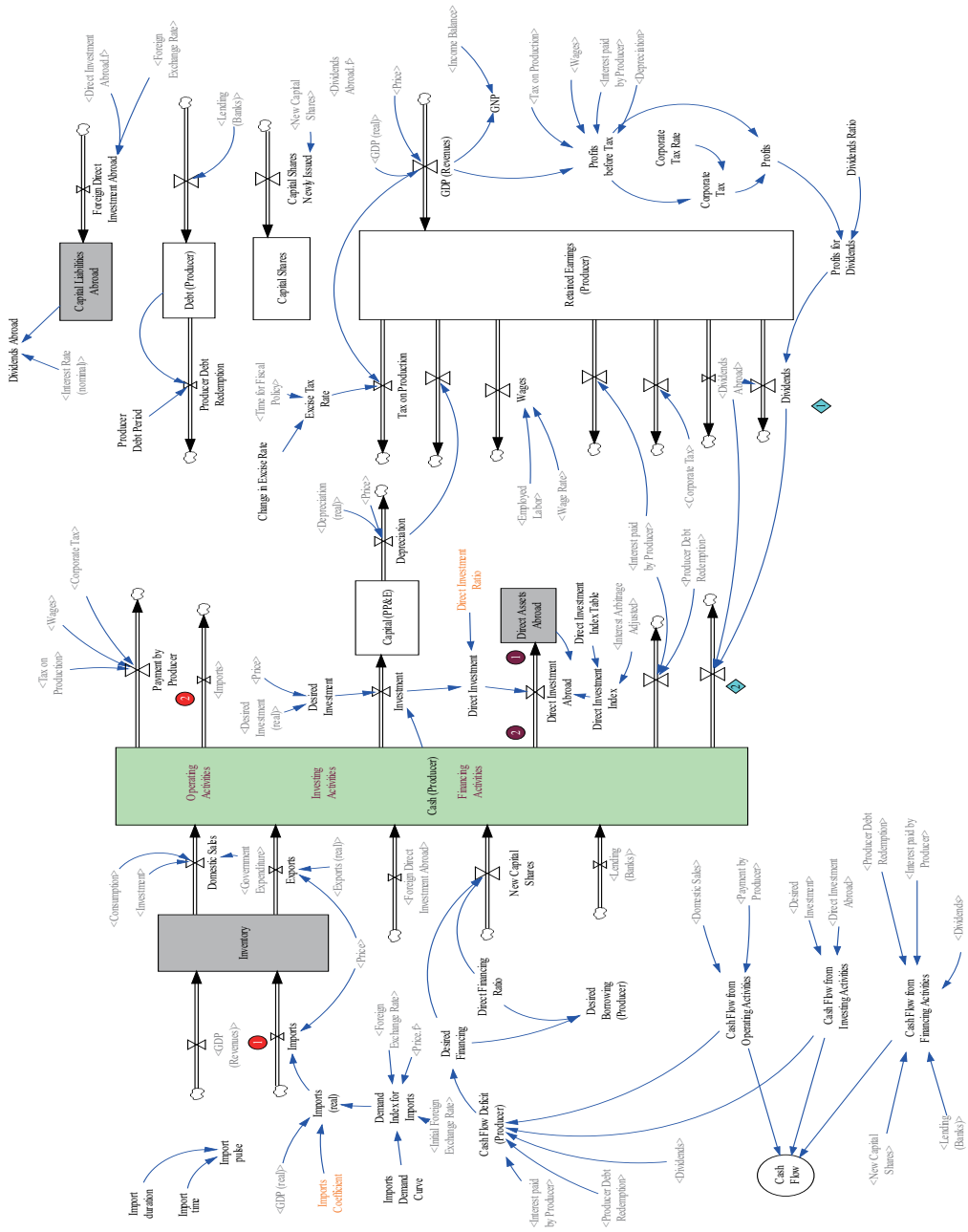


Figure 11.6: Transactions of Producers



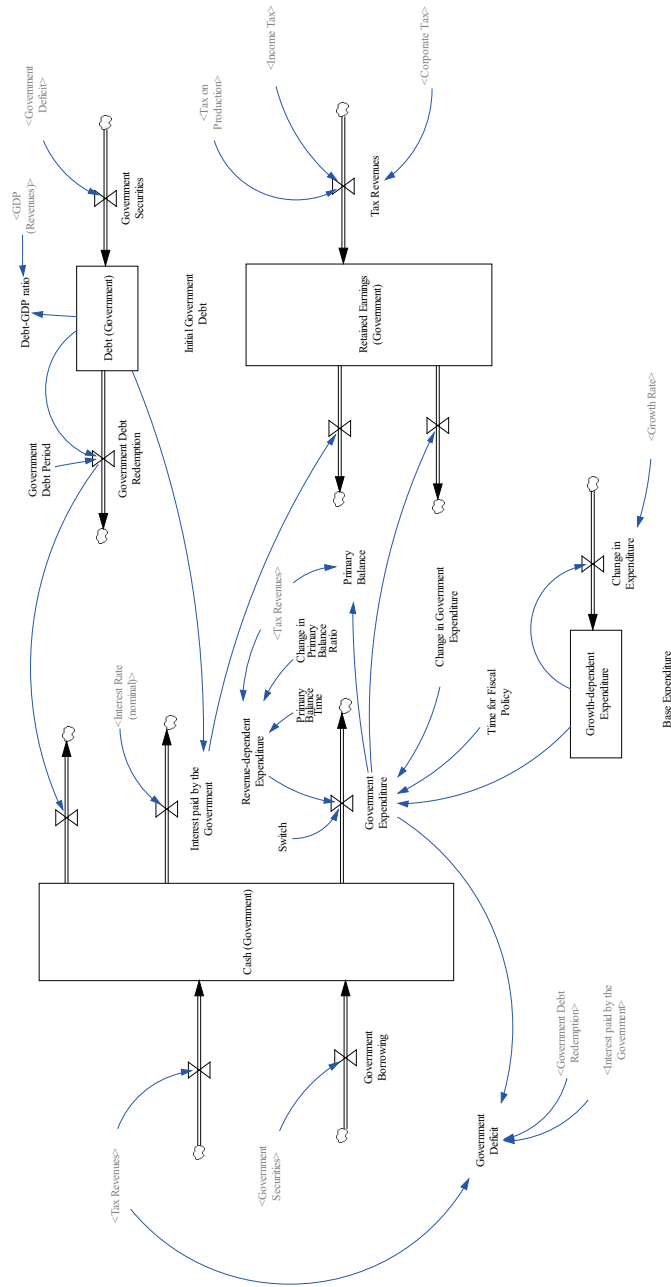


Figure 11.8: Transactions of Government

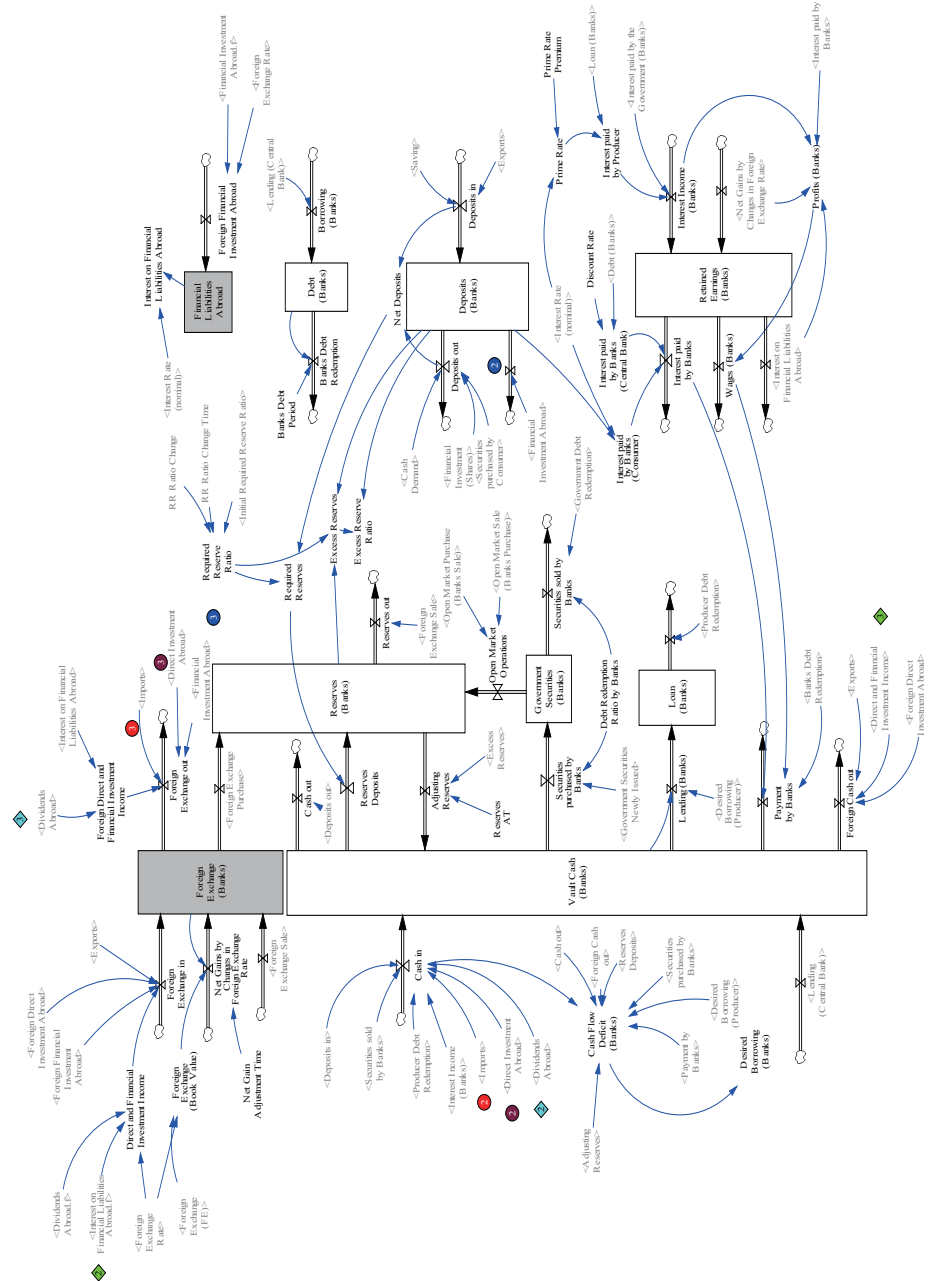


Figure 11.9: Transactions of Banks



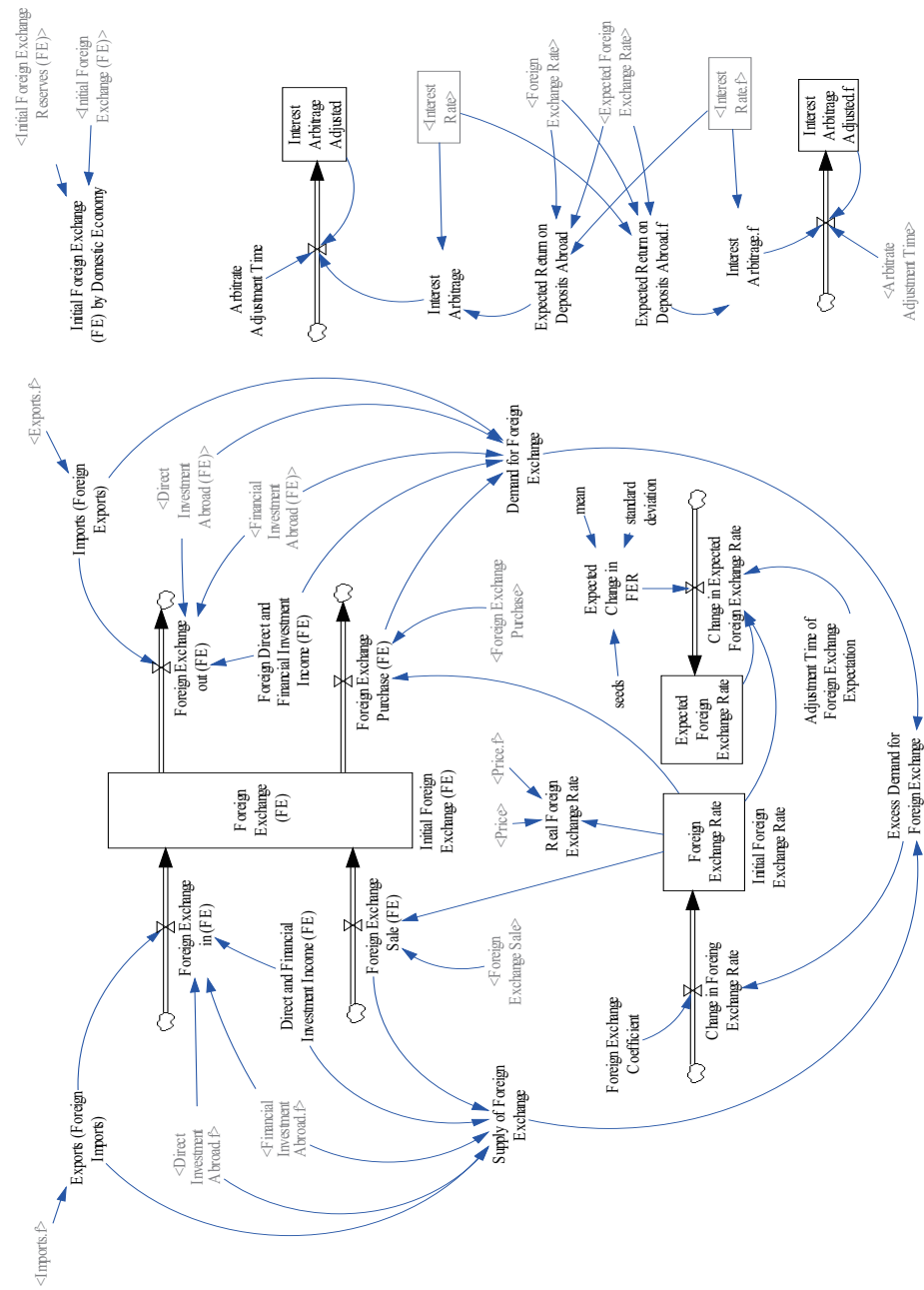


Figure 11.11: Foreign Exchange Market



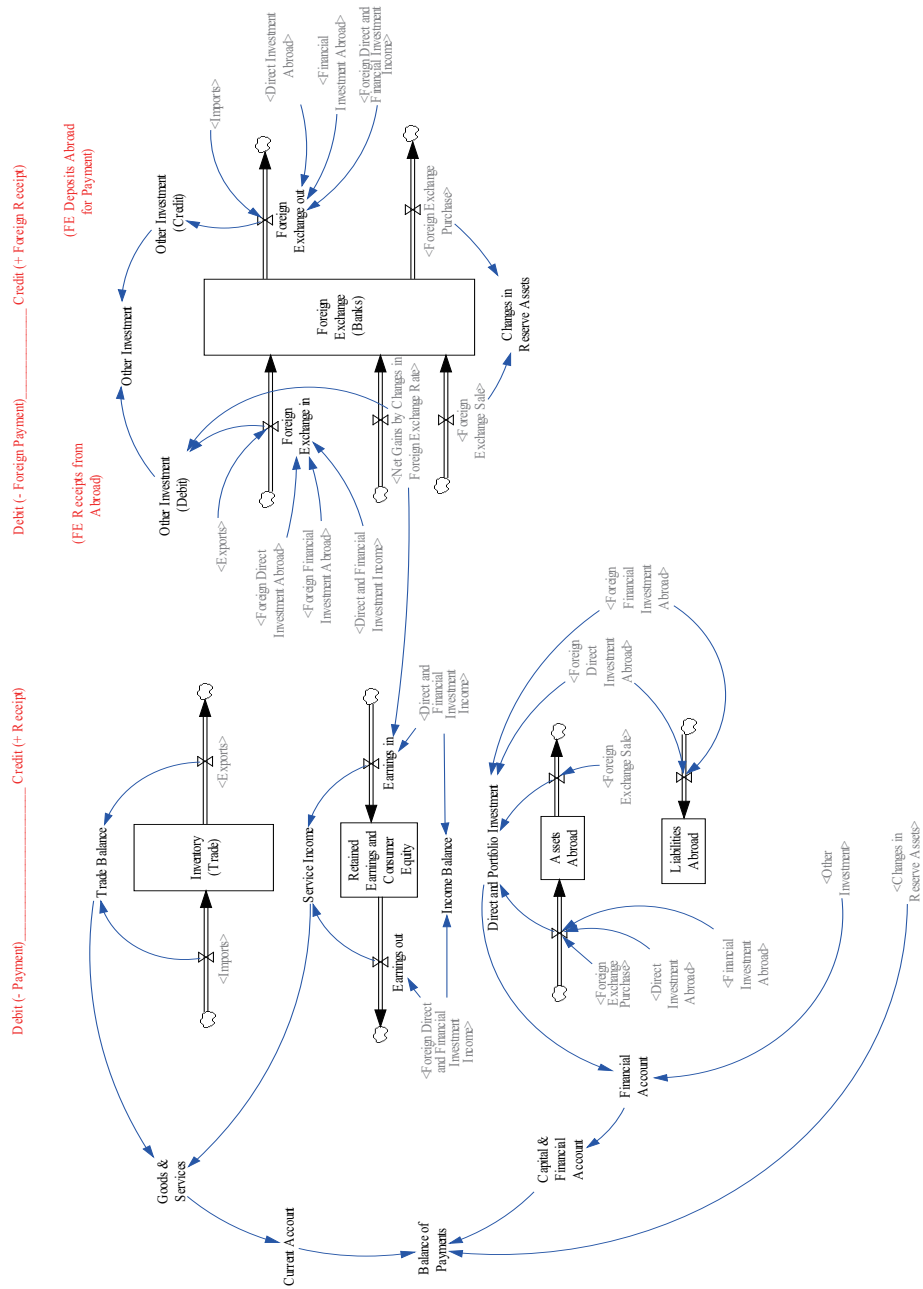


Figure 11.12: Balance of Payment



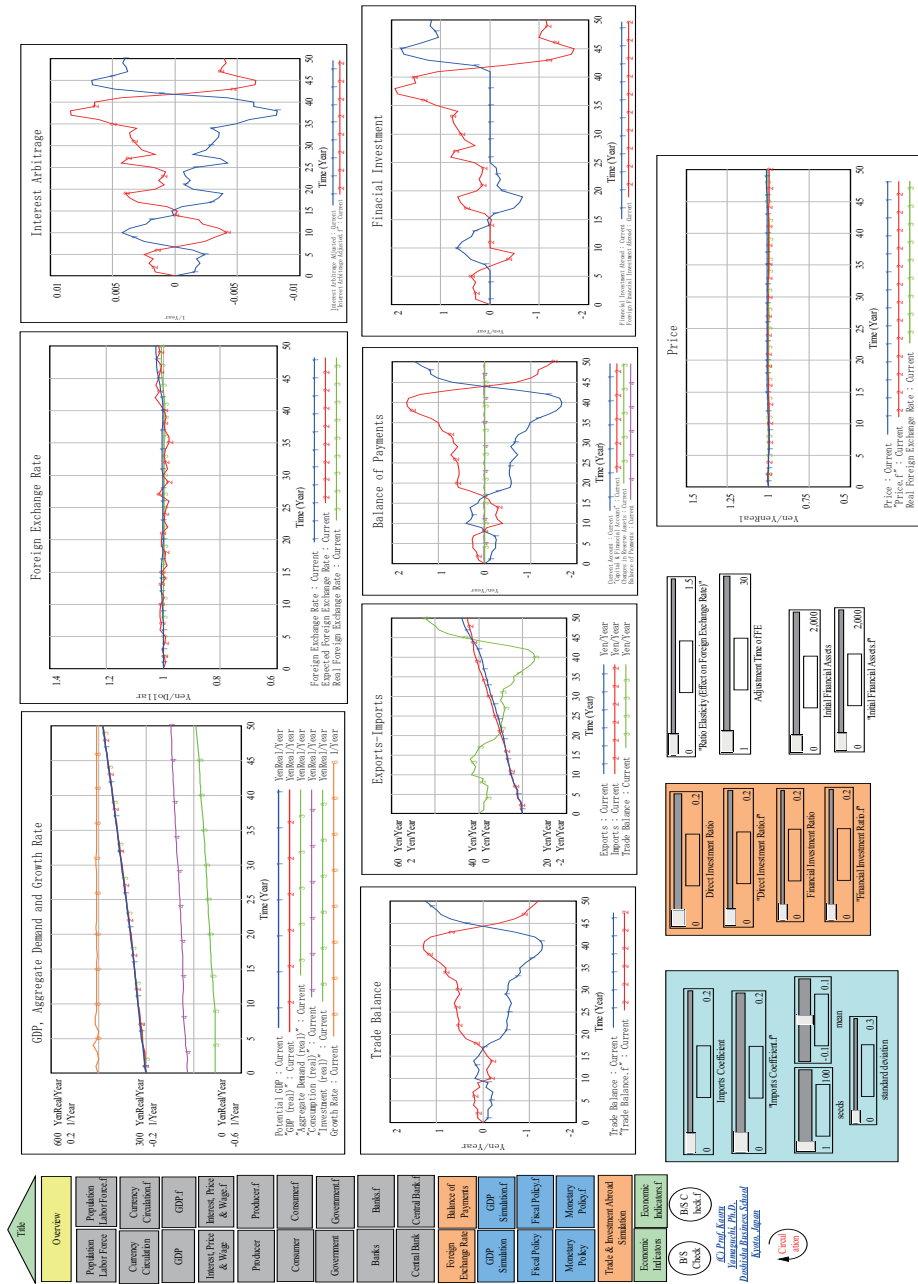


Figure 11.14: Simulation Panel of Trade and Investment Abroad

### 11.3 Behaviors of Open Macroeconomies

#### Mostly Equilibria under Trade and Capital Flows

The construction of open macroeconomies is now completed. There are three channels to open a domestic economy to a foreign economy. Trade channel is opened by allowing producers to import a portion of its GDP for domestic production and distribution. Capital flows have two channels. First, producers are allowed to make direct investment abroad as a portion of their domestic investment. Secondly, consumers are allowed to make deposits abroad out of their domestic deposits as a financial portfolio investment. (For simplicity, portfolios among deposits, shares and securities are not considered here.) These capital flows by direct and financial investment are determined by the interest arbitrage as analyzed in the previous chapter.

Let us now open all three channels by setting the values of import coefficient, direct investment ratio, and financial investment ratio to be the same 10%, respectively. Under the international activities of such trade and capital flows, Figure 11.15 demonstrates that our open macroeconomies can attain mostly equilibrium states.

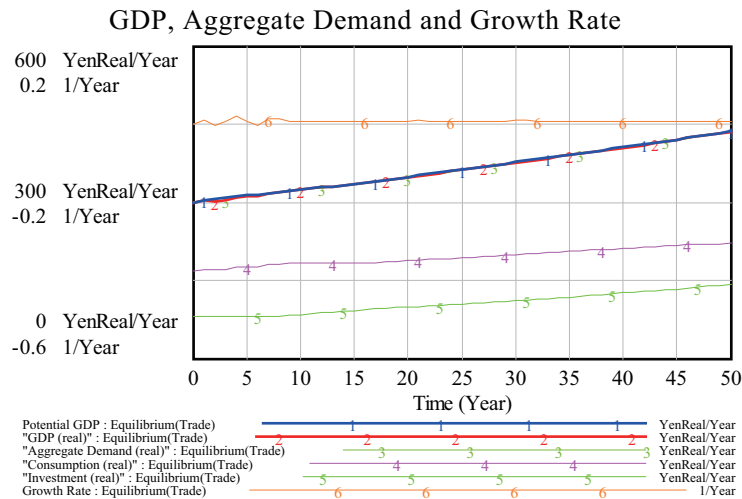


Figure 11.15: Mostly Equilibria under Trade and Capital Flows

Mostly equilibria thus obtained, however, do not imply balances of trade and capital flows. In fact, very small amount of trade imbalance is still observed as illustrated in Figure 11.16. Moreover, alternating interest arbitrages generate very small amounts of capital inflows and outflows as illustrated in Figure 11.17 due to the different interest rates prevailing over two economies, and random normal distribution that is exerted on the expected foreign exchange rate. Compared with the size of GDP, however, variances of trade and capital flows are

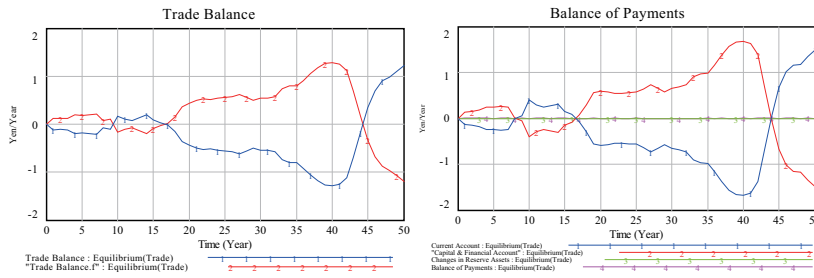


Figure 11.16: Trade Balance and Balance of Payments

within the range of less than 0.5% of GDP.

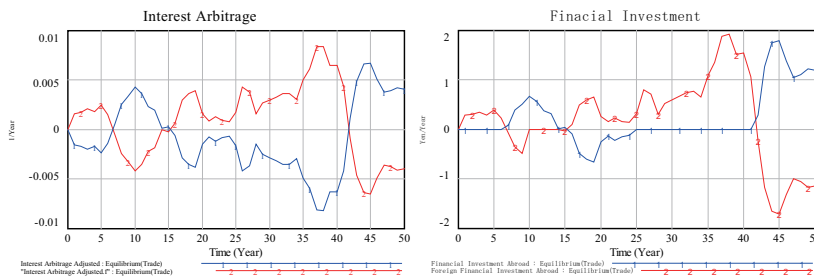


Figure 11.17: Interest Arbitrage and Financial Investment

### Inventory Business Cycles under Trade and Capital Flows

Our generic model of open macroeconomies could be applied in many different ways to the economic analyses of specific issues. In chapter 9, two types of business cycles are triggered out of the mostly equilibrium states such as the ones by inventory coverage, price fluctuation and cost-push wages, as well as an economic recession by credit crunch. It would be interesting, as a continuation of our discussions, to examine how these domestic business cycles and recession affect foreign macroeconomies through trade and capital flows.

Let us first consider a business cycle caused by inventory coverage. Suppose a normal inventory coverage is set to be 0.7 or 8.4 months instead of the initial value of 0.1 or 1.2 month as done in chapter 9. As expected again a similar business cycle is being generated in the domestic economy as illustrated in Figure 11.18.

Does this business cycle affect a foreign economy? Figure 11.19 illustrates the foreign country's GDP and its growth rate. It clearly displays that business cycles are being exported to the foreign economy through trade and capital flows. This means vice versa that our domestic economy cannot be also free from the influence of foreign economic behaviors. In this sense, open macroeconomies can

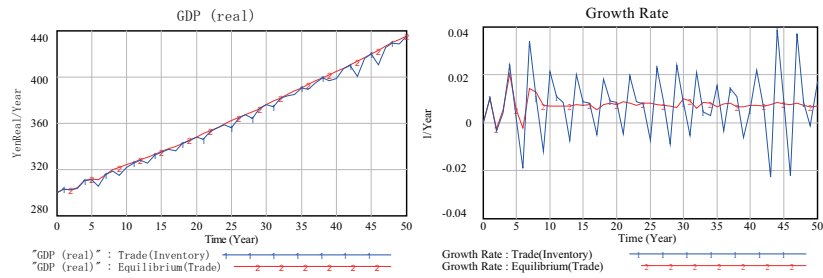


Figure 11.18: Inventory Business Cycles under Trade and Capital Flow

be said to be mutually interdependent and constitute indeed a closed economic system as a whole.

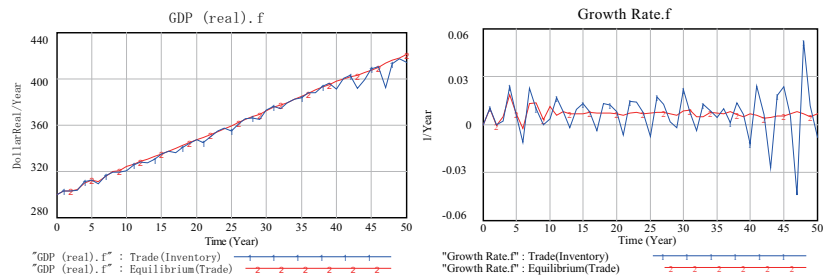


Figure 11.19: Inventory Business Cycles Affecting Foreign Macroeconomy

### Credit Crunch under Trade and Capital Flows

Now let us examine an economic recession triggered by the credit crunch. For this purpose, let us now assume that the central bank reduces the amount of credit loans by 40%. An economic recession is similarly generated again in the domestic economy as illustrated in Figure 11.20.

Does this domestic recession affect the foreign economy? Figure 11.21 illustrates the foreign country's GDP and its growth rate. It clearly displays that economic recession is being exported to the foreign economy through trade and capital flows. This means vice versa that our domestic economy cannot be also free from the influence of foreign economic behaviors. In this sense, open macroeconomies can be said to be mutually interdependent and constitute indeed a closed economic system as a whole.

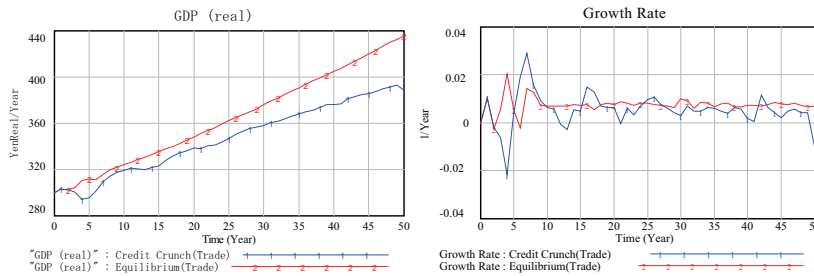


Figure 11.20: Credit Crunch under Trade and Capital Flow

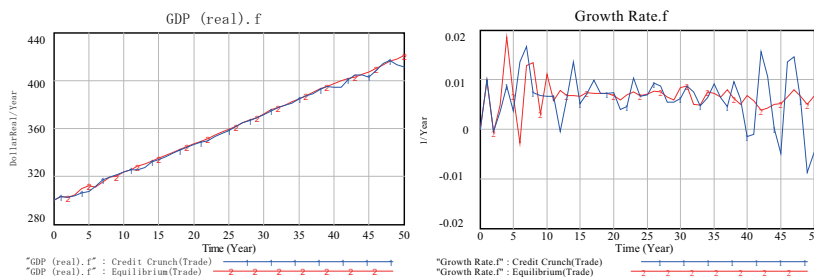


Figure 11.21: Credit Crunch Affecting Foreign Macroeconomy

## 11.4 Where to Go from Here?

### Robust Foundation of the Model

Our macroeconomic model building is based on the following two well-established scientific methods;

- Double-entry accounting system: a foundation of social science
- Theory of differential equations: a foundation of natural science

Accounting system has been said to be the most rigorous methodology in social science, and widely used since ancient times to keep orderly records of chaotic market transactions. Differential equations have been, since Newton, widely applied to describe dynamic movements in natural science as the most fundamental tool for dynamical analysis. System dynamics is in a sense a computer-based tool for the numerical computation of differential equations.

These two well-established scientific methods are consolidated as the principle of accounting system dynamics in [83] and Chapter 3, and have been applied in our model building of macroeconomic system. Hence, our open macroeconomic model can be said to have been built on the robust foundation, and in this sense provides a sturdy and versatile framework for further behavioral

analyses in macroeconomic theory. Where should we go, then, from here more specifically? At least the following four trails seem to lie ahead of us.

### Trail 1: Unified Macroeconomic Systems View

By its nature as a generic model, our model could be refined to clarify the fundamental causes of disputes among different schools of economic thoughts; for instance, in the line of unification among Neoclassical, Keynesian and Marxian schools in [78]. It is our belief that their differences are those of the assumptions made in the model, not the framework of the model itself. If this is right, the model could provide a common framework for further theoretical discussions among economists. Accordingly, depending on the economic issues for clarification the model could be fine-tuned for sharing various economic views.

Following are some of these fine-tuning directions for further analysis of the economic issues if they are the focus of macroeconomic controversies.

1. Portfolio decisions for financial assets and wealth among cash, shares and securities are not yet incorporated.
2. Housing investment and real estate transactions by consumers are not treated. This could be an interesting extension to analyze the subprime housing investment bubbles, followed by the housing crisis in 2007, and financial crisis in 2008.
3. Consumption is a function of basic consumption  $C_0$ , income  $Y$  and Price  $P$ , but interest  $i$  and wealth effect  $W_e$  are still not considered such that

$$C = C(C_0, Y, P, i, W_e) \quad (11.2)$$

4. An interdependent relation between money supply and inflation is weak, and only the following causal route is covered;  
 $\text{Money}(\uparrow) \longrightarrow \text{Investment}(\uparrow) \longrightarrow \text{Desired Output}(\uparrow) \longrightarrow \text{Price}(\uparrow)$ .  
 Moreover, inflation in financial assets and real estate is not treated.
5. Proportionate movement of price and wages is weak.
6. Comparative advantage theory of international trade is not handled.

### Trail 2: Japanese and US Macroeconomic Modeling

The series of macroeconomic modeling was originally intended to construct a Japanese macroeconomic model for strategic applications among business executives and policy makers. Accordingly, it seems natural to follow this trail as a next step, and simultaneously analyze the world two largest<sup>2</sup> economies; that is, Japanese macroeconomy as a domestic economy and US macroeconomy as a foreign economy along the framework of our open macroeconomies.

<sup>2</sup>Chinese GDP surpassed Japanese GDP in 2010, and Japan is now the third largest economy.



For this purpose, actual macroeconomic data have to be incorporated into the model. It would be very interesting to observe, out of many possible behaviors the model can produce like chaos being produced out of a simple deterministic equation, which behavior is to be chosen historically by the real economy.

### **Trail 3: Systems of National Account**

Our modeling method turns out to be along the United Nations *System of National Accounts 1993*, known as ‘the SNA93’, though in a more wholistic way. Accordingly, it could be extended closer to the complete SNA93 in a systemic way.

Three trails discussed above can be followed under the current macroeconomic systems of debt money. Readers who are interested in further analyses of debt money system are encouraged to follow these off-road journeys.

### **Trail 4: Public Money and Sustainability**

Financial crises following the bankruptcy of Lemman Brothers in 2008 have awakened my mind further into the exploration of the root cause of monetary and financial instabilities and national debt crises that our current economies have begun facing more seriously since then.

Before this awakening, my interest was partially in a sustainability modeling such as the one in chapter 3 of “Handbook of Sustainable Development Planning” [84], which was based on my step-by-step definition of sustainability in terms of physical, social and ecological reproducibilities [81], with a belief that macroeconomic activities cannot be sustained without a support by ecological environment. More specifically, I believed that the current macroeconomic activities are destroying our living environment, which is in turn threatening our sustainable futures that our macroeconomic activities are supposed to provide.

This irony convinced me that our sustainable futures are threatened by our aggressive macroeconomic activities for endless pursuit of economic and financial growth, which in turn are driven by the current macroeconomic system of debt money as briefly discussed in Chapter 6. In other words, the root cause of both economic instability, debt crises and unsustainable futures is the current debt money system!

What is the alternative to the debt money system, then? From our analysis for the nature of money in Chapter 5, it has to be the public money system. Understanding in this way, our next off-road journey has to be the one in which we explore an alternative macroeconomic system of public money to find out if it works better than the current debt money system in the sense of monetary and financial stability, liquidation of national debt and sustainable futures. Our final off-road journey is now set toward the public money and sustainability.

## 11.5 Conclusion

This is the final chapter that completes our series of building macroeconomic system of debt money. The integrated model in chapter 9 is extended to the open macroeconomies on the basis of the balance of payment in the previous chapter. Its main feature is that two similar macroeconomies are needed to analyze international trade and capital flows through direct and financial investment.

With a completion of building the open macroeconomies this way, many possibilities are made available for the analysis of economic issues. Our analyses are confined to the issues of inventory business cycles and credit crunch. Then, it is shown that a business cycle and an economic recession triggered in the domestic economy causes similar recessions in a foreign economy through the transactions of trade and capital flows. In this sense, open macroeconomies are indeed demonstrated to be a closed system in which economic behaviors are reciprocally interrelated.

Since our open macroeconomic model is still far from being complete, these three trails are suggested to follow if the reader is interested in the investigation of the current debt money system. We've decided to take the forth off-road journey that explores the alternative macroeconomic system of public money for the monetary and financial stability, liquidation of national debt and our sustainable futures.