

Essays on International Finance and Macroeconomics

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Abstract

This thesis aims to investigate several economic issues in the field of international finance and macroeconomics and attempts to apply theoretical and empirical techniques to explore economic mechanisms and macroeconomic implications behind these economic phenomena.

In Chapter 2, we focus on the hot money issue aroused by the enormous stock of foreign exchange reserves in China. This subject is worth exploring because these abnormal amounts of foreign exchange assets have been suspected to result from the crowding international speculative capital, so-called "hot money," which is considered to target the expected excess returns from Renminbi (RMB) appreciation. Enlightened by China's case, we investigate whether higher expected excess returns from local currency appreciation accounts for the inflow of international speculative capital. Based on the "return-chasing" hypothesis developed by Bohn and Tesar (1996), we take the undervaluation index as a proxy for the expected excess returns on currency and explore its relationship with international speculative capital by using large-sample panel data. To overcome the bias due to the endogenous problem, we adopt the System Generalized Method of Moments (System-GMM) to conduct estimation and test the robustness of the results using other possible sources of expected return. Finally, we find that when controlling for the country-specific, time-variant economic environments, there is a significant return-chasing effect between movements of expected currency excess returns and hot money. Other possible sources of expected returns (such as interest rate differential) can not explain the dynamics of hot money inflow according to our results.

After providing empirical evidence for why abnormal financial flows in the foreign sector occurred, in Chapter 3, we begin to think seriously about the macroeconomic effects of the perturbation that originated in the financial sectors. The recent financial disaster that occurred in the U.S. suggests that the financial sector has played an important role as a source of business cycle fluctuations, which is different from the propagation opinion in literature. Enlightened by the US's experience, following Jermann and Quadrini (2012), we apply the dynamic stochastic general equilibrium (DSGE) modeling method to assess

whether financial shocks matter for the Japanese economy. We construct time series of financial shocks and productivity shocks using Japan's quarterly data since 2001 and conduct simultaneous replication on major indicators of aggregate financial flows and real variables. Preliminary results tell that in a closed economy, financial shocks seem less important than they were in the U.S. economy. However, after extending the original model to a small open economy in which firms can borrow from overseas lenders but may have to pay a default risk premium on interest payments, simulated results show that financial shocks have contributed heavily to the dynamics of aggregate debt and dividend flows. This is consistent with Jermann and Quadrini's (2012) finding on the U.S. economy. By contrast, however, productivity shocks seem to have been dominant in accounting for fluctuations of real variables, such as output, consumption ratio, and investment ratio in Japan.

Chapter 3 demonstrates that productivity shocks still play an important role in Japan's business cycles. Since the small open economy model has limitations for excluding external shocks from abroad, in Chapter 4, we decide to perform a deeper quantitative investigation regarding the role of productivity and financial shocks to the macroeconomies in a theoretically enriched model. Concretely speaking, we develop a simple two-country model featuring an international bond market and enforcement constraints within both countries in an attempt to quantify the role of productivity and financial shocks. We construct time series of productivity shocks and financial shocks using the US and Japanese quarterly data since 2001 and conduct simultaneous replication on major indicators of real variables and aggregate financial flows. The main results were as follows. First, for both the US and Japan, productivity shocks account for most real variable dynamics such as output and investment, while financial shocks well capture the trend of consumption, current account, and labor trends in the US and succeed in replicating Japan's debt repurchase behavior. Nevertheless, it is noteworthy that financial shocks served as key factors in accounting for the observed troughs of output, labor, and consumption, as well as the peaks of debt repurchase and the US current account during the 2007-09 financial crisis. Second, it is surprising that observable international spillover effect appeared only in Japan's debt repurchases. As it is widely considered that the Japanese economy have been deeply influenced by US economic fluctuations, our quantitative results raise questions about this opinion.

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Needless to say, all the remaining errors in this thesis are mine.

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Chapter 1

Introduction

From the beginning of this century, many significant economic issues (such as external imbalance in China and the financial crisis originating in the US) have occurred as a result of unstable financial sectors at home and abroad. These abnormal phenomena or painful experiences remind us of the growing importance of understanding the mechanism behind these unusual economic occurrences. The objective of this research is to investigate economic mechanisms and the macroeconomic implications behind issues relevant to financial instability so as to make contributions to policy making in the financial and real sectors.

This thesis aims to use theoretical and empirical techniques to explore two important economic issues in international finance and macroeconomics: one is international speculative capital and currency undervaluation, and the other is the macroeconomic effects of financial shocks.

The former issue is motivated by the external imbalance issue in China. Since 2003, the "twin" surpluses in China's balance of payments (BOP) have brought about the undervaluation problems in the Renminbi, and consequently induced a one-way expectation of RMB appreciation. Under such a background, the stock of foreign exchange reserve in China has reached over 3.6 trillion in Sept. 2013. Therefore, we became interested in whether it is the currency undervaluation or the potential expected currency excess return that has attracted the influx of international speculative capital and, consequently, contributed to the growth in China's foreign reserve. Although there are several studies about the determinants of hot money in individual countries, to the best of our knowledge, few studies have attempted to use an undervaluation index to measure the currency excess returns and investigate its empirical relationship with hot money for multiple countries. In order to fill this gap, we adopt a Generalized Method of Moments to conduct empirical tests on expected currency excess returns and international speculative capital based on

panel data that consists of over 150 countries.

The latter issue is inspired by the recent financial crisis in 2007-09. After the crisis, there has been an increase in the literature focusing on financial frictions and their roles in aggregate economies. Different from many studies that emphasized the propagating effects of financial frictions, Benk, Gillman, and Kejak (2005) began to consider credit shocks that originate from bank sectors and suggested that these shocks be considered candidates in accounting for the growth of gross domestic product (GDP). Since then, many researchers have begun to focus on the direct effects of financial shocks to macroeconomies. Among the recent studies, Jermann and Quadrini (2012) quantitatively show that financial shocks (i.e., disturbances that affect firms' ability to borrow) have played a key role in accounting for the U.S. economy, not only for business fluctuations, but also for the dynamics of financial flows. After noticing that financial flows have displayed features similar to those in the United States, we applied the model of Jermann and Quadrini (2012) to the closed and small open economies, respectively, to explore the importance of these financial shocks in the Japanese economy. To the best of our knowledge, few previous studies have followed Jermann and Quadrini (2012) to explore the macroeconomic effects of financial shocks in the case of Japan.

Chapter 3 demonstrates that productivity shocks play a more important role than financial shocks in Japan's real business cycles. Since the small open economy model has limitations in excluding external shocks from abroad, in Chapter 4, we decide to make a deeper quantitative investigation about the role of productivity and financial shocks to the macroeconomies in a theoretically enriched model. This time, we extend Jermann and Quadrini (2012) and Quadrini (2012) into a simple two-country model with incomplete international bond market and enforcement constraints within countries and attempt to address two questions left by Chapter 3: (1) whether financial shocks play a greater role than productivity shocks in accounting for real business cycles in the presence of financial integration and financial frictions and (2) whether there have been international spillover effects of country-specific shocks. Although there are some studies that adopt a similar idea as that of Jermann and Quadrini (2012) and quantify the macroeconomic effects of financial shocks in the two-country model, to the best of our knowledge, few of them have conducted quantitative analysis on the US and Japan simultaneously, not to mention investigating international spillover effects of financial shocks between these two important economic blocs.

Based on the above motivation, this thesis is developed as follows:

In Chapter 2, we conduct empirical analysis on the relationship between movements of expected currency excess returns and the inflow of international speculative capital based on the return-chasing hypothesis developed by Bohn and Tesar (1996). Concretely

speaking, we take the undervaluation index as the proxy for expected currency excess returns and conduct estimation using large-sample panel data. To overcome the bias owing to the endogenous problem, we adopt the System Generalized Method of Moments (System-GMM) and test the robustness of the results using other possible sources of expected return. Finally, we find that, when controlling for the country-specific time-variant economic environments, there is a significant return-chasing effect between movements of expected currency excess returns and hot money inflow. In other words, higher expected currency excess returns tend to cause larger hot money inflows. On the other hand, other possible sources of expected returns (such as interest rate differential) cannot explain the dynamics of hot money inflow, according to our results.

In Chapter 3, we follow Jermann and Quadrini (2012) and apply the dynamic stochastic general equilibrium modeling method (DSGE) to assess whether financial shocks matter for the Japanese economy. This model includes two features: (1) the firm prefers debt to equity financing for the tax benefit, and (2) the degree of financial rigidity for changing financing tools is reflected by the cost of dividend adjustment. First, we applied Jermann and Quadrini's (2012) closed business cycle model and computed the parameters to fit the properties of its empirical counterparts. After constructing the time series of financial shocks and productivity shocks using Japan's quarterly data since 2001, we conduct a simultaneous replication of the major indicators of aggregate financial flows and real variables. The preliminary results suggest that, in a closed economy, financial shocks seem less important than they were in the U.S. economy. However, after extending the original model to a small open economy in which firms can borrow from overseas lenders but may have to pay a default risk premium on interest payments, the simulated results show that financial shocks have contributed heavily to the dynamics of aggregate debt and dividend flows. By contrast, however, productivity shocks seem to have been dominant in accounting for fluctuations of real variables, such as output, consumption ratio, and investment ratio in Japan.

In Chapter 4, we extend the models of Jermann and Quadrini (2012) and Quadrini (2012) into a simple two-country model with incomplete international bond market and enforcement constraints within countries. After constructing a time series of productivity shocks and financial shocks using the US and Japan's quarterly data since 2001, we conduct a simultaneous replication on major indicators of real variables and aggregate financial flows. The main results show that, firstly, for both the US and Japan, productivity shocks have accounted for most dynamics of real variables, such as output and investment, while financial shocks have effectively captured the trend of consumption, current accounts, and labor in the US and succeeded in replicating debt repurchase in Japan. Nevertheless, it is still worth noting that financial shocks were the key factors in

accounting for the observed troughs of output, labor and consumption, and the peaks of debt repurchase and the US current account during the financial crisis of 2007-09. Second, it is surprising that the observable international spillover effect had only appeared in the debt repurchase in Japan. As it is widely considered that the Japanese economy have been deeply influenced by US economic fluctuations, our quantitative results raise questions about this opinion. Moreover, such a two country model can be extended and applied to other countries or regions, such as the EU and China, and further comparative studies employing this model can enrich the literature examining the role played by financial and productivity shocks.

Chapter 2

International Speculative Capital and Currency Undervaluation: A System-GMM method

2.1 Introduction

International speculative capital, so-called "hot money," is generally referred to as the international capital flows that can not be explained by the trade surplus and foreign direct investment¹. They are called "hot money" because they can move in and out of markets very quickly, and it is often regarded as a high-risk instrument used by financial speculators to pursue interest. During the last century, large-scale hot money has even been frequently connected with financial instability, even financial crisis. For example, before 1985, the strong dollar policy induced speculative capital flowing back to the United States, triggering the skyrocketing price in the real estate and stock markets. After the collapse of the bubble on October 19, 1987, the stock market crash commenced the breakout of a financial crisis in the United States. Since the beginning of this century, China's burgeoning foreign reserve has placed the hot-money issue in the limelight. More specifically, the "twin" surpluses in China's balance of payments (BOP) have brought about the undervaluation problems in the Renminbi (RMB) and, consequently, induced a one-way expectation of RMB appreciation. Against such a background, the stock of reserve assets in China reached over \$3.6 trillion in September 2013. Therefore, we be-

¹Martin and Morrison (2008) define hot money as the flow of funds (or capital) moving from one country to another in order to earn a short-term profit from the interest rate differential and/or anticipated exchange rate shifts. Bishop (2004) states that hot money is "the money held in one currency but is liable to switch to another currency at a moment's notice in search of the highest available return. It is often used to describe the money invested in currency markets by speculators."

came interested in whether it is the currency undervaluation or the potential expected currency excess return that has attracted the influx of international speculative capital and, consequently, contributed to the growth in China's foreign reserve.

Although there are several studies about determinants of hot money in individual countries, to the best of our knowledge, few studies have attempted to use an undervaluation index to measure currency excess returns and investigate its empirical relationship with hot money for multiple countries. In order to fill this gap, we conducted empirical tests based on large-sample panel data. As Evans (2013) mentioned, hot money can be treated as the capital flows driven by the portfolio choices of foreign investors; therefore, we decided to base our study on the "return-chasing" hypothesis proposed by Bohn and Tesar (1996), which states that investors adjust their investment decisions according to the time-variant expected excess returns. We conducted a new trial to use the undervaluation index as the proxy of expected currency excess returns and applied the Generalized Method of Moments (GMM) to solve the endogenous problems². The results show that there is significant evidence of a return-chasing relationship between expected currency excess returns and international speculative capital when controlling for economic environments.

This study is most related to the return-chasing hypothesis in international portfolio choice theory, which is developed by Bohn and Tesar (1996). They examine the role of net purchase within an intertemporal, international capital-asset-pricing model. The model deconstructs the motive of the net purchase of an asset into two types of effect: the "portfolio-rebalancing" effect and the return-chasing effect. The former reflects the requirement on the net purchase to maintain constant portfolio weights, and the latter implies that investors will adjust portfolio weights with movements of expected excess returns, given a fixed level of risk aversion and a constant variance-covariance matrix of returns. Based on this model, Bohn and Tesar (1996) prove that U.S. investors tend to acquire stocks with higher expected excess returns rather than selling off "winning stocks" to maintain balanced portfolio weights in the sample period. Therefore, U.S. transactions in foreign equities were primarily driven by the return-chasing effect from January 1981 to November 1994. Tu and Chen (2002) show supportive evidence for the return-chasing hypothesis in Asia Pacific developed and emerging markets. They find flow securities investment tends to move into the markets whose returns are expected to be high and retreat from markets whose returns are predicted to be low. We also chose the return-chasing theory as our theory base, for it describes a similar profit-chasing mechanism of hot money from an investor's perspective risk and return.

²Souriounis (2003) documents that equity flows, rather than bond flows, are important in explaining exchange rates.

Our study is also related to empirical studies about the relationship between capital flows and the exchange rate. Souriounis (2003) uses unrestricted Vector Autoregression (VAR) to investigate the empirical relationship between capital flows and the nominal exchange rate for five major countries. That study finds that net cross-border equity flows help improve the in-sample performance of the standard linear empirical exchange rate model. Hau and Rey (2006) develop an equilibrium model in which exchange rates, stock prices, and capital flows are jointly determined under incomplete foreign exchange risk trading. They use daily, monthly, and quarterly frequency data from 17 OECD countries and prove that net equity flows into the foreign market are positively correlated with a foreign currency appreciation. Jongwanich and Kohpaiboon (2012) examine the impact of capital flows on real exchange rates in emerging Asian countries in 2000-2009 using a dynamic panel-data model. The estimation results show that portfolio investment brings in a faster speed of real exchange rate appreciation than foreign direct investment. Our study is different from the above studies in two respects: (1) we focus only on the one-way effect from the real exchange rate to capital flows; and (2) we use the undervaluation index to indicate the expected currency excess returns, which is quite a different challenge from those presented in other literature.

This chapter is also related to studies about determinant factors of international capital flow. One popular theory in this area is the "pull" and "push" factors hypothesis, which was first proposed by Calvo et al. (1993). The core argument of this theory is that it is the poor investment opportunities in industrial countries (so-called push factors) and macroeconomic fundamentals in recipient countries (so-called pull factors) that lead to the surge of international private flows³. Hernandez, Mellado, and Valdes (2001) use the panel data to show that private capital flow to developing countries between 1977 and 1997 is mainly determined by country-specific characteristics of the developing countries, while external or push factors are not significant. Vita and Kyaw (2008) apply the structural vector autoregressive model and use the quarterly data for the period 1976-2001 to show that domestic productivity is the most important force explaining the variations in capital flow to developing countries. Forbes and Warnock (2012) demonstrate that global factors, especially global risk, are significantly associated with extreme capital flow episodes. Contagion, whether through trade, banking, or geography, is also associated with stop and retrenchment episodes, and domestic macroeconomic characteristics are generally less important. Fratzscher (2012) shows that common factors (push factors) were, overall, the

³Montiel and Reinhart (1999) illustrate that push factors involve two aspects. First, it is the temporary response to the business cycle, such as the lowering interest rate policy; second, it is relevant to the financial development in industrial countries, such as the boom in financial intermediaries. On the other hand, pull factors usually involve enhancements in the private risk-return tradeoffs that are achieved by improvement in the socioeconomic or political environment.

main drivers of capital flows during the crisis, while country-specific determinants (pull factors) have been dominant in accounting for the dynamics of global capital flows in 2009 and 2010, particularly for emerging markets. Other studies based on the pull and push factors hypothesis include World Bank (1997); Fernandez-Arias (1996); Chohan, Claessens, and Mamingi (1998); Mody, Taylor, and Kim (2001); Culha (2006); Alfaro, Kalemli-Ozcan, and Volosovych (2005); and Reinhart and Reinhart (2009). Our study is related to these because we are also interested in the motive behind international capital flows. However, our study is different from the above in two respects: (1) we mainly focus on investigating or making clear the relationship between currency undervaluation and speculative capital flows but do not aim to discover which one has been dominated among many domestic and global factors; (2) the pull and push factors hypothesis usually has been applied in explaining private capital flows from industrial countries to developing countries, whereas we do not consider the direction of private capital.

This chapter is structured as follows: Section 2 illustrates the theoretical background of the return-chasing hypothesis; Section 3 first introduces the estimation model, then constructs series of undervaluation index and international speculative capital (hot money), and finally illustrates source data and an index for use; Section 4 conducts empirical analysis and explains the results; Section 5 concludes.

2.2 Theoretical background

Our estimation is based on the intertemporal, international capital-asset-pricing model issued by Bohn and Tesar (1996). Their model deconstructs the net purchases of foreign assets into two types of transactions: those that are essential to maintaining a balanced portfolio of securities and those that are triggered by time-varying investment opportunities. Specifically, the net purchase of asset k can be described as follows:

$$NP_{kt} = x_{kt}W_t - (1 + g_{kt})(x_{kt-1}W_{t-1}), \quad (2.1)$$

where NP_{kt} indicates the net purchase of asset k , x_{kt} is the relative share of asset k in the whole portfolio, W_t represents the total wealth, and g_{kt} is the capital gain on asset k . Because wealth at time t is a function of return on the total portfolio between $t-1$ and t , net purchases can be described approximately as

$$NP_{kt} = (x_{kt} - x_{kt-1})W_{t-1} + (d_t^p + g_t^p - g_{kt})x_{kt-1}W_{t-1}, \quad (2.2)$$

where d_t^p and g_t^p are dividends and capital gains, respectively, on the total portfolio. Assuming that an investor chooses a portfolio of equity based on the standard trade-off between mean return and variability, Cox, Ingersoll, and Ross (1985) provide an optimal condition for the portfolio weight on individual asset k and the return process:

$$x_{kt} = \alpha e_k \sum_t^{-1} \bar{\mu}_t + \eta_{kt}, \quad (2.3)$$

where α is the coefficient of relative risk aversion, $\bar{\mu}_t$ is the vector of expected excess returns on all assets, e_k is a 0-1 vector that selects element k , $\sum_t$ is the covariance matrix of returns, and η_{kt} is the hedge component of the portfolio, which is to hedge against risks that are not reflected in equity returns. This hedge term reflects the covariance of equity returns with state variables characterizing time-varying investment opportunities and with inflation (Bohn and Tesar 1996). We follow the assumption that all time variation in the model only occurs in the first moments; therefore, equation (2.2) is rewritten as

$$NP_{kt} = \underbrace{(d_t^p + g_t^p - g_{kt})x_{kt-1}W_{t-1}}_{\text{portfolio-rebalancing effect}} + \underbrace{e_k \sum_t^{-1} (\bar{\mu}_t - \bar{\mu}_{t-1}) \alpha W_{t-1} + (\eta_{kt} - \eta_{kt-1}) W_{t-1}}_{\text{return-chasing effect}} \quad (2.4)$$

The first term in equation (2.4) reflects the requirement that investors want to keep constant portfolio weights, which is referred as the portfolio-rebalancing effect, while the second term reflects the investor's requirement for re-optimizing the portfolio over time. Given a constant level of risk aversion and a variance-covariance matrix of returns, the adjustment in portfolio weights only happens when investors adjust their expectations of excess returns. This is referred as the return-chasing effect. To test the return-chasing hypothesis, Bohn and Tesar (1996) make an assumption that the portfolio-rebalancing motive has played an insignificant role in investors' purchase decisions⁴. The second term in equation (2.4) suggests that net purchases of asset k are triggered by changes in the investor's expectation of excess returns in asset k . In the next section, we follow Bohn and Tesar (1996) and examine the relationship between international capital inflow and adjustment in currency excess returns.

⁴Bohn and Tesar (1996) show that the portfolio-rebalancing hypothesis fails to explain U.S. investors' purchase activities in most large equity markets.

2.3 Data

2.3.1 Estimation model

In this section, we will make preparations for the empirical investigation of the relationship between capital inflow and expected excess returns in the exchange rate. Our regression will be conducted based on the following equation:

$$HM_{kt} = c_{k0} + c_{k1}E_t[R_{kt} - R_{kt-1}] + \sum_{i=0} z_{kt}^i + u_{kt}, \quad (2.5)$$

where HM_{kt} is the hot money inflow scaled by GDP in country k ; $E_t[R_{kt}]$ is the expected excess returns based on forecasting variables conditional on information in period t ⁵; c_{k0} is the constant term assumed to absorb all other time-invariant factors in country k ; z_{kt}^i is the country-specific time variant variables i that possibly endogenously influence the expected returns on currency or other types of expected returns for testing the robustness of the results; and u_{kt} is the error term assumed to absorb all other time-variant risk factors not reflected in returns in country k .

Two important assumptions are necessary before estimation: (1) Following most literature, we define international speculative capital (hot money) as the net increase of foreign reserve, subtracting the trade surplus and the net foreign direct investment⁶. Therefore, hot money is comprised of three parts: the errors and omissions, portfolio plus other investment, and the remaining parts of current accounts. It is worth noting that for the countries with liberalized capital accounts, portfolio investment is an important channel for transferring hot money. As to others with capital controls, a positive residual in the errors and omissions is often interpreted as a signal for hot money inflow. Of course, it is also possible that hot money is transferred through "false" foreign direct investment or trade channels; however, we do not account for that here because of the difficulty in differentiation; (2) We choose to form the expected excess returns by comparing the actual exchange rate with the expected variable obtained by regressing the actual exchange rate on prediction variables. The difference between actual value and expected value is considered as the expected currency excess return. If the difference is positive, it implies that the currency is undervalued. Based on the above assumptions, our hypothesis states that after controlling for all other factors, greater currency undervaluation implies more intense pressure on currency appreciation and a greater potential to realize higher

⁵Bohn and Tesar (1996) assume that investors transacting during month t base their forecasts of returns on information available in month $t - 1$, since they found forecasts based on lagged information variables have stronger explanatory power for net purchases.

⁶See Martin and Morrison (2008)

excess returns from currency speculation. Alternatively, we can interpret this to mean that greater undervaluation of local currency implies higher capital gains when changing the local currency-denominated assets to those dominated by foreign currency. Therefore, a higher degree of currency undervaluation tends to attract a larger scale of hot money inflow. Under this hypothesis, we expect that a higher degree of currency undervaluation positively correlates with an inflow of hot money.

2.3.2 Data construction

As the first step in empirical testing, we will calculate the undervaluation index and hot money inflow.

2.3.2.1 Undervaluation index

Following the work of Rodrik (2008), we construct a time-variant undervaluation index of the real exchange rate using panel data. Here, undervaluation indicates the upward deviation of the actual real exchange rate from the expected value adjusted for the Balassa-Samuelson effect. The Balassa-Samuelson effect, proposed by Balassa (1964) and Samuelson (1964), explains that the real exchange rate tends to positively relate to the level of output per capita across countries. Specifically, as countries become richer, the relative prices of nontradables tend to rise due to the growth of productivity in tradable goods. Because price index is an average of two sectors, a relative increase in domestic goods prices will eventually trigger an appreciation in the real exchange rate. Another method is to estimate the level of the (real) exchange rate in a balance-of-payments equilibrium (See Elbadawi 1994, Razin and Collins 1997, and Aguirre and Calderon 2005). We choose the method of Rodrik (2008) for its superiority in price comparability in both geographical and time dimensions. The setup of the undervaluation index involves three steps:

- First, we choose the inverse of PPP conversion factors (PPP) to market exchange rate (XR) ratio ($PPPXR$) obtained from the World Bank as the real exchange rate (RER), since this ratio, also referred to as the price level of GDP, makes it possible to compare the cost of the bundle of goods that make up gross domestic product (GDP) across countries (World Bank). This ($PPPXR$) tells how many dollars are needed to buy a dollar's worth of goods in the country as compared to the United States. Therefore, the smaller the value of $PPPXR$ is, the cheaper national currency is in dollar terms. Notice that both the PPP conversion factors and market exchange ratio are expressed as national currency units per U.S.dollar.

$$\ln RER_{it} = \ln(XR_{it}/PPP_{it}) = \ln(1/PPPXR_{it})$$

Table 2.3.1: Test for Balassa-Samuelson effect

Dependent Variable	Real exchange rate (lnRER)
Real GDP per capita, PPP (lnRGDPPC)	-0.368*** (0.0377)
Constant	4.289*** (0.419)
Observations	1,420
R-squared	0.946

1. Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

Here, i indicates country, and t is the index for time periods. If RER is greater than one, it indicates that the value of the currency is lower (more depreciated) than indicated by purchasing power parity.

- Second, we adjust the Balassa-Samuelson effect by regressing $\ln(RER)$ on the GDP per capita, PPP (constant 2005 international dollar) ($RGDPPC$) with fixed effects for time (f_t) and country (f_i). The country fixed effect is to capture time-invariant cross-country differences, while the time fixed effect is to capture shocks common across countries in a given year.

$$\ln(RER_{it}) = \alpha + \beta \ln RGDP_{it} + f_i + f_t + u_{it}$$

According to Table 2.3.1, the estimated value of coefficient β equals -0.368, significant at the 1 percent level and with a standard error of 0.0377. This means that every 1 percent increase in real GDP per capital will appreciate the real exchange rate by approximately 0.368 percent.

- In the last step, we calculate the difference between the actual RER and the predicted RER adjusted for the Balassa-Samuelson effect ($\ln \tilde{RER}_{it}$); then the undervaluation index is obtained as follows:

$$\ln UNDERVAL_{it} = \ln RER_{it} - \ln \tilde{RER}_{it}.$$

If the $UNDERVAL$ exceeds unity, it means the actual RER is larger than the predicted value. This implies that the currency is undervalued, since 1 unit of the local currency's purchasing power measured in U.S. dollars is underestimated. Therefore, higher $UNDERVAL$ indicates a greater degree of currency undervaluation. Now

we can obtain the difference in expected currency returns:

$$diffunderval_{it} = underval_{it} - underval_{it-1}.$$

2.3.2.2 Hot money

As introduced at the beginning of this section, we construct hot money series by the following equation:

$$Hot\ money = Net\ foreign\ reserves - Net\ trade\ surplus - Net\ foreign\ direct\ investment.$$

All data are from the World Bank. Net foreign reserves are "Reserves and related items," and net trade surplus is "Net trade in goods and services." All data are measured in current U.S. dollars. Here, we standardize hot money by GDP in each country.

2.3.2.3 Other variables and data

Our large-sample panel data comprise annual data ranging from 2005 to 2012 due to the data availability⁷ covering most advanced, emerging, and developing countries. In addition to the undervaluation index and hot money flows, we also use the interest rate differential, GDP per capita, growth rate of GDP, and capital openness.

- **Interest rate differential**

Interest rate differential is measured by the growth rate of a 1-year deposit interest rate and the growth rate of the interest rate spread in a country. Since we know that the expected return from an interest rate differential could be an important source of excess returns, and they potentially correlated with the real exchange rate, we would like to investigate whether they would exert independent influence on hot money.

- **GDP per capita, PPP**

We use real GDP per capita, PPP (constant 2005 international dollar), to index the country-specific, time-variant economic environments. Portes and Rey (1999) prove that cross-border equity flows depend positively on various measures of country size (GDP, market capitalization, or financial wealth). Martin and Rey (2004) show that a large market size positively determines international financial flows because

⁷Claessens, Dooley, and Warner (1995) find that it is hard to give an exact definition of the short-term feature of hot money in practice, since capital flows labeled "short-term" exhibit the same degree of time-series persistence as other flows.

of the higher asset prices and lower transaction costs. We include it so as to control economic environments that influence investment decisions made by investors.

- **Growth rate of GDP**

The growth rate of GDP is a proxy for the economic productivity in recipient countries; it represents the vigor of the economy.

- **Capital openness index**

The capital openness index indicates the degree of financial liberalization. Usually, a higher degree of openness implies fewer impediments to inward capital and a greater likelihood of facilitating movements of hot money. However, the effects of capital openness on capital flow are mixed according to the literature, especially when its opposite side (capital control index) is taken as the proxy. For example, Montiel and Reinhart (1999) suggest that although capital control can alter the composition of capital flow (significantly decreasing the share of short-term flow), it is vague on reducing the volume of net inflows. In contrast, Reinhart and Smith (1996) suggest that capital control can reduce both the volume and the share of short-term capital inflow. Magud and Reinhart (2006) explain mixed results as follows: (i) there is no unified theoretical framework in analyzing the macroeconomic consequences of controls; (ii) there is significant heterogeneity in areas, as well as the implementing time; (iii) there are various understandings of a "successful" result; and (iv) the empirical studies differ in methods. Therefore, it is difficult to guarantee positive effects of openness variables in all cases. The capital openness index here is the Chinn and Ito index series, initially introduced in Chinn and Ito (2008). It is an index to measure capital account openness, calculated based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). A higher value in capital openness implies easier cross-border capital transactions or looser capital control. In addition, it is considered to be a de jure measure of financial openness because of its focus on measuring regulatory restrictions on capital account transactions.

2.4 Findings

2.4.1 Fixed effect estimation

As the first step, we conduct fixed effect estimation on vectors of variables. As we can see from Table 2.4.1, although the positive sign of the coefficient supports the hypothesis,

no significant linkage is shown between hot money flow and change in currency undervaluation. As is known, large international capital inflow could put heavier stress on the market exchange rate and indirectly influence the undervaluation degree of national currency. Therefore, we estimate that it is possible that an endogenous relationship between hot money and the undervaluation index has biased the estimators. Since Claessens, Dooley, and Warner (1995); Froot, O’Connell, and Seasholes (2001); and Bohn and Tesar (1998) have demonstrated that international portfolio flows are strongly persistent and the persistence decays only slowly over time, we add up to 2-period lag value of the dependent variable into the regression⁸. This shows that there is a gradual decreasing persistence in flow adjustment, which is generally consistent with the literature. It is possible that such a phenomenon has resulted from herding behavior by speculators, since enormous hot money inflow in previous times gave positive signals to speculators that are vulnerable to market sentiments.

⁸For the limitation in time length, we decided not to add longer lag values.

Table 2.4.1: Fixed effects estimation

Fixed effects Dependent Variable	1	2 Hot money (HM)	3
Change in expected currency returns (diffunderval)	0.0376 (0.0638)	0.0736 (0.0621)	0.0416 (0.0705)
1-period lag of hot money (LHM)		0.192*** (0.0339)	0.114*** (0.0372)
2-period lag of hot money (L2HM)			0.0724*** (0.0391)
Constant	-0.574*** (0.149)	0.176* (0.102)	0.195 (0.146)
Observations	1,057	1,051	887
R-squared	0.787	0.800	0.810

1. Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2.4.2 System Generalized Method of Moments (System-GMM)

Arellano-Bond (1991) and Arellano-Bover (1995)/Blundel-Bond (1998) have designed quite popular dynamic panel estimators for the following situations: (1) "small T, large N" panels, implying a few time periods and many individuals; (2) a linear functional relationship; (3) a single left-hand-side variable that is dynamic, depending on its own past realizations; (4) endogenous regressors; (5) fixed individual effects; and (6) heteroscedasticity and autocorrelation within individuals but not among them. The Generalized Method of Moments allows us to use lagged values of regressors as instruments for right-hand-side variables and lagged endogenous (left-hand-side) variables as regressors in short panels (number of identities > length of time). There are two kinds of GMM methods, Difference-GMM and its augmented edition, System-GMM. 'Difference GMM' is to transform all regressors, usually by differencing, and use the Generalized Method of Moments (GMM). 'System GMM' is to estimate simultaneously in differences and levels by adding an additional assumption-that first differences of instrumenting variables are uncorrelated with the fixed effects. This augmentation allows the introduction of more instruments and dramatically improves efficiency.

After comparison, we decide to conduct System-GMM estimation in our regression. The reasons are as follows: (1) According to Bond, Hoeffler, and Temple (2001), when time series are persistent and the number of time series observations is small, the first-differenced GMM estimator is poorly behaved because the lagged level of variables is weak instruments for the subsequent first differences. Since hot money flows are proved to be highly persistent and only short periods of data (7 years for each country) are available, first-differenced GMM estimators could be problematic for weak instruments. (2) Windmeijer (2005) finds that the two-step efficient GMM performs somewhat better than the one-step in estimating coefficients, with lower bias and standard errors. Additionally, two-step estimation with corrected errors seems slightly superior to a robust one-step estimation. (3) System-GMM allows us to include time-invariant regressors, which would disappear in Difference-GMM. This is because all instruments for the level equation are assumed to be orthogonal to all time-invariant variables. As expected, removing them from the error term does not affect the moments that are the basis for identification (Roodman 2006). This is suitable for our case, since we find that value of the capital openness index (we will use it for the robustness test) has barely changed for many countries during the sample periods and even turned out to be time invariant for some countries. Our regression based on System-GMM is shown in Table 2.4.2.

Table 2.4.2: Dynamic panel-data estimation, two-step system GMM

GMM	1	2	3	4	5	6
Dependent Variables			Hot money (HM)			
Change in expected currency returns (diffunderval)	0.0564 (0.109)	0.231*** (0.0879)	0.254** (0.104)	0.272*** (0.0901)	0.394** (0.163)	0.281* (0.144)
1-period lag of hot money (LHM)	0.433*** (0.126)	0.457*** (0.100)	0.513*** (0.1000)	0.332*** (0.120)	0.396*** (0.0927)	0.370*** (0.102)
2-period lag of hot money (L2HM)	0.440*** (0.167)	0.368*** (0.139)	0.324*** (0.103)	0.529*** (0.137)	0.443*** (0.113)	0.469*** (0.172)
Real GDP per capita, PPP (lnRGDPPC)		-0.0263*** (0.00767)	-0.0242*** (0.00790)	-0.0265* (0.0136)	-0.0459*** (0.0159)	-0.0236 (0.0189)
Change of GDP growth (diffGDPgrowth)			0.00238 (0.00182)			
Change of deposit interest (diffDepINT)				0.00816 (0.00811)		
Change of interest rate spread (lending rate minus deposit rate, %) (diffINTspread)					-0.000252 (0.00781)	
Capital openness index (kaopen)						0.000238 (0.0122)
Constant	0.0108 (0.0101)	0.255*** (0.0705)	0.215*** (0.0753)	0.258** (0.124)		0.219 (0.172)
Observations	887	887	887	707	641	745
Number of country	163	163	163	136	123	156
Arellano-Bond test for AR(1) in first differences $Pr > z$:	0.265	0.156	0.086	0.246	0.167	0.094
Arellano-Bond test for AR(2) in first differences $Pr > z$:	0.588	0.800	0.846	0.247	0.323	0.412
Hansen test of overid. restrictions: Prob > chi2:	0.245	0.285	0.498	0.705	0.506	0.026

1. Standard errors in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

2. Besides the standard year instruments, the sets of instrumental variables are: 2-period and longer lags of L2HM and diffunderval for GMM1; 2-period and longer lags of L2HM, diffunderval and lnRGDPPC for GMM2; 2-period and longer lags of L2HM, diffunderval, lnRGDPPC and diffGDPgrowth for GMM3; 2-period and longer lags of L2HM, diffunderval, lnRGDPPC and diffDepINT for GMM4; 2-period and longer lags of L2HM, diffunderval, lnRGDPPC and diffINTspread for GMM5; 2-period and longer lags of L2HM, diffunderval, lnRGDPPC and kaopen for GMM6.

Before analyzing results, it is essential to check the validity of the instruments. First, we check situation of autocorrelations by using the Arellano-Bond test. As is known, the Arellano-Bond test is applied to the residuals in differences. Since the differenced residual in period t is inevitably related to the previous one (they share a common residual term in period $t-1$), first-order serial correlation is expected in the differences. Usually, in such a case, we see second-order correlation in differences to check for first-order serial correlation in levels. As we can see from Table 2.4.2, all the regressions in Table 2.4.2 have demonstrated failure to reject the null hypothesis of no autocorrelation in the Arellano-Bond test for AR(2). Second, we use the Hansen test for overall validity of the instruments⁹. The null hypothesis of the Hansen test is that all the instruments are exogenous (except GMM6). The P-values in the Hansen test have demonstrated the validity of the instruments in our regression.

After checking the validity of the instruments, we examine the estimated coefficients of change in expected currency returns (*diffunderval*). As before, the sign of estimated coefficients on *diffunderval* is positive. We find that after solving the endogenous problem of *diffunderval* and controlling for country-specific, time-variant economic environments, the return-chasing effect turns out to be statistically significant. It is demonstrated that there is a significant return-chasing effect between hot money inflow and a change in expected currency returns, which is in line with our hypothesis. Moreover, we find that no matter which robust variables have been added in the regression, the value of the estimated coefficient is generally stable in a range of $0.23 \sim 0.39$. This implies that every 1 percent increase in expected returns on national currency will attract 0.23 percent to 0.39 percent more hot money inflow after controlling for country-specific, time-variant economic environments.

We also find that there have been slow dynamic adjustments in hot money inflow. The 2-period early information on hot money flow still exerts significant influence on the current choices of speculators. The effect of real GDP per capita on hot money flow has remained negative, which is opposite from our expectation. This is because on standard Balassa-Samuelson grounds, a higher real GDP per capita will lead to a lower estimated real exchange rate, indirectly increasing the expected undervaluation index in the current period and causing an increase in expected currency returns. However, it is worth noting that this negative effect from real GDP per capita is quite limited compared to other regressors, only averaging around 0.03 in our cases. We also control for the effect of a country's degree of capital account openness by using the Chinn-Ito index. Although the positive sign is in line with the expectation, it turns out to be insignificant for hot money.

⁹We only report the Hansen test because it is more robust than the Sargan test and more reliable for our purposes.

On the other hand, we find that other possible sources of expected returns, such as the interest rate differential (deposit interest and interest rate spread) or GDP growth rate, do not have significant influence on hot money inflow. Therefore, based on the results shown in Table 2.4.2, we conjecture that movements in expected currency returns have been the main driving force of hot money inflow since 2005.

2.5 Conclusion

In this chapter, we empirically investigate whether higher expected currency excess returns, indexed by currency undervaluation, account for the inflow of international speculative capital by using large-sample panel data. To our knowledge, few studies have attempted to use such an index to measure currency returns and investigated its empirical relationship with hot money for large numbers of countries. Our theoretical framework is based on the return-chasing hypothesis proposed by Bohn and Tesar (1996). To overcome the bias due to the endogenous problem, we adopt the System Generalized Method of Moments to conduct empirical analysis. As a result, we find that when controlling for the country-specific, time-variant economic environments, there is a significant return-chasing effect on the expected currency excess returns and hot money. Further, other possible sources of expected returns (such as the interest rate differential) cannot adequately explain the dynamics of hot money inflow according to our results.

Chapter 3

Macroeconomic Effects of Financial and Productivity Shocks in Japan : A Case for a Small Open Economy

3.1 Introduction

Recently, there has been an increase in literature focusing on financial constraints and their roles in aggregate economies. Different from many studies that emphasized the propagating effects of financial frictions¹, Benk, Gillman, and Kejak (2005) began to consider credit shocks that originate from bank sectors and suggested that these shocks could be candidates for accounting for the growth of gross domestic product (GDP). Since then, many researchers have begun to focus on the direct effects of financial shocks to macroeconomies. Among recent studies, Jermann and Quadrini (2012) quantitatively show that financial shocks, that is, perturbations that originate directly from financial sectors, have played a key role in accounting for the U.S. economy, not only for business fluctuations, but also for the dynamics of financial flows. After noticing that financial flows have displayed features similar to those in the United States, we applied the model of Jermann and Quadrini (2012) to explore the importance of these financial shocks in the Japanese economy and attempted to conduct simulations on key indicators, such as output, consumption ratio, and investment ratio.

First, we found that aggregate financial flows, that is, aggregate debt flows and dividends flows, in Japan have shown some cyclical features since 2001². Figure 3.1.1 (a)

¹Such as Kiyotaki and Moore (1997); Bernanke, Gertler, and Gilchrist (1999); Mendoza and Smith (2006); and Mendoza (2010).

²The time span we used was selected for three reasons: (1) As we show later, the corporate tax rate is an important parameter in our study. Since there are several adjustments in corporate tax rate

describes aggregate dividend flows paid to shareholders in Japan and the log value of Japan's GDP. Both data are from the Statistics of Japan and have been seasonally adjusted. Financial data is normalized by GDP. According to this figure, we find that there is a somewhat positive relationship between these two variables. However, Figure 3.1.1 (b) plots net debt repurchases in nonfinancial corporate business (normalized by GDP) and the log value of GDP. Here net debt repurchases indicate a net reduction in firms' outstanding debt. Outstanding debt includes corporate bonds, bank loans, foreign debt, and financial derivatives, and these data are all from the Bank of Japan. If firms increase their debt issuance, the value of net debt repurchases will become negative. Through this simple but effective indicator, we can easily capture the dynamics of firms' debt-financing activities. Figure 3.1.1 (b) implies that there is a positive relationship between net debt repurchases and GDP. Especially after 2004, this relationship becomes even more obvious. Therefore, we conjecture that the Modigliani-Miller theorem does not hold in Japan, and it is reasonable for us to conjecture that there have been financial frictions in Japan's financial sector since at least 2001.

Enlightened by such a finding, we decided to apply Jermann and Quadrini's (2012) framework to explore the role of financial shocks in the Japanese economy. First, we applied Jermann and Quadrini's (2012) business cycle model and computed parameters to fit the properties of empirical counterparts. This model includes explicit roles for debt and dividend, which is helpful in capturing cyclical properties of financial flows. Additionally, this model includes two features: (1) firm prefers debt to equity financing due to its tax benefit, and (2) the existence of financial rigidity when firms want to change tools of financing and the degree of this rigidity as reflected by the cost of dividend adjustment. Financial shocks in this model are denoted by the disturbances that affect firms' ability to borrow.

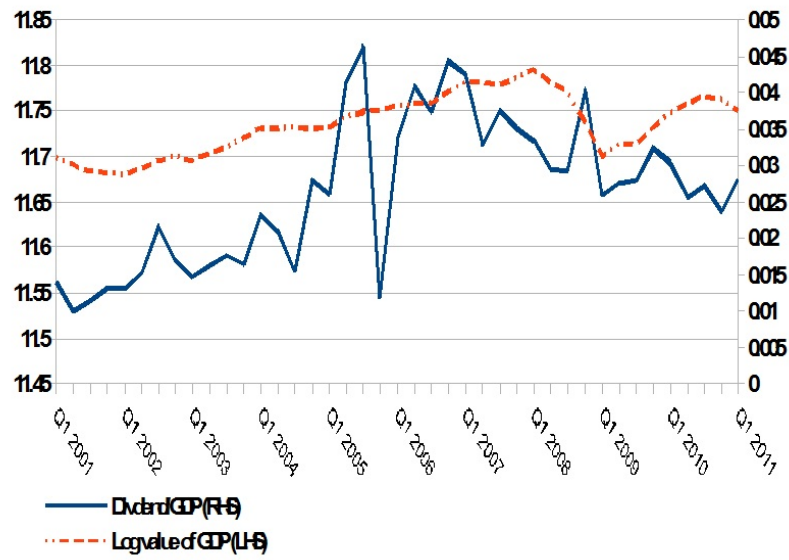
Second, we constructed productivity and financial shocks by quarterly time series for Japan. Productivity shocks are computed as the Solow residuals. Financial shocks are computed by a similar method, that is, we constructed this series as residuals of the enforcement constraint in the model. Using the constructed shock series, we not only conducted impulse responses to two kinds of shock but also made simultaneous replications on key indicators of real variables and aggregate financial flows. Preliminary simulation results in a closed economy show that financial shocks seem less important to the Japanese economy than to the U.S. economy. However, after we extend the closed

before 2000, we chose a long period (after 2000) without tax rate adjustment so as to exclude its possible effect. (2) The Bank of Japan has adopted a new method of statistics (Flow of Funds (1993 SNA)) since 1997Q12; therefore, there would be an inevitable gap in data if we chose data from a period earlier than 1997. (3) Quarterly dividend flows in real value (2005=100) started in 2001. Based on the above reasons, we chose 2001 as the beginning of the period.

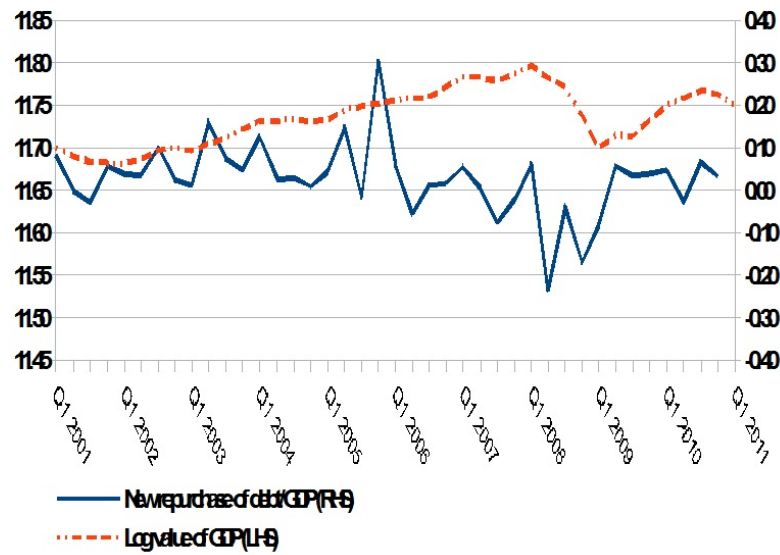
economy model to a small open economy in which firms can borrow from overseas lenders but have to pay a default risk premium on interest payments, we find that financial shocks could play a dominant role in capturing the dynamics of financial flows in Japan. This is consistent with Jermann and Quadrini (2012). By contrast, productivity shocks play an important role in explaining macroeconomic fluctuations whether in closed or open economies. Therefore, we conclude that financial shocks are important in understanding movements in Japanese financial flows, while productivity shocks matter for the real variables. This is in line with the findings of Kaihatsu and Kurozumi (2010), which also show that the main driving force of output fluctuations is the technology shock. This chapter is related to several areas of study. First, it is related to studies about the role of financial sectors in macroeconomies. As we introduced at the beginning of this chapter, two views recently dominate: one is the shock-propagating effect of financial sectors, and the other is the direct effect of financial disturbances on aggregate economies. Representative studies about the former view include Kiyotaki and Moore (1997); Bernanke, Gertler, and Gilchrist (1999); Mendoza and Smith (2005); and Mendoza (2010). However, our study is more related to the latter view, which is advocated by Jermann and Quadrini (2012); that is, we try to explore the possible direct effect of financial disturbances on the aggregate economy. Other literature that starts from this view includes Benk, Gillman, and Kejak (2005); Christiano, Motto, and Rostagno (2008); Kiyotaki and Moore (2008); and Del Negro, Eggertsson, Ferrero, and Kiyotaki (2010). Most of these studies are conducted within a closed economy framework, while we analyze problems within both closed and open economies. Another contribution in this direction is Hirakata, Sudo, and Ueda (2011), but it focuses on shocks to financial intermediaries' net worth.

Another topic related to our chapter is the DSGE models within a small open economy. Studies related to this field are Otsu (2010); Fujiwara and Teranishi (2011); and Christiano, Trabandt, and Walentin (2011). Otsu (2010) conducts a stochastic business cycle accounting simulation to investigate how the wedges acting as exogenous shocks affected the East Asian economics over the 1990-2003 period. Our study is different from it in that we focus on "which" shocks are important rather than "where" the important shocks are. Fujiwara and Teranishi (2011) constructed a new open economy macroeconomic model with staggered loan contracts as a simple form of financial friction. However, the main focus of their study was the effect of financial friction to the real exchange rate dynamics, which is different from our focus in this chapter. Christiano, Trabandt, and Walentin (2011) changed the standard new Keynesian model by incorporating financing friction for capital and employment friction for labor and further extending the model into a small open economy setting. They found that financial shock is pivotal for explaining fluctuations in investment and GDP in the Swedish economy.

Figure 3.1.1



(a) Aggregate dividend flows and Japan's GDP



(b) Net debt repurchases and Japan's GDP

Our chapter is structured as follows: Section 2 reviews the closed model suggested by Jermann and Quadrini (2012), constructs time series of productivity and financial shocks, and applies them to the closed economy. Section 3 proposes a small open economy version by incorporating foreign debt and default risk premium on interest and studies the quantitative properties again. Section 4 concludes.

3.2 Case 1: A closed economy with financial frictions

In this section, we start with a brief review of Jermann and Quadrini (2012) and make a quantitative analysis with quarterly data from Japan. A closed economy model contains three sectors: households, firms, and financial sectors. There are four basic assumptions in this environment: (1) Due to tax benefits, firms prefer to use debt financing instead of equity financing. (2) Firms not only face enforcement constraints when conducting debt financing in markets but also incur additional costs when adjusting equity payout. (3) Firms prefer not to change production plans. (4) Financial constraints are binding all the time³.

3.2.1 Model

3.2.1.1 Firms

There is a continuum of firms in the $[0,1]$ interval. At the beginning of the period, firms hold capital k_{t-1} and intertemporal liabilities b_{t-1}^H . Here b_{t-1}^H indicates the beginning-of-period value of intertemporal liabilities in period t , and positive value denotes liabilities. Before conducting production activities, firms repay previous debts b_{t-1}^H and choose labor input l_t , investment i_t , equity payout, adjustment cost⁴, and next-period debt b_t^H . Payments to workers, suppliers of investments, equity holders, and previous debt holders must be made before the realization of revenues, so firms need to take intraperiod loans (no interest occurs) from lenders. Firms will repay these loans after the realization of revenues.

There are two ways for firms to finance their production activities: equity and debt. Debt is preferred to equity due to its tax advantage. Concretely speaking, if r_t represents the interest rate of an intertemporal loan, the effective gross rate for the firm is $1 + r_t(1 -$

³When we conduct simulations on the Lagrangian multipliers of enforcement constraints, we find the fluctuations of their values are less than 100 percent of their steady-state values; therefore, this assumption seems reasonable in our models.

⁴This will be introduced later.

τ), where τ is equal to the tax benefit. Since interest payments on corporate debt are treated as an operational cost, every one unit of debt will save firms τ units of tax payment when compared with equity financing. The problem of firms is maximizing their present equity value, which is equal to the total expected discounted value of equity payout d_t paid to the shareholders. The optimization problem is:

$$E_0 \left[\sum_{t=0}^{\infty} m_t d_t \right]$$

s.t

$$y_t - w_t l_t + \frac{b_t^H}{1 + r_t(1 - \tau)} = b_{t-1}^H + i_t + \varphi(d_t) \quad (3.1)$$

$$y_t = z_t k_{t-1}^\theta l_t^{1-\theta} \quad (3.2)$$

$$i_t = k_t - (1 - \delta)k_{t-1} \quad (3.3)$$

$$\varphi(d_t) = d_t + \kappa(d_t - d)^2 \quad (3.4)$$

$$\xi_t(k_t - \frac{b_t^H}{1 + r_t}) \geq y_t, \quad (3.5)$$

where m_t is the stochastic discount factor decided by shareholders, the value of which is equal to that of the household, and taken as given. Equation (3.1) represents the budget constraint of the firm. The gross revenue of the firm is y , which is represented by the production function equation (3.2), where z_t represents total factor productivity in period t . Wage rate and interest rate, w_t and r_t , respectively, are determined in the general equilibrium. Here b_t^H represents intertemporal debt issued in the domestic financial markets, which are only purchased by domestic households. Finally, i_t represents investment in period t , which is equal to equation (3.3).

As equation (3.4) shows, $\varphi(d_t)$ is equal to equity payout plus the adjustment cost; d is the long-run dividend target; and $\kappa > 0$ is a parameter to reflect the rigidity that affects the substitution between debt and equity. Jermann and Quadrini (2012) emphasized that this parameter should not be interpreted as a pecuniary cost but should be accepted as a way of modeling how flexibly firms can adjust sources of funds. The larger the value of κ , the more inflexible the substitution between debt and equity becomes. Jermann and Quadrini (2012) mentioned that κ is the key factor determining the impact of financial shocks.

Firms face enforcement constraints when they borrow intraperiod debt from financial sectors, since they could default on the obligations. Equation (3.5) represents financial constraints in a linearized form. A simple way to interpret this equation is that the largest amount firms can borrow intraperiod from the public in period t is equal to a fraction ξ_t of

the equity value at the end of period, and not more than gross revenues y . Here ξ_t is stochastic and same for all firms, and the financial shocks we indicate are the stochastic innovations of ξ_t . Therefore, financial shocks can be treated as aggregate shocks. Here, we assume that enforcement constraints are binding prior to shocks and that firms prefer not to change production plans. To understand the effect of ξ_t , Jermann and Quadrini (2012) rewrote the enforcement constraint by assuming $\tau = 0$:

$$\left(\frac{\xi_t}{1 - \xi_t}\right) [(1 - \delta)k_{t-1} - b_{t-1}^H - w_t l_t - \varphi(d_t)] \geq F(z_t, k_{t-1}, l_t),$$

Whether financial shocks affect production plans is decided by the rigidity of substitution between debt and equity financing. If adjusting the dividend costs too much, firms would have to change the production plan and, therefore, change labor inputs. For this reason, Jermann and Quadrini (2012) advocate that, supposing constraints are binding all the time, financial shocks could affect the real economy through enforcement constraints.

We define η_t and λ_t^f respectively as the Lagrangian multipliers of enforcement constraints and budget constraints in period t . The first-order conditions of firms are:

$$1 = \lambda_t^f [1 + 2\kappa(d_t - d)] \quad (3.6)$$

$$w_t = \left(1 - \frac{\eta_t}{\lambda_t^f}\right) (1 - \theta) \frac{y_t}{l_t} \quad (3.7)$$

$$1 - \frac{\eta_t}{\lambda_t^f} \xi_t = m_{t+1} \frac{\lambda_{t+1}^f}{\lambda_t^f} \left[1 - \delta + \left(1 - \frac{\eta_{t+1}}{\lambda_{t+1}^f}\right) \theta \frac{y_{t+1}}{k_t}\right] \quad (3.8)$$

$$\frac{1}{1 + r_t(1 - \tau)} - \frac{\eta_t}{\lambda_t^f} \xi_t \left[\frac{1}{1 + r_t}\right] = m_{t+1} \frac{\lambda_{t+1}^f}{\lambda_t^f}. \quad (3.9)$$

Equation (3.6) implies that when the amount of equity payout is larger than the long-run target, the marginal utility of the additional unit of dividend becomes smaller than its marginal cost. By contrast, if equity payout is lower than the steady-state value, the marginal utility of the dividend will become larger than 1. Equation (3.7) is the key equation in Jermann and Quadrini (2012), since it reveals the main channel through which financial shocks influence the real economy. When enforcement constraints are not binding, the marginal cost of labor is equal to its marginal utility. However, when financial conditions worsen and enforcement constraints become more binding, the Lagrangian multiplier η_t becomes larger than zero, and a labor wedge will lead to efficiency loss. Consequently, the demand for labor would decrease due to a higher wage rate. It should

be noted that the labor wedge is related not only to the tightness of the enforcement constraint but also to the rigidity of financing substitution κ . Higher rigidity will induce a higher labor wedge, since the cost of changing the source of funds is higher.

Equation (3.8) tells us that the conditions of k_{t+1} will be optimal if the marginal cost of capital is equal to its marginal benefit. Compared with the standard real business cycle (RBC) model, the existence of enforcement constraints reduced the marginal cost of capital, since an additional unit of capital increases the collateral value and relaxes constraints. However, the efficiency of capital in the next period is reduced because the increase in capital implies larger intraperiod loans, and the enforcement constraints will tighten in the next period. Equation (3.9) implies that the marginal benefit of intertemporal debt becomes smaller, since larger liabilities could tighten enforcement constraints and induce extra loss.

3.2.1.2 Households

There is a continuum of homogeneous households in the $[0,1]$ interval. Households receive wages from firms, trade shares of firms, and hold noncontingent bonds issued by firms in every period. The problem of households is maximizing the lifetime utility as follows:

$$E_0 \sum_{t=0}^{\infty} \beta^t [\ln c_t + \alpha \ln(1 - l_t)]$$

s.t

$$w_t l_t + s_t(d_t + p_t) + b_{t-1}^H = \frac{b_t^H}{1 + r_t} + s_t p_t + c_t + T_t, \quad (3.10)$$

where

$$T_t = \frac{B_t^H}{1 + r_t(1 - \tau)} - \frac{B_t^H}{1 + r_t},$$

where c_t is consumption, l_t is labor, and β is the time discount factor. In the utility function, α is a parameter representing the disutility of labor. Equation (3.10) represents the budget constraint of the household. The one-period bonds issued by firms are represented by b_t^H ; s_t and q_t , respectively, are the amount of equity shares and the share price; and T_t is the lump-sum tax that governments collect from households to subsidize firms' debt-financing activities. Then we derive first-order conditions as follows:

$$\frac{w_t}{c_t} = \frac{\alpha}{1 - l_t} \quad (3.11)$$

$$U_c(c_t, l_t) - \beta(1 + r_t)EU_c(c_{t+1}, l_{t+1}) = 0 \quad (3.12)$$

$$1 = \beta \frac{\lambda_{t+1}^h}{\lambda_t^h} \left(\frac{d_{t+1} + p_{t+1}}{p_t} \right), \quad (3.13)$$

where λ_t^h is the Lagrangian multiplier of a household's budget constraint. Equation (3.11) is the household's decision rule on labor supply, and equation (3.12) is the key condition to decide the risk-free interest rate. Based on equation (3.13) and equation (3.12), we obtain the stochastic discount factor:

$$m_{t+1} = \beta \frac{\lambda_{t+1}^h}{\lambda_t^h} = \frac{1}{1 + r_t}. \quad (3.14)$$

3.2.1.3 Market-clearing conditions

When a market clears, we suppose that the total quantity of equity shares is equal to 1 unit. We assume that large characters represent aggregate variables, and small characters indicate variables of individual agents. Therefore,

$$S = 1. \quad (3.15)$$

Since all the market participants are assumed to be identical and take the same actions, the total resource constraint is:

$$Y_t = I_t + C_t + \kappa(D_t - D)^2 \quad (3.16)$$

$$Y_t = y_t \quad I_t = i_t \quad C_t = c_t \quad D_t = d_t \quad K_t = k_t \quad (3.17)$$

$$B_t^H = b_t^H. \quad (3.18)$$

Definition 3.2.1. (Competitive equilibrium of a closed economy) A competitive equilibrium is defined as a set of functions for:

- Households' policies c_t , l_t , and b_t^H .
- Firms' policies d_t , l_t , b_t^H , and i_t .
- Aggregate prices w_t , r_t , m_{t+1} , and p_t .

Such that:

- Households' policies satisfy conditions (10)-(13), given w_t , r_t , p_t , and T_t .
- Firms' policies are optimal, given w_t , r_t , k_{t-1} , z_t , ξ_t , and m_{t+1} .
- The wage and interest rates clear the labor and bond markets, and $m_{t+1} = \beta \frac{U_c(C_{t+1})}{U_c(C_t)}$.

3.2.2 Quantitative analysis

In this section, we show that in a closed economy model with financial frictions, financial shocks can explain the aggregate dividend flows to a certain extent but cannot capture the aggregate debt flows at all. In comparison, productivity shocks play an important role in replicating the movements of real variables but have little relationship with the movements of financial flows such as debt.

3.2.2.1 Data and parametrization

In this chapter, we apply the seasonally adjusted quarterly data of Japan to a closed economy model. We chose data from 2001 because there was a tax reform in fiscal year 1999. That is, corporate tax (national) was reduced from 34.5 to 30 percent. In order to study effects from financial shocks and productivity shocks, we chose periods without reforms in the basic corporate tax rate. Financial data such as average contracted lending rate, interest rate, and liabilities of nonfinancial corporate businesses⁵ are taken from the Bank of Japan, while other data such as dividends of corporate businesses, real gross domestic product, gross capital formation of corporate business, and domestic final consumption expenditure of households are from the Cabinet Office⁶ and are taken at the real value (2005=100). Average working hour per week is computed as follows: (average working hour per week in all industries $\times$ working population in all industries) $\div$ (labor force $\times$ 24hours $\times$ 7days). Capital stock is calculated as follows: (capital stock of nonfinancial corporate business (end of last period) + gross capital formation of corporate business⁷ – consumption of fixed capital). We use the net wealth of nonfinancial corporate businesses at the end of 1980 as the initial value and divide the constructed nominal capital stock by the GDP deflator (2005=100). Other data such as basic corporate tax rate are from the Ministry of Finance, Japan. Average majority prime rate charged by banks in the United States (the world interest rate) is from the Board of Governors of the Federal Reserve System. All data are seasonally adjusted by Census X12 (except interest rate) and are detrended by the Hodrick-Prescott filters with a default smoothing parameter of 1600. Table 3.2.1 shows parameters computed by the long-run targets or the second moments of data.

⁵Liabilities of nonfinancial corporate businesses are constructed by adding corporate bonds, bank loans, foreign debt, and financial derivatives and adjusting by the GDP deflator (2005=100).

⁶Data from the Cabinet Office are obtained from the Office Portal Site of Official Statistics of Japan, developed by Statistics Japan.

⁷This is calculated by subtracting gross fixed capital formation and inventory of government from gross capital formation.

Table 3.2.1: Parameters set by the long-run targets or the second moments

Parameters	Value
Discount factor	0.982
Tax advantage	0.300
Utility parameter	1.799
Production technology	0.362
Depreciation rate	0.049
Enforcement parameter	0.636
Payout cost parameter	3.150

1. Long-run targets are calculated based on seasonally adjusted quarterly data of Japan.

The discount factor is set to 0.982 because the steady-state value of the average contract interest rate is 1.86 percent. The tax advantage is set to 0.30 because the interest payment is exempt from corporate tax. The disutility parameter is set to 1.799 to make the steady-state value of relative working hours equal to 0.329, which is equal to the relative length of working hours per quarter. The Cobb-Douglas parameter in the production function follows Hayashi (2002). The depreciation rate is set so the output per capital ratio is equal to 0.174. The enforcement parameter is computed by the long-run target of output, capital stock, and domestic liabilities of nonfinancial corporations in Japan. The payout cost parameter κ was chosen to have a standard deviation of dividend output ratio generated by the model equal to the empirical standard deviation 0.0061.

An important procedure in this chapter is to construct productivity and financial shocks. Basically, we follow the standard Solow residuals approach, computing productivity shocks from the linearized form of production function as follows:

$$\hat{z}_t = \hat{y}_t - \theta \hat{k}_{t-1} - (1 - \theta) \hat{l}_t,$$

where hat variables imply percentage deviations from deterministic trends, or long-run targets. Using time series data of output, capital stock, and working hours, we obtain the series of $\hat{z}_t$ and further derive innovations $\epsilon_{z,t}$ of $\hat{z}_t$ by the following equation:

$$\hat{z}_{t+1} = \rho_z \hat{z}_t + \epsilon_{z,t+1}.$$

As to financial shocks, we apply a similar approach to derive innovations of financial variable $\hat{\xi}_t$. An important assumption of this chapter is that enforcement constraints are always binding. Therefore, we derive an empirical series of $\hat{\xi}_t$ from the linearized form of

the enforcement constraint as follows:

$$\hat{\xi}_t = \hat{y}_t - \frac{\xi K}{Y} \hat{k}_t + \frac{\xi B}{Y} \hat{b}_t^e,$$

where hat variables denote log deviations from long-run targets. Large characters without time scripts denote the steady-state value of aggregate variables ⁸. The end-of-period value of debt is represented by $\hat{b}_t^e = \hat{b}_t^H / (1 + r_t)$. The empirical counterparts we use here are the domestic liabilities of nonfinancial corporations collected from the Bank of Japan and adjusted to real terms by GDP deflators (2005=100). The log value is linearly detrended by the Hodrick-Prescott filter. Following the construction of productivity shocks, we derive innovations $\epsilon_{\xi,t}$ by the following equation:

$$\hat{\xi}_{t+1} = \rho_{\xi} \hat{\xi}_t + \epsilon_{\xi,t+1}.$$

We summarize the properties of constructed series in Table 3.2.2.

Table 3.2.2: Parameters calculated by the time series of Japan

Description	
Std of productivity innovations	0.0107
Std of financial innovations	0.0349
Autocorrelation of TFP	0.7416
Autocorrelation of enforcement parameter	0.7378

In the following section, we follow Jermann and Quadrini (2012) to use series of innovations $\epsilon_{z,t}$ and $\epsilon_{\xi,t}$ to replicate the series of z_t and ξ_t . It should be noted that market analysts do not anticipate innovations that occur in every period; they only use the autoregressive function to forecast shocks in the next period. Therefore, by using an innovations series, we can replicate continuous exogenous shocks, simulating real external environments in models.

3.2.2.2 Impulse response

In this section, we will explore the impulse response of productivity shocks and financial shocks, respectively. First, we assume that no unexpected financial shock has occurred,

⁸ We tried two methods of constructing the parameters $\frac{\xi K}{Y}$ and $\frac{\xi B}{Y}$. One is to use a fixed long-run steady-state value of each variable; the other is to use the deterministic trend derived from the Hodrick-Prescott filter. Both ways derive similar series of $\hat{\xi}_t$.

only productivity shocks. According to the following equation,

$$\left(\frac{\xi_t}{1-\xi_t}\right) \{(1-\delta)k_{t-1} - b_{t-1}^H - w_t l_t - [\frac{b_t^H}{1+r_t(1-\tau)} - \frac{b_t^H}{1+r_t}] - \varphi(d_t)\} \geq F(z_t, k_{t-1}, l_t),$$

which is rewritten in light of firms' budget constraints and enforcement constraints, we know that after receiving productivity shocks, firms can adjust their labor input, new intertemporal debt, or equity payout to reach balance again. As Figure 3.2.1 shows, after receiving a one-time negative productivity shock, enforcement constraints suddenly get looser, and the values of their Lagrangian multiplier η instantly drop. Under this circumstance, because the marginal cost of debt suddenly declines, firms first choose to increase the intertemporal debt position for its low financing cost. As there is change in the value of η , equation (3.7) implies that if firms want to keep their original production plans, they have to increase their equity payout. However, because there is additional cost in adjusting dividend, firms choose to increase demand for labor. After a short period, enforcement constraints become binding again, and the tightness of enforcement constraints makes firms' debt-financing cost more than the previous period; therefore, firms need to reduce new intertemporal debt as well as other expenditures. Although firms want to keep production plans unchanged, adjustments in the cost of dividends still force them to reduce part of the labor input.

However, if we assume that there are financial shocks but no productivity shocks, responses of aggregate debt and dividend flows show different styles. We show the impulse responses of key variables in Figure 3.2.2. After receiving a one-time negative financial shock, enforcement constraints suddenly become tighter, and the Lagrangian multiplier of enforcement constraints η_t becomes dramatically larger than its steady-state value. Therefore, debt financing becomes costly, and firms begin to reduce their new borrowing for the next period. Under these circumstances, if firms want to keep their production plans unchanged, they have to reduce their dividend according to equation (3.7). However, the adjustment costs force firms to reduce labor input to control the total cost. As the firms' debt position becomes smaller, the value of multiplier η_t drops. Since the marginal cost of debt financing becomes cheaper, firms choose to use debt financing again, so debt repurchases drop below the steady-state level.

3.2.2.3 Simulation

In this part, we simulate series in order to check whether financial shocks matter for the movements of aggregate financial flows or real variables. Before showing figures, we first present standard deviations of simulated series and empirical data. According to Table

Figure 3.2.1: Response to a one-time negative productivity shock in a closed economy

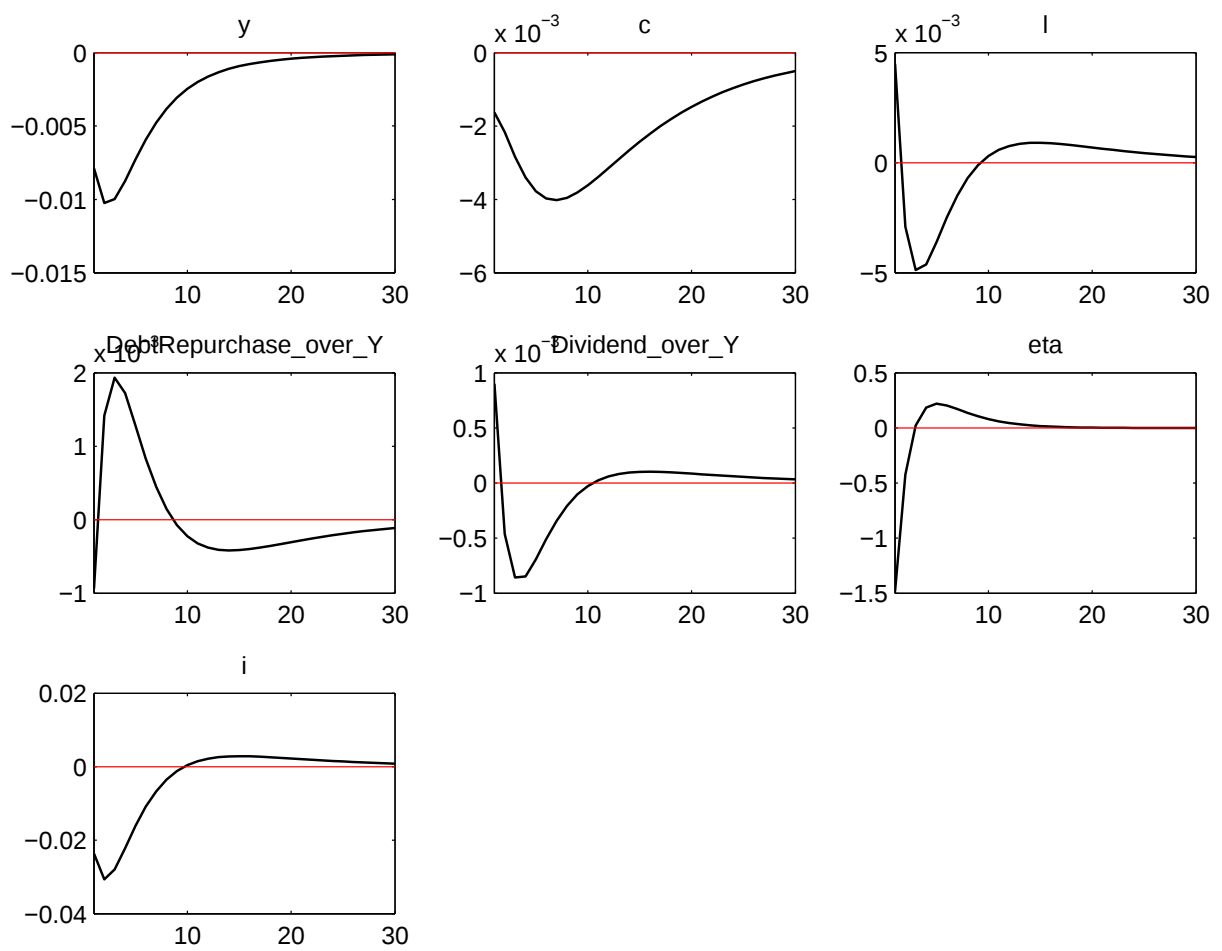
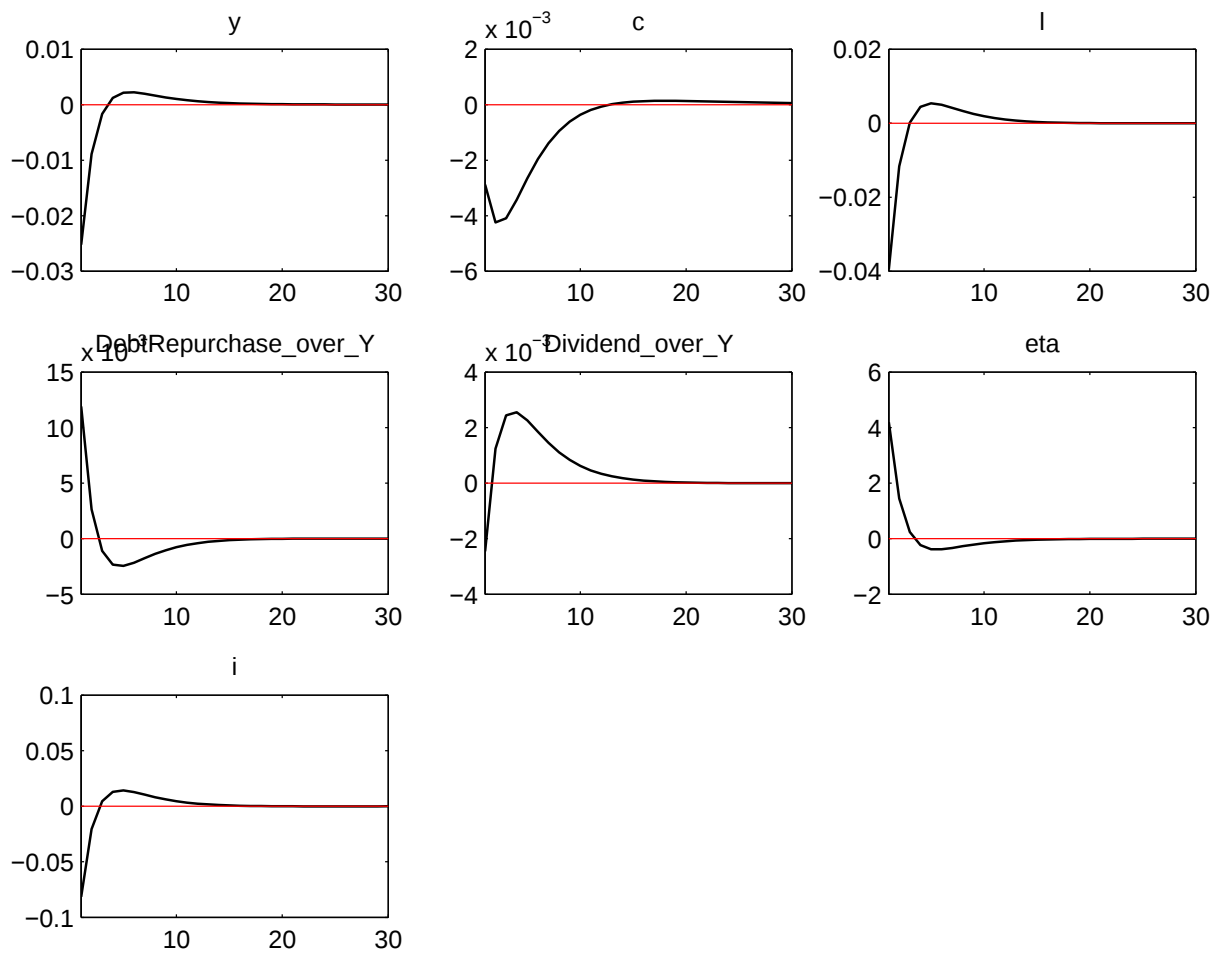


Figure 3.2.2: Response to a one-time negative financial shock in a closed economy



3.2.3, we see that simulated volatilities of debt repurchases are far lower than the real value. As to dividends, the standard deviation generated by financial shocks is closer to the data. Yet we can see that in a closed model with only productivity shocks, second moments of simulated macroeconomic variables match the real data quite well, especially for labor and investment. By contrast, standard deviations of real variables generated only by financial shocks are mostly too large.

In order to further confirm the importance of financial shocks, we would like to show the whole process of simulation using figures. Figure 3.2.3 shows that empirical data of debt repurchases is far more volatile than simulated series, but dividends generated by financial shocks show a better performance. However, although the rebound of dividends in later 2005 is captured very well, simulated dividends still fail to account for the peak in early 2005. As to real variables, productivity shocks play a significant role in capturing the dynamics of key real variables. Figures 3.2.4 and 3.2.5 show that series generated by productivity shocks capture the trends of empirical data quite well, especially for labor and output. However, simulated consumption and investment seem more volatile than the data, especially after 2008. By contrast, as to real variables simulated by financial shocks, they are more volatile than the real level of empirical data. One thing we would like to emphasize is that, although second moments imply that the performances of simulated output and investment ratio are similar, Figures 3.2.4 and 3.2.5 show that the performance of output series is actually better than that of investment. Therefore, it reminds us that when we check the performance of the model, besides the second moments, presenting the simulation result by figure is also helpful for drawing conclusions.

Table 3.2.3: Estimated business cycle properties in a closed economy : second moments

Variables	Data	Model:only PS	Model:only FS
<i>Financial Variables</i>			
Dividend/GDP	0.0061	0.0017	0.0048
Debt repurchases/GDP	0.0789	0.0037	0.0151
<i>Macroeconomic Variables</i>			
Output	0.0186	0.0233	0.0342
Consumption ratio	0.0124	0.0194	0.0282
Investment ratio	0.0510	0.0489	0.0712
Hours	0.0084	0.0094	0.0517

Figure 3.2.3: Simulation in a closed economy (- - -: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

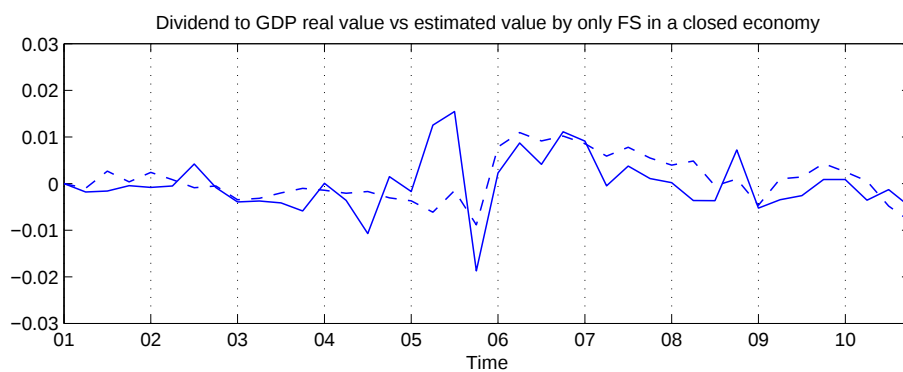
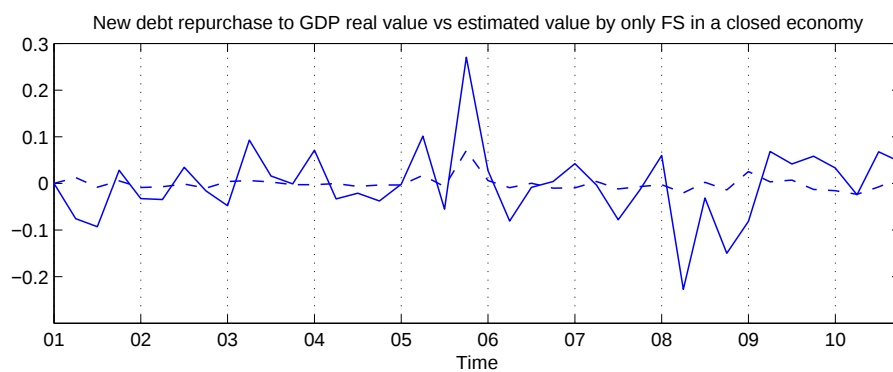
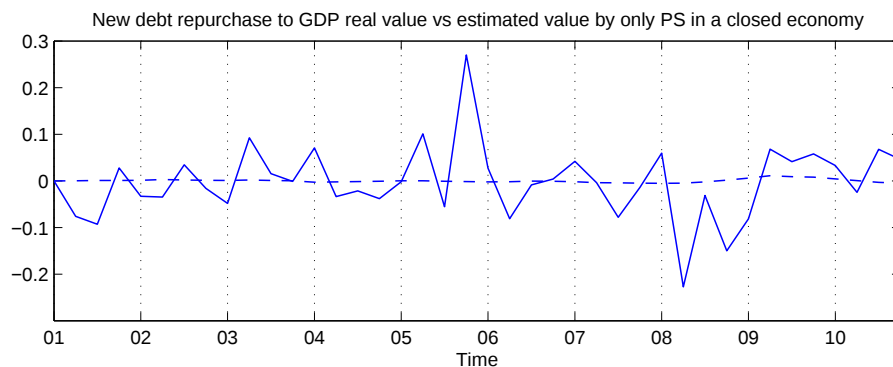


Figure 3.2.4: Simulation in a closed economy (- - -: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

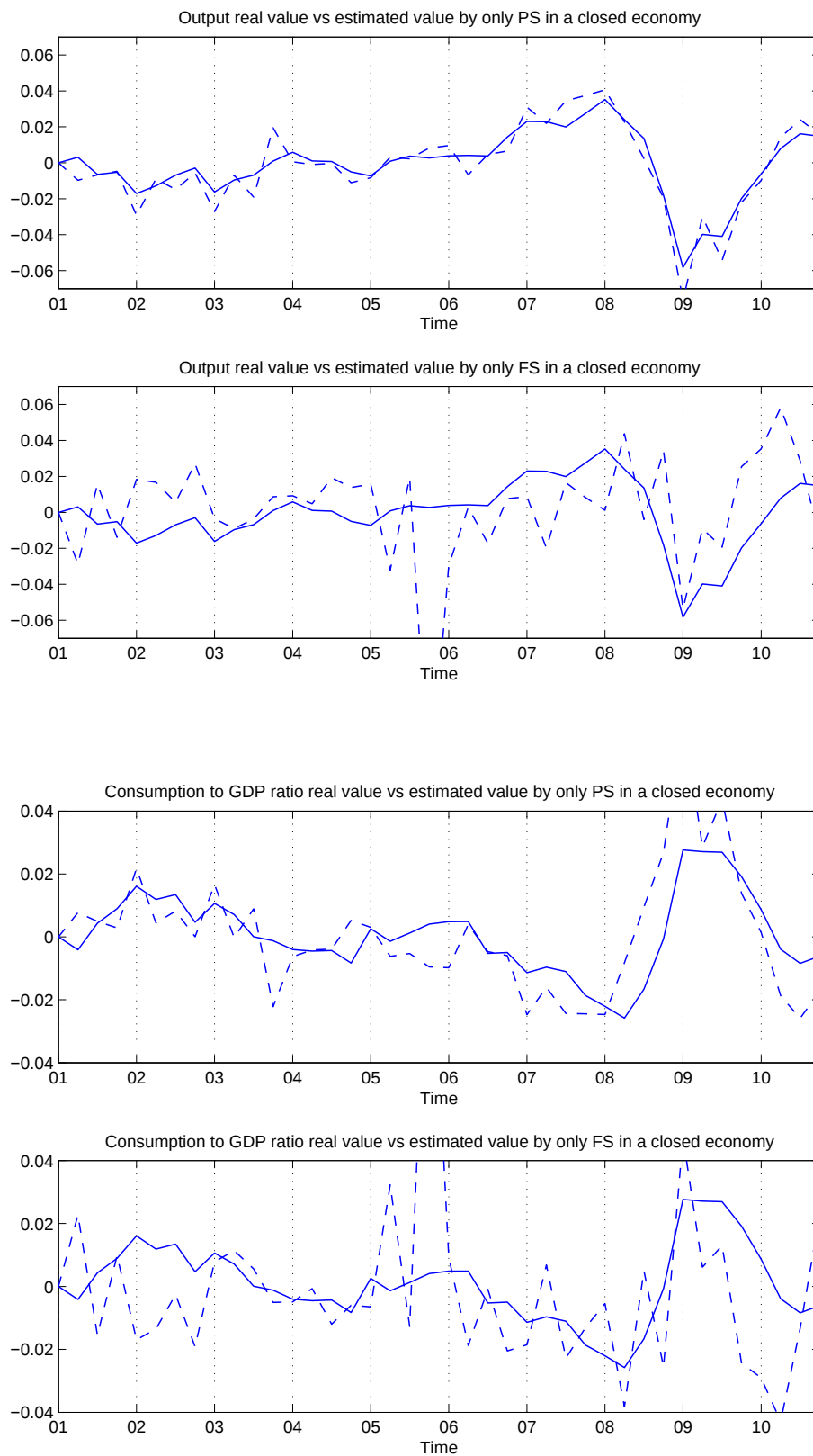
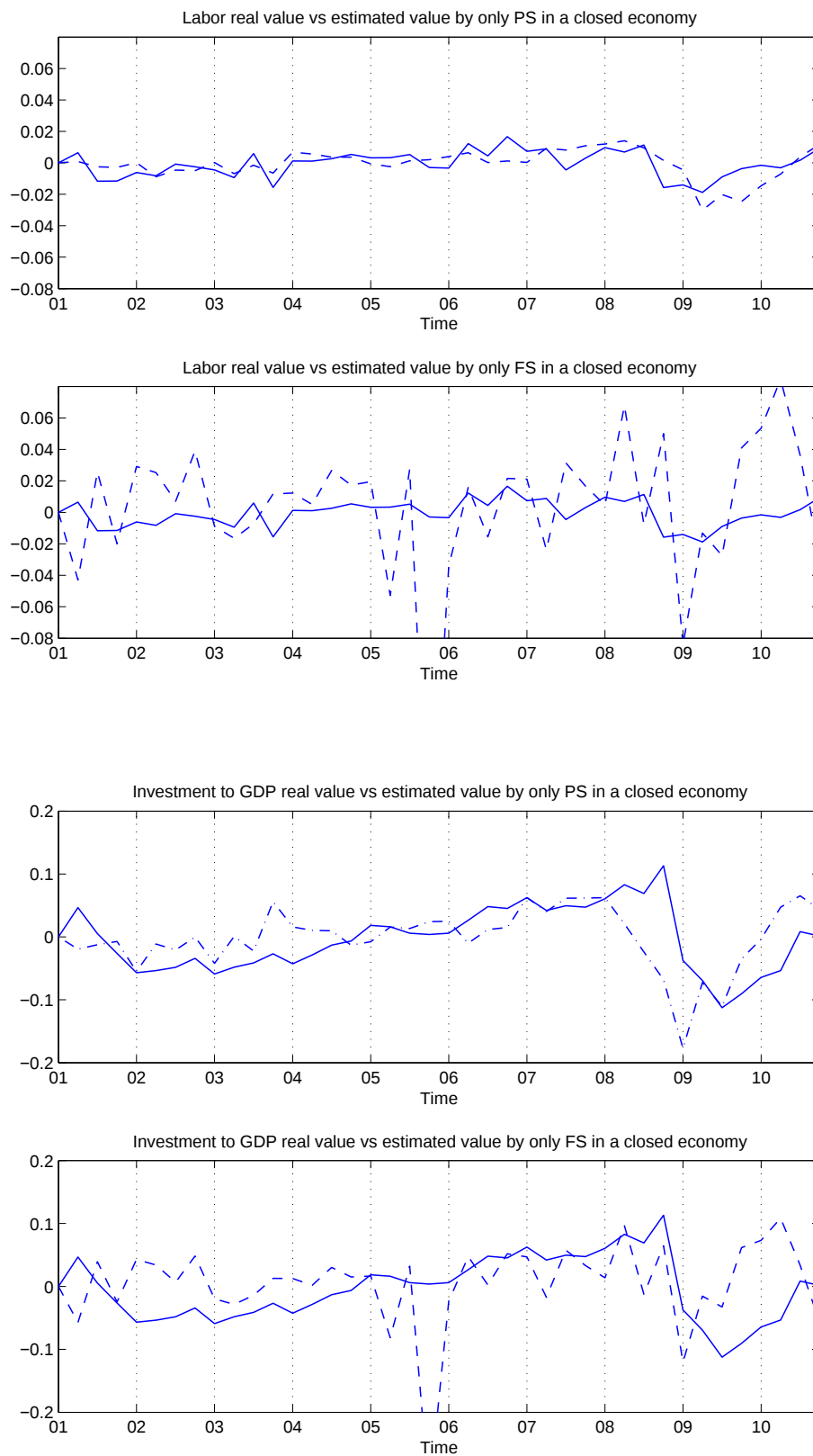


Figure 3.2.5: Simulation in a closed economy (- - -: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)



3.2.3 Summary

Based on the above work, we can conclude that in the closed model suggested by Jermann and Quadrini (2012), if we assume the credit constraint is binding from 2001Q1 to 2010Q4, and there exists some degree of rigidity in the financial sector in Japan, then:

- Financial shocks can capture the trend of aggregate dividend flows after 2001 but fail to explain the dynamics of aggregate debt flows and macroeconomic variables.
- Productivity shocks could well explain the movements of real variables, especially for output and labor.

Since Japan is often treated as a small open economy in financial literature, we would like to extend a closed economy to a small open economy in the next section to see whether this extension could improve the performance of financial shocks to the dynamics of the Japanese economy.

3.3 Case 2: A small open economy with financial frictions

In this section, we extend a closed economy to a small open economy to see whether it helps improve the performance of financial shocks in accounting for the Japanese economy. Generally, we extend the original model in two aspects: first, we assume a domestic interest rate subject to the world interest rate and default risk premium. The default risk premium here is determined by the leverage ratio of the economy. Second, we assume firms can borrow from foreign lenders.

3.3.1 Model

3.3.1.1 Firms

The setup of firm sectors basically follows that in a closed economy except that firms can also accumulate intertemporal debt by borrowing from foreign investors. The amount of foreign debt is denoted by b_t^F , and $b_t^F > 0$ implies that firms hold net liabilities. Each firm solves the problem as follows:

$$E_0 \left[\sum_{t=0}^{\infty} m_t d_t \right]$$

s.t

$$y_t - w_t l_t + \frac{(b_t^H + b_t^F)}{1 + r_t(1 - \tau)} = b_{t-1}^H + b_{t-1}^F + i_t + \varphi(d_t) \quad (3.19)$$

$$\xi_t(k_t - \frac{b_t^H + b_t^F}{1 + r_t}) \geq y_t \quad (3.20)$$

and using equations (3.2), (3.3), and (3.4). Because we assume that there is no difference between trading domestic and foreign liabilities, first-order conditions of firms in a small open economy are the same as those in a closed economy.

3.3.1.2 Households

The setup of household sectors is generally the same as that in a closed economy except for lump-sum taxes. Because aggregate amounts of taxes are exogenous to households, first-order conditions of each household are still the same as those in a closed economy.

3.3.1.3 Interest rate in a small open economy

Different from that in a closed economy, the interest rate in a small open economy model is not determined by the general equilibrium of an economy. We assume that an additional risk premium is required by foreign lenders and is determined by the leverage ratio of a small open economy. We use the following equation to represent this relationship:

$$r_t = r_t^* + \chi \left(\frac{B_t^F}{K_{t-1}} \right), \quad (3.21)$$

where r_t^* represents the world interest rate. The default risk parameter is denoted by χ and is assumed to be a positive value. This parameter implies that an additional premium is charged to the borrowers, and the amount is determined by their repayment ability. The ratio of net foreign liability to capital stock is interpreted as the leverage ratio in international borrowing market. The lower this ratio becomes, the lower default risk the borrowers are considered to have, and thus less of a premium is required by foreign lenders. Since Japan has kept a positive net financial assets position, its contracted lending rate has been lower than the world interest rate.

3.3.1.4 Market-clearing conditions

In this part, we want to emphasize two points: First, since capital stock is predetermined, this implies that there is an optimal level of net foreign liability in a small open economy. Second, aggregate revenue is not only used to support domestic expenditure, but it also

is needed to cover the interest payments of an external liability as follows:

$$Y_t = I_t + C_t + B_{t-1}^F - \frac{B_t^F}{1 + r_t} + \kappa(D_t - D)^2. \quad (3.22)$$

The following definition summarizes the equilibrium conditions of a small open economy in our chapter.

Definition 3.3.1. (Competitive equilibrium of a small open economy) A competitive equilibrium is defined as a set of functions for:

- Households' policies c_t , l_t , and b_t^H .
- Firms' policies d_t , l_t , b_t^H , b_t^F and i_t .
- Aggregate prices w_t , r_t , m_{t+1} , and p_t .

Such that:

- Household's policies satisfy conditions (10)-(13), given w_t , r_t , p_t , and T_t .
- Firms' policies are optimal, given w_t , r_t , k_{t-1} , z_t , ξ_t , and m_{t+1} .
- The wage clears the labor market, the interest rate is determined by $r_t = r_t^* + \chi \left(\frac{B_t^F}{K_{t-1}} \right)$, and $m_{t+1} = \beta \frac{U_c(C_{t+1})}{U_c(C_t)}$, where r_t^* represents the world interest rate and $\frac{B_t^F}{K_{t-1}}$ represents the aggregate leverage ratio.

3.3.2 Quantitative analysis

In this section, we show that a small open economy model shows a better performance in capturing movements of aggregate financial flows in Japan, especially debt.

3.3.2.1 Data and parametrization

We use the same data as for a closed economy, but some adjustments have been made to match empirical counterparts, such as the utility parameter and equity payout parameter. Also, the world interest rate, denoted by the U.S. average majority prime rate charged by banks, is introduced here to estimate the domestic interest rate. Moreover, the parameter of the default risk premium is estimated by the average contracted lending interest rate and the aggregate leverage ratio. This parameter implies that every 1 percent increase in leverage ratio will induce about a 0.01 percent increase in default risk premium. Parameters are listed in Table 3.3.1.

Table 3.3.1: Parameters set by the steady-state or second moments

Parameters	
Discount factor	0.982
Tax advantage	0.300
Utility parameter	1.792
Production technology	0.362
Depreciation rate	0.049
Enforcement parameter	0.636
world interest rate	0.055
the parameter of default risk premium	1.036
Payout cost parameter	7.000

3.3.2.2 Impulse response

In this section, we study responses of key indicators to one-time productivity shocks and financial shocks, respectively. Figure 3.3.1 shows that, after a one-time productivity shock, enforcement constraints instantly loosen, and the shadow price of enforcement constraint η suddenly goes down. Therefore, firms increase bond issuance to finance production activities. According to equation (3.7), if firms want to keep production plans unchanged, a downturn in η requires a larger equity payout. However, due to the adjustment cost of dividends, firms have to increase hiring to reduce total cost. Yet sudden debt expansion induces an increase in foreign liabilities, leading to a downturn in the current account. As the debt position becomes larger, enforcement constraints become tighter and gradually become binding again. Under these circumstances, the marginal cost of enforcement constraints becomes larger, and firms start to reduce their debt position to ease binding constraints. At this time, dividends and labor input are forced to decrease. The current account also is rebound due to the decline in foreign liabilities.

Figure 3.3.2 shows that if the economy receives a one-time financial shock, enforcement constraints suddenly become tighter, and the value of multiplier η surges up and forces firms to reduce equity payout. Because there is an adjustment cost that accompanies dividend adjustment, labor input is also reduced. The immediate repurchases of debt reduce the external debt position and lead to an increase in the current account. As enforcement constraints are released by debt reduction, constraints are loosened, and firms turn to debt financing again. Therefore, equity payout recovers, and the length of working hours also recovers at the release of constraint tightness. However, because the reduction in investment and the increase in foreign debt position, the interest rate goes up, implying that the cost of debt financing is also increased. Therefore, firms issue more

Figure 3.3.1: Response to a one-time negative productivity shock with enforcement constraint in small open economy

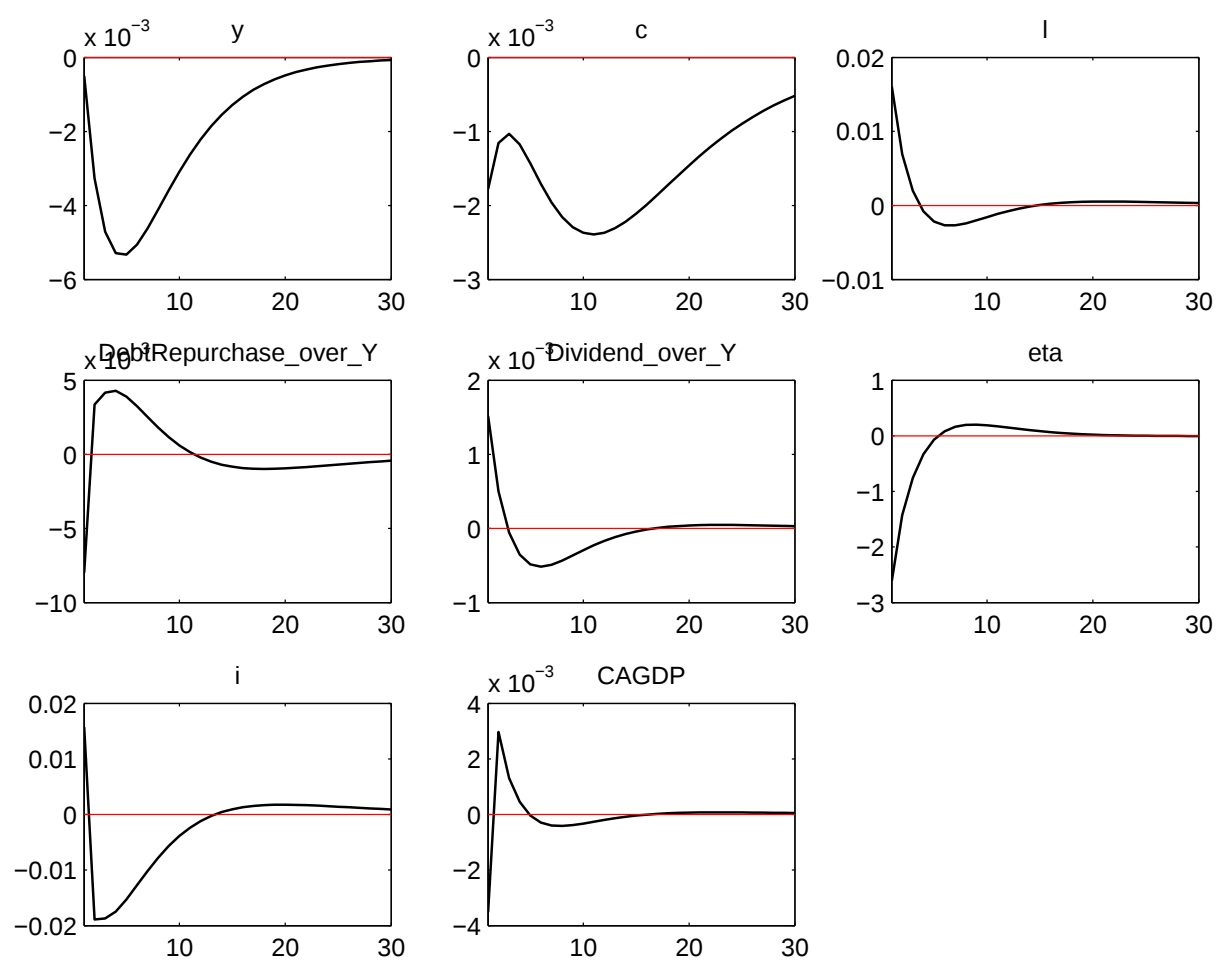
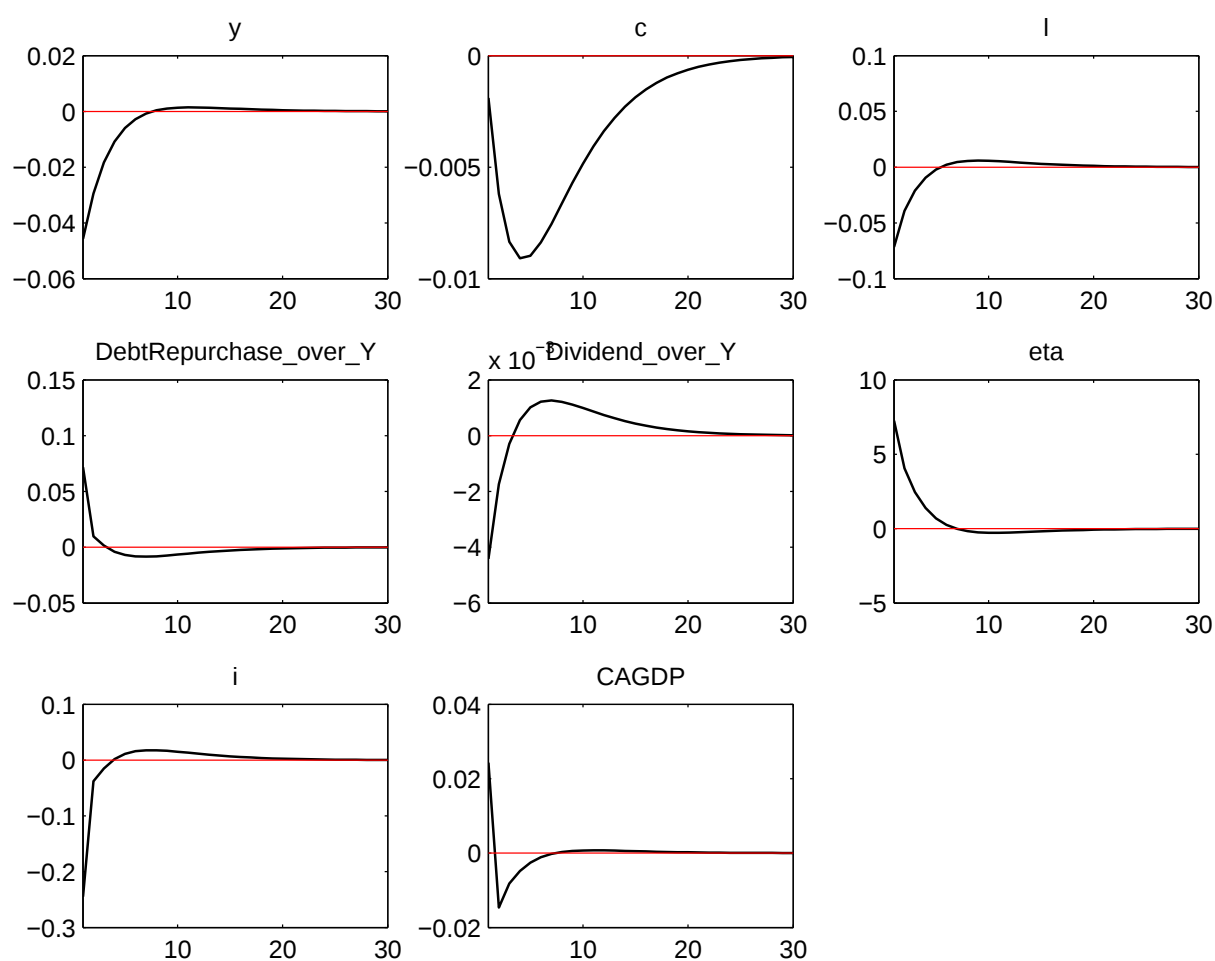


Figure 3.3.2: Response to a one-time negative financial shock with enforcement constraint in small open economy



domestic debt instead of borrowing externally, and the current account recovers after a downturn.

3.3.2.3 Simulation

In order to see whether a small open economy model can improve the performance of financial shocks, we conducted simulations on some key indicators in which we are interested. Besides variables explored in a closed model, we also paid attention to the current account variable in this section. The biggest surprise we found is that, as shown in Figure 3.3.3, financial shocks can capture movements of new debt repurchases quite well compared with those in a closed economy. Especially, the second moment of debt repurchase output ratio is improved from 0.0151 to 0.0842, which is quite close to empirical value 0.0789. We conjecture that the main reason is that a higher level of financial rigidity (larger κ) is required in the small open economy to match the empirical value. Therefore, the adjustment cost of dividends in a small open economy is relatively larger than that in a closed one; as a result, labor input displays a higher volatility. Additionally, since capital stock directly influences the interest rate, its volatility has to be depressed by firms. Therefore, the aggregate debt position, especially the domestic debt position, becomes a main channel for adjusting the tightness of enforcement constraints. Consequently, debt repurchases become dramatically more volatile. Also, it shows that the dividend (Figure 3.3.3) is still well explained by financial shocks in a small open economy, and the second moment of dividend is improved from 0.0048 to 0.0069. However, financial shocks still generally fail in explaining movements of real variables.

As to productivity shocks, according to Table 3.3.2, we find that they are still dominant in explaining business cycles, although most key indicators are relatively underestimated compared with empirical value, except labor. Moreover, we can see from Figures 3.3.4 and 3.3.5 that there is a significant improvement in replication of investment and consumption. In a closed economy, investment ratio is estimated to drop to the bottom in 2009Q1; yet the biggest recession occurred in 2009Q3. In a small open economy, not only has this kind of time mismatching been successfully overcome, but the span of the downturn is also accurately estimated. As to other variables, we are pleased to find that the volatility of consumption is obviously smaller than that in the closed economy, and the second moment of this variable in the open economy also demonstrated this improvement. However, by contrast, we find that the performance of labor becomes worse. As to the current account, Figure 3.3.6 implies that this model does not capture the trends well.

Figure 3.3.3: Simulation with data of Japan (---: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

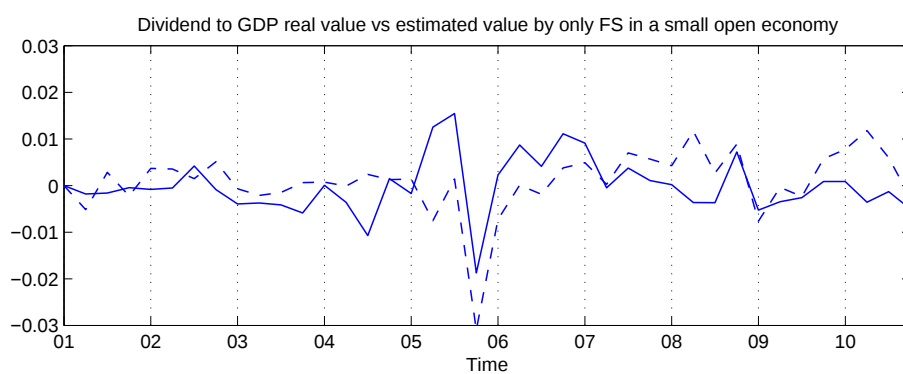
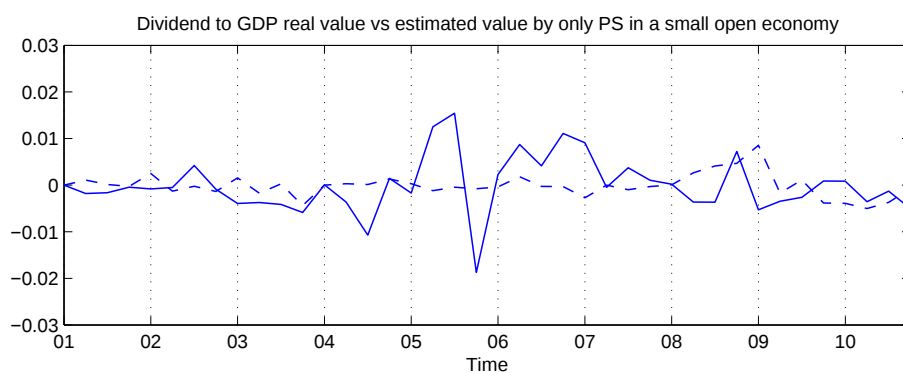
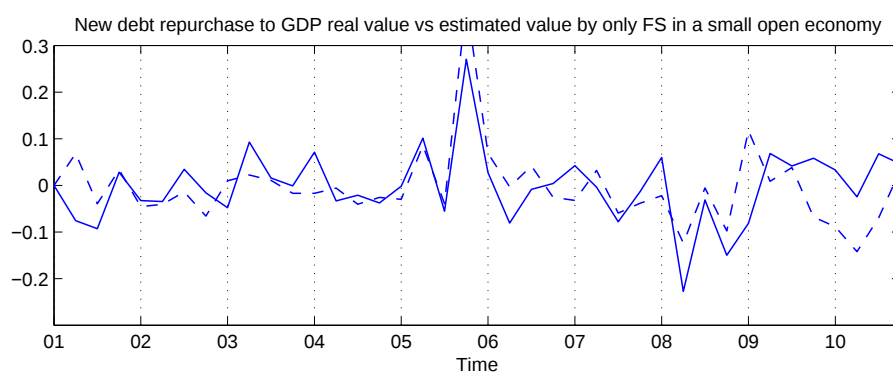
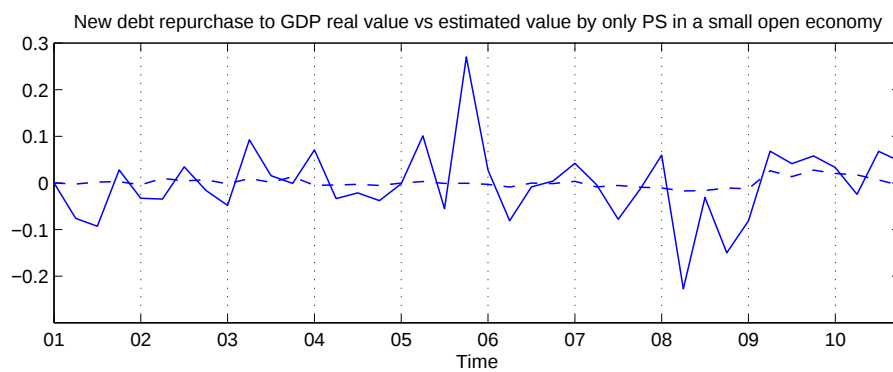


Figure 3.3.4: Simulation with data of Japan (---: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

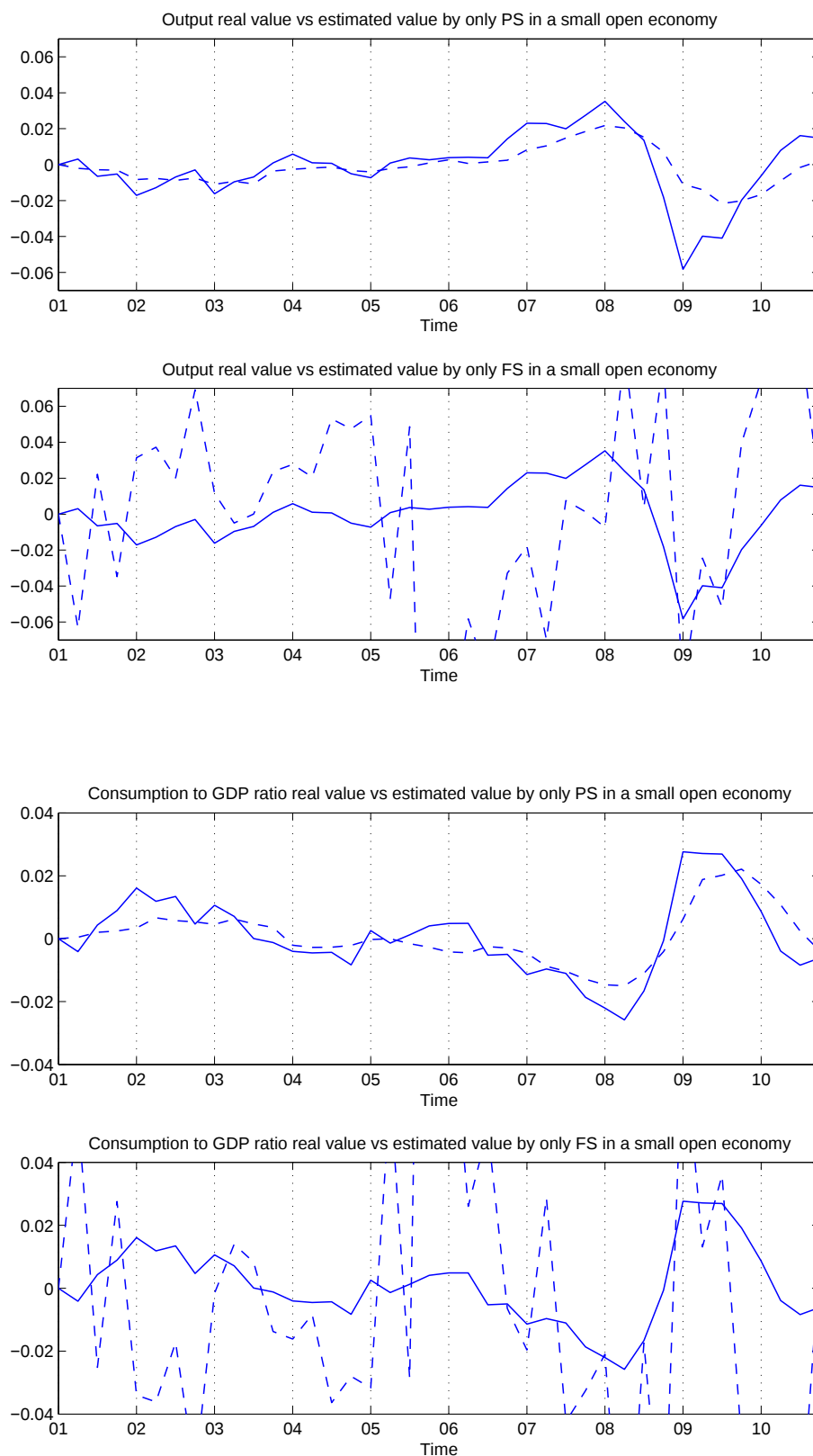


Figure 3.3.5: Simulation with data of Japan (---: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

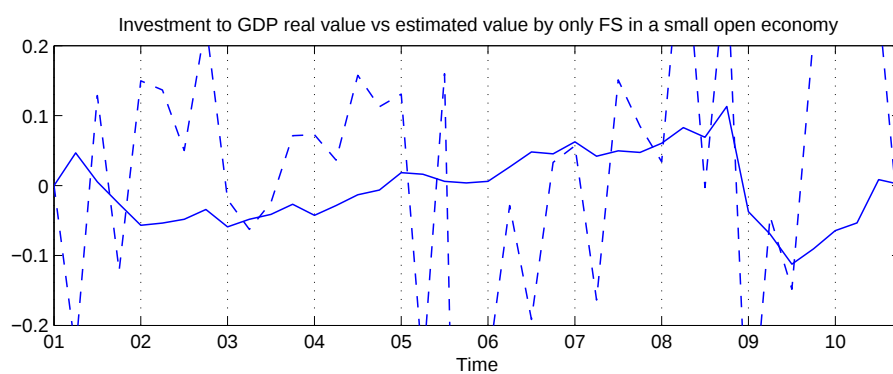
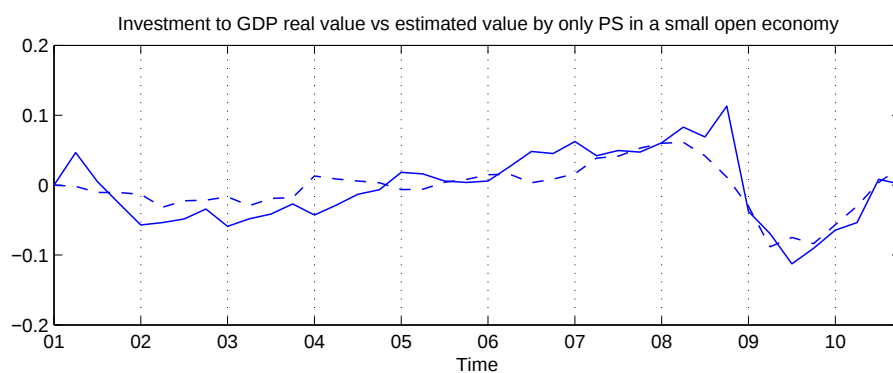
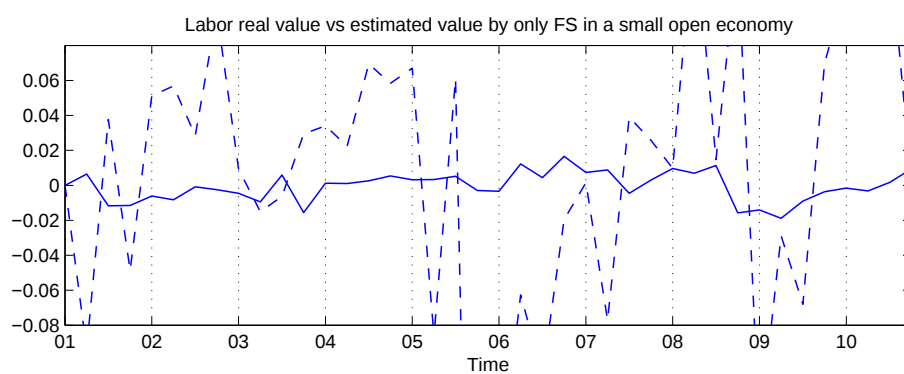
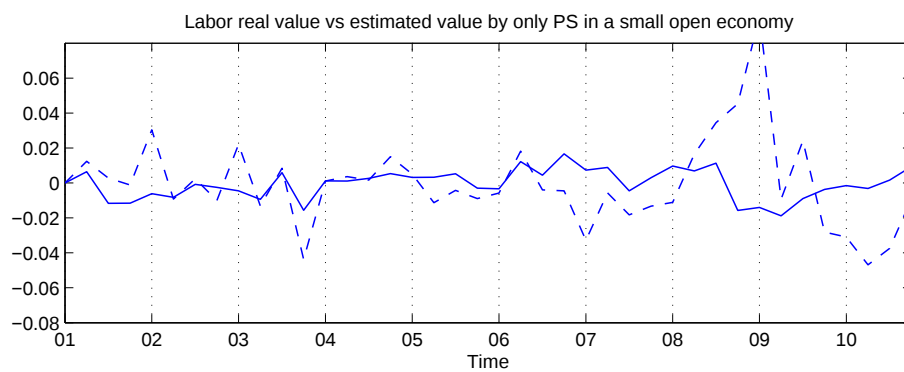


Figure 3.3.6: Simulation with data of Japan (---: simulated data ; —: real data ; PS : productivity shocks ; FS : financial shocks)

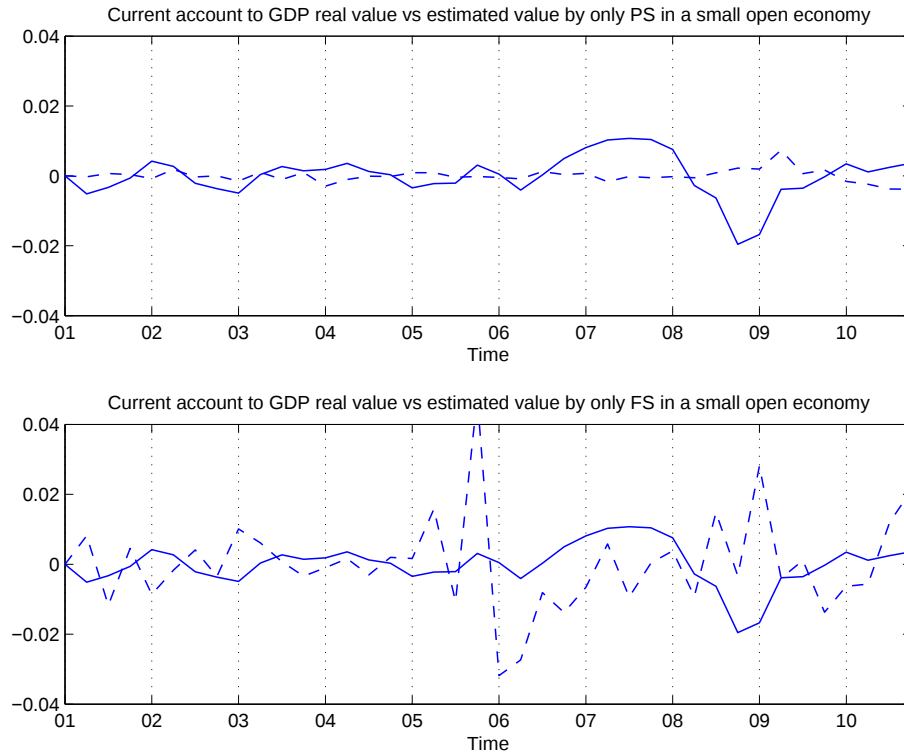


Table 3.3.2: Estimated business cycle properties in small open economy : second moments

Variables	Data	Model:only PS	Model:only FS
<i>Financial Variables</i>			
Dividend/GDP	0.0061	0.0025	0.0069
Debt repurchases/GDP	0.0789	0.0104	0.0842
<i>Macroeconomic Variables</i>			
Output	0.0186	0.0102	0.0788
Consumption ratio	0.0124	0.0087	0.0710
Investment ratio	0.0510	0.0348	0.2795
Hours	0.0084	0.0254	0.1155
Current account/GDP	0.0060	0.0018	0.0137

3.3.3 Summary

Since a closed economy cannot replicate the trends of aggregate financial flows in Japan, we extend it to a small open economy to see whether the performance of financial shocks can be improved. Two additional conditions are included to make extension: (1) firms can borrow from overseas lenders. (2) the interest rate requires a default risk premium, and it is now determined by the world interest rate and the aggregate leverage ratio. After we assume enforcement constraints are binding since 2001 and that there exists some degree of rigidity in the financial sector of Japan, we find conclusions as follows:

- Financial shocks play a key role in explaining the aggregate financial flows, especially for equity and debt financing.
- Productivity shocks are significant to real variables in Japan. Specifically, investment and consumption activities are better replicated in a small open economy, but labor and current accounts cannot be explained well by either kind of shock.

3.4 Conclusion

Have financial shocks been important for the Japanese economy since 2001? This chapter suggests that they are dominant factors in the dynamics of Japanese aggregate financial flows, which is consistent with the findings of Jermann and Quadrini (2012). However, they seem less important than productivity shocks for the Japanese real economy, at least for the last decade.

In order to find answers, first we applied the DSGE model of Jermann and Quadrini (2012) to the Japanese economy. In the model, we assume that firms prefer debt issuance to equity financing due to the tax advantage. However, when firms borrow intraperiod debt from the financial sectors, they face enforcement constraints that are subjected to their net worth. In addition, they have to pay an extra cost when adjusting equity payout, and it is regarded as a form of financial rigidity. Second, using quarterly data from Japan, we constructed time series of financial and productivity shocks as residuals of enforcement constraints and production functions, respectively. Finally, we conducted simulations on key indicators and compared them to empirical series, not only by second moments but also through figures. Preliminary results in a closed economy show that financial shocks do not seem important for the Japanese economy.

Is this a final conclusion? In order to further explore this problem, we extend the closed economy to a small open economy, which has not been widely applied in DSGE studies until recently. The extension includes two additional conditions: (1) Assume firms can

borrow from overseas lenders. (2) Assume that the domestic interest rate is subject to the world interest rate and default risk premium and that this premium is positively related to the leverage ratio of the whole economy. By such an extension, we find that, different from those in a closed economy, debt and dividend flows simulated by financial shocks track quite closely the empirical counterparts; this also has been proven by comparing second moments. However, this extension proves that productivity shocks seem to have been dominant in accounting for fluctuations of real variables, such as output, consumption ratio, and investment ratio in Japan.

Chapter 4

Role of Financial and Productivity Shocks in the US and Japan: A Two-Country Economy

4.1 Introduction

This chapter aims to address two main questions: (1) whether financial shocks play a greater role than productivity shocks in accounting for real business cycles in the presence of financial integration and financial frictions and (2) whether there have been international spillover effects of country-specific shocks.

The financial crisis in 2007 spurred much debate regarding the financial sector's impact on the real business cycle¹. Post-crisis, many studies examining business cycles not only model financial frictions but also began to incorporate financial shocks, i.e., shocks originating directly from the financial sector², into their dynamic stochastic general equilibrium models. For example, Jermann and Quadrini (2012) quantitatively show that in a closed economy framework, financial shocks have accounted significantly for the dynamics of US business fluctuations. Christiano, Motto, and Rostagno (2008) augment a standard monetary DSGE model to include financial markets and apply the model to Eurozone and US data. They suggest that new shocks originate in the financial sector and account for a significant portion of business cycle fluctuations. However, by incorporating a global

¹Before that, the mainstream traditional opinion regarding the role of financial frictions, such as credit market distortions, held that they played an important role in propagating shocks originating in productive sectors ("productivity shock") or monetary authorizations ("monetary shocks"). See for example Kiyotaki and Moore (1997); Bernanke, Gertler, and Gilchrist (1999); Mendoza and Smith (2006); and Mendoza (2010).

²See for example Devereux and Yetman (2010, 2011), Yao (2012), and Jermann and Quadrini (2012).

bank into a two-country business cycle model, Kollmann, Enders, and Muller (2011) show that under normal economic situations, loan default shocks make a negligible contribution to business cycle fluctuations in the US and Eurozone. Furthermore, Kollmann (2012) shows that output components that are accounted for by non-banking shocks³ fit very closely with historical US and Eurozone GDP data, a sharp contrast to the insignificant role found for banking shocks. In reference to other countries such as Japan, Otsu (2009, 2011) and Kaihatsu and Kurozumi (2010) show that productivity shocks remain the main driving force behind real business cycles. We notice that most studies reached different conclusions regarding whether financial or productivity shocks are more important in different background settings, and few studies have focused on spillover effects from these country-specific shocks to the other countries' business cycles. Therefore, to attempt to construct a model that could shed light on these issues, we built a calibrated two-country model incorporating financial frictions within countries and financial integrations across countries. Including both these factors allows us to explore whether productivity or financial shocks are more important to real business cycles under a more enriched background, as well as attempt to determine whether international spillover effects of country-specific shocks impact other countries' business cycles.

The model used in our chapter follows that of Jermann and Quadrini (2012) and Quadrini (2012). Jermann and Quadrini (2012) built a closed business cycle model emphasizing the existence of enforcement constraints and financial rigidity when firms want to switch between debt and equity financing. The degree of rigidity is reflected by the dividend adjustment's cost. Financial shocks denoted in Jermann and Quadrini (2012) are disturbances that affect firms' ability to borrow intra-period debt from the credit market. When credit market distortions become more serious, firms have to reduce their intertemporal borrowing, turning instead to equity financing. Because equity financing imposes additional adjustment costs, firms have to reduce working hours, which has a knock-on effect on production activity. However, in contrast with Jermann and Quadrini (2012), the two country model in this chapter implies that countries can also borrow or lend money from foreign countries and therefore face external asset exposure, which is similar to aspects of Quadrini's (2012) structure. Therefore, leverage constraints and external asset exposure combine to generate an international financial mechanism that could possibly transfer country-specific productivity or financial shocks to each other, which we refer to as spillover effects.

This chapter first introduces a simple two-country model. Each country consists of three sectors: a firm, a household and an international financial market. Firms in each

³Non-banking shocks include productivity shocks and labor supply shocks, investment efficiency, and government purchases.

country borrow intra-period debt from the domestic market in order to pay workers, suppliers of capital, shareholders, and holders of previous debt before the realizing revenues. In addition, they contract intertemporal loans from both domestic and international financial market, which are subject to the domestic interest rate or international interest rate, respectively. We assume that only firms can trade bonds internationally, and both lenders and borrowers have to pay additional fees for international transactions. Firms' intra-period borrowing is limited by enforcement constraints, which implies that intra-period borrowing, the amount of which is equal to revenue, cannot exceed a certain extent of firms' net worth. Households can only trade bonds and firm equity in their domestic markets. Each country's external asset exposure consists of bonds, which are dominated in home currency (US dollars in our chapter). The key mechanism is as follows: financial or productivity shocks occurring in one country influence enforcement constraints and directly affect domestic firms' intertemporal debt plans. Because adjusting equity payouts incurs additional costs, domestic firms have to change production plans so as to control their total financing costs. On the other hand, bond transactions in international financial markets provide a mechanism by which shocks originated in one country will exert indirect influence upon foreign firms' enforcement constraints and therefore affect production activity in foreign countries, which is considered to be the channel of international spillover effects.

Secondly we constructed productivity and financial shocks by quarterly time series for both the US and Japan. Following Jermann and Quadrini (2012), productivity shocks are computed as Solow residuals while financial shocks are computed as residuals of the model's enforcement constraints. Using the constructed shock series, we not only conducted impulse responses, but also performed simultaneous replications to show the major statistic indicators on original real variables and aggregate financial flows, which will ensure a comprehensive evaluation of the role shocks play.

Our results show that first, for both the US and Japan, productivity shocks account for most dynamics observed for both output and investment. Financial shocks have contributed significantly to fluctuations in consumption, current accounts, and labor in the US. In particular, the effect of domestic financial shocks on the US current account is quite large according to the simulated series, which have tracked quite well to their empirical counterparts over the whole periods under investigation. In terms of financial variables, financial shocks in the model have succeeded in replicating Japan's debt repurchase behavior. In addition to the above results, it is worth noting that financial shocks are key factors in accounting for the observed troughs of output, labor, and consumption, as well as the peaks of debt repurchases and US current accounts during the 2007-09 financial crisis. Second, our model revealed the unexpected finding that observable international

spillover effects only appeared in Japan's debt repurchases behavior which turned out to be vulnerable to shocks originating in the US. For other variables such as output or investment, no significant effects from shocks originating in other countries are observed.

This chapter is directly related to research on the role of financial frictions in real business cycles. In addition to Jermann and Quadrini (2012), Benk, Gillman, and Kejak (2005) suggested the credit shock as a candidate shock important to determining GDP; Christiano, Motto, and Rostagno (2008) suggest that the new candidate shock originates in the financial sector and accounts for a significant portion of business cycle fluctuations by using Eurozone and US data. Other papers exploring this angle include Kiyotaki and Moore (2008) and Del Negro, Eggertsson, Ferrero, and Kiyotaki (2010). Most of these studies were conducted within a closed economy.

Another topic closely related to our chapter is the international business cycle model incorporating financial frictions. Devereux and Yetman (2010) introduce a model of international transmission of shocks due to interdependent portfolio holdings among leverage-constrained financial institutions. They show that when leverage constraints bind, they combine with the presence of diversified portfolios to introduce a powerful financial transmission channel that results in a high correlation among macroeconomic aggregates during business cycle downturns. Devereux and Sutherland (2011) develops a two-country model in which financial liberalization across countries takes place in the presence of domestic credit market distortions, finding that financial integration in bond markets alone generates highly-negative related co-movement across countries. Yao (2012) is close to Devereux and Yetman (2010) in studying financial frictions and capital portfolio choice in a two-country model, and further introduces into the model both capital accumulation and endogenous labor choice. Our chapter differs from their studies in two aspects: (1) we use a different form of financial friction, concentrating on financial frictions existing in the intra-period debt market rather than the intertemporal debt market; (2) the above studies focus on the co-movement of output between two countries, while our study concentrates on determining the relative importance of various shocks in accounting for historical data; and (3), we present not only impulse responses, but also conduct simulations and compare these results with the empirical data. Other studies include Faia (2007), which uses OECD data to demonstrate that business cycles are more correlated among countries having similar financial structures, then builds a two-country DSGE model with financial frictions that replicates this observed pattern.

Our study is also related to studies examining Japanese business cycles in an open economy. Kaihatsu and Kurozumi (2010) show that, in both Japan and the US, neutral technology shocks are the main driving force behind output fluctuations, and financial shocks play as important a role in investment fluctuations as technology shocks. Otsu

(2009, 2011) extend the business cycle accounting method la Chari, Kehoe, and McGrattan (2007) to a two-country international business cycle model and find that disturbances to the labor market and production efficiency account for much of the recent increase in the cross-country output correlation. Chakraborty (2009) finds that efficiency and investment wedges can almost wholly account for output increases of the 1980s, while in the 1990s, efficiency, labor and investment wedges all contributed to the recession.

Our chapter is structured as follows: Section 2 introduces the three-sector-two-country model expanded from Jermann and Quadrini (2012). Section 3 calibrates the model using US and Japanese quarterly data and constructs time series of productivity and financial shocks. Section 4 presents the impulse response and simulation of business cycles' major indicators. Section 5 concludes.

4.2 Model

4.2.1 Firms sector

A continuum of firms exists in the $[0,1]$ interval in each country: "home" and "foreign." Firms in each country have the same characteristics. Their utility is given by the following expression:

$$E_t \left[\sum_{t=0}^{\infty} m^t d_t \right]$$

Firms face the problem of maximizing dividend payments' expected value, which is subject to the exogenous time preference m . They hire workers and invest in capital to engage in production activity, and pay dividends to shareholders. We assume that firms in each country can engage in bond trading both domestically and abroad. Therefore, at the beginning of the period, each firm holds capital k_{t-1} , domestic intertemporal liabilities b_{t-1}^f and foreign intertemporal liabilities n_{t-1} . Here $b_t^f > 0$ indicates holding domestic liabilities and $b_t^f < 0$ refers to domestic asset holdings, both of which are subject to domestic interest rate r_t . For foreign bonds, $n_t > 0$ indicates liabilities and $n_t < 0$ indicates assets. Following Quadrini (2012), we assume that foreign bond holdings are denominated in the home country's currency and are subject to international interest rate $\tilde{r}_t$ and are costly⁴. Here we assume that their cost is related only to foreign bond aggregate holdings (N_t), and is represented by ψN_t . Based on the above assumption,

⁴This assumption is useful for making the model stationary in terms of foreign asset positions.

the budget constraint of each home firm can be written as

$$y_t - w_t l_t + \frac{b_t^f}{1 + r_t} + \frac{n_t}{1 + \tilde{r}_t} = b_{t-1}^f + i_t + n_{t-1}(1 + \psi N_{t-1}) + d_t + \kappa(d_t - \bar{d})^2 \quad (4.1)$$

where y_t denotes revenue, w_t is the real wage paid to workers, l_t is working hours. d_t is the equity payout and $\kappa(d_t - \bar{d})^2$ is its adjustment cost, where $\bar{d}$ is the long-run dividend target, and κ denotes the financial rigidity of changing financing tools from debt to equity. The production function and investment are described as follows:

$$y_t = z_t k_{t-1}^\theta l_t^{1-\theta} \quad (4.2)$$

$$i_t = k_t - (1 - \delta)k_{t-1} \quad (4.3)$$

Before engaging in production activities, firms take out new intertemporal loans (domestically and abroad), repay previous debts, and choose labor inputs, investments, equity payouts and their adjustment costs. Following Jermann and Quadrini (2012), we assume that payments to workers, suppliers of investments, equity holders, and previous debt holders must be made before realization of revenues; therefore, firms need to take intra-period loans (at no interest) from lenders, and promise to repay these loans after realizing their revenues. Here the intra-period loan can be considered a way to cover the cashflow mismatch during the period and is equal to $w_t l_t + i_t + d_t + \kappa(d_t - \bar{d})^2 + b_t^f + n_{t-1}(1 + \psi N_{t-1}) - \frac{b_t^f}{1 + r_t} - \frac{n_t}{1 + \tilde{r}_t}$. Combining with the budget constraint, we find that the intra-period loan is equal to revenue y_t . Because default on the intra-period loan could occur following the realization of revenues (firms could divert these revenues), an enforcement constraint is required on the contract to ensure repayment of the intra-period debt.

$$\xi_t \left(k_t - \frac{b_t^f}{1 + r_t} - \frac{n_t}{1 + \tilde{r}_t} \right) \geq y_t \quad (4.4)$$

This constraint can be interpreted simply as the understanding that the intra-period loan can be no greater than ξ_t times the net worth of firm ($\xi_t < 1$). Because lenders need to liquidate the involved firms when default occurs, we interpret ξ_t as a way to capture the degree of financial friction. The smaller the value of ξ_t , the larger the loss of value that will occur in liquidation, meaning that larger collateral value is required to sign the contract⁵. We assume ξ_t is stochastic and uniform for all firms, and the financial shocks

⁵Jermann and Quadrini (2012) interpret the enforcement constraint as the best solution if both lenders and firms have an interest in renegotiating debts. They deduct the enforcement constraint from the bargaining problem and incentive-compatibility constraint. Since they assume firms have full bargaining power when renegotiating debts, ξ_t is equal to the fraction recovered following the firms being sold.

we indicate are the stochastic innovations of ξ_t . To simplify the analysis, we assume enforcement constraints to be binding prior to shocks, which is possible because firms are assumed to be less patient than households.

To understand the effect of ξ_t , the enforcement constraint is rewritten as

$$\left(\frac{\xi_t}{1-\xi_t}\right) [(1-\delta)k_{t-1} - b_{t-1}^f - n_{t-1}(1+\psi N_{t-1}) - w_t l_t - d_t - \kappa(d_t - \bar{d})^2] \geq y_t$$

The occurrence of financial shocks affects production plans according to the rigidity of substitution between debt and equity financing. If adjusting dividend payments is too costly, firms have to change their production plan and, therefore, change labor inputs. If constraints are binding all the time, financial shocks would affect the real economy through enforcement constraints.

We define η_t and λ_t^f respectively as the Lagrangian multipliers of enforcement and budget constraints in period t . Firms' first-order conditions are

$$1 = \lambda_t^f [1 + 2\kappa(d_t - \bar{d})] \quad (4.5)$$

$$w_t = \left(1 - \frac{\eta_t}{\lambda_t^f}\right) (1 - \theta) \frac{y_t}{l_t} \quad (4.6)$$

$$1 - \frac{\eta_t}{\lambda_t^f} \xi_t = E_t m \frac{\lambda_{t+1}^f}{\lambda_t^f} \left[1 - \delta + \left(1 - \frac{\eta_{t+1}}{\lambda_{t+1}^f}\right) \theta \frac{y_{t+1}}{k_{t+1}}\right] \quad (4.7)$$

$$1 - \frac{\eta_t}{\lambda_t^f} \xi_t = E_t m \frac{\lambda_{t+1}^f}{\lambda_t^f} (1 + r_t) \quad (4.8)$$

$$1 - \frac{\eta_t}{\lambda_t^f} \xi_t = E_t m \frac{\lambda_{t+1}^f}{\lambda_t^f} (1 + \tilde{r}_t)(1 + \psi N_t) \quad (4.9)$$

Equation (4.5) implies that the marginal utility of the additional dividend unit becomes smaller than its marginal cost when the amount of equity payout is larger than the long-run target. Equation (4.6) reveals the main channel through which financial shocks influence the real economy. When financial conditions worsen and enforcement constraints become tighter, the Lagrangian multiplier η_t becomes positive and generates a labor wedge. This labor wedge in turn leads to a high wage rate and decreases demand for labor. Equation (4.7) tells us that if the enforcement constraint binds, the marginal cost of capital is less than 1 because additional capital would relax the enforcement constraint. However, capital's efficiency in the next period is reduced because an additional unit of capital implies an additional intra-period loan unit, and therefore tighter constraints, in the next period. Equation (4.8) implies that binding constraints will lead intertemporal debt to

have a smaller marginal benefit. Equation (4.9) shows that although the marginal cost of foreign debt is same as intertemporal debt, it has additional cost ψN_t for every unit of debt. In addition, domestic debt is subject to domestic interest, while foreign debt is subject to international interest. Therefore, when a country is a net borrower ($N_t > 0$) in the international financial market, its domestic interest will be higher than its international interest due to the arbitrage condition. If it is a net lender, its domestic interest will be lower than its international interest.

Following the same logic, the foreign country's problem can be described as follows:

$$E_t \left[\sum_{t=0}^{\infty} m_t^* d_t^* \right]$$

s.t

$$y_t^* - w_t^* l_t^* + \frac{b_t^*}{1 + r_t^*} + \frac{e_t n_t^*}{1 + \tilde{r}_t} = b_{t-1}^* + i_t^* + e_t n_{t-1}^* (1 + \psi^* N_{t-1}^*) + d_t^* + \kappa^* (d_t^* - \bar{d}^*)^2 \quad (4.10)$$

$$y_t^* = z_t^* k_{t-1}^{*\theta} l_t^{*1-\theta^*} \quad (4.11)$$

$$i_t^* = k_t^* - (1 - \delta^*) k_{t-1}^* \quad (4.12)$$

$$\xi_t^* (k_t^* - \frac{b_t^*}{1 + r_t^*} - \frac{e_t n_t^*}{1 + \tilde{r}_t}) \geq y_t^* \quad (4.13)$$

where r_t^* is the interest rate in the foreign country (on local bonds denominated in the currency of the foreign country) and e_t is the exchange rate (units of foreign currency for one unit of home country currency). We assume the law of one price holds here. n_t^* is dominated in "home" country currency, and $n_t^* < 0$ implies that the foreign country is a net lender in international financial market, and $n_t^* > 0$ implies that the foreign country is a net borrower. The first order conditions of firms in the foreign country are

$$1 = \lambda_t^{f*} [1 + 2\kappa^* (d_t^* - \bar{d}^*)] \quad (4.14)$$

$$w_t^* = \left(1 - \frac{\eta_t^*}{\lambda_t^{f*}} \right) (1 - \theta^*) \frac{y_t^*}{l_t^*} \quad (4.15)$$

$$1 - \frac{\eta_t^*}{\lambda_t^{f*}} \xi_t^* = E_t m^* \frac{\lambda_{t+1}^{f*}}{\lambda_t^{f*}} \left[1 - \delta^* + \left(1 - \frac{\eta_{t+1}^*}{\lambda_{t+1}^{f*}} \right) \theta^* \frac{y_{t+1}^*}{k_{t+1}^*} \right] \quad (4.16)$$

$$1 - \frac{\eta_t^*}{\lambda_t^{f*}} \xi_t^* = E_t m^* \frac{\lambda_{t+1}^{f*}}{\lambda_t^{f*}} (1 + r_t^*) \quad (4.17)$$

$$1 - \frac{\eta_t^*}{\lambda_t^{f*}} \xi_t^* = E_t m^* \frac{\lambda_{t+1}^{f*}}{\lambda_t^{f*}} (1 + \tilde{r}_t) \frac{e_{t+1}}{e_t} (1 + \psi^* N_t^*) \quad (4.18)$$

If we combine equations (4.8) with (4.9) and (4.17) with (4.18), and further abstract from the uncertainty between $E_t m^* \frac{\lambda_{t+1}^{f*}}{\lambda_t^{f*}}$ and $\frac{e_{t+1}}{e_t}$ (to simplify the analysis), we obtain

$$1 + r_t = (1 + \tilde{r}_t)(1 + \psi N_t) \quad (4.19)$$

$$1 + r_t^* = (1 + \tilde{r}_t)(1 + \psi^* N_t^*) \left(\frac{e_{t+1}}{e_t} \right) \quad (4.20)$$

If using the equilibrium condition $N_t + N_t^* = 0$ and ignoring exchange rate fluctuations⁶, we can obtain the international interest as follows:

$$\tilde{r}_t = \frac{\psi r_t^* + \psi^* r_t}{\psi + \psi^*} \quad (4.21)$$

Furthermore, if we abstract $\tilde{r}_t$ from equations (4.19) and (4.20), we obtain the following relationship between r_t and r_t^* :

$$\frac{1 + r_t^*}{1 + r_t} = \frac{1 - \psi^* N_t}{1 + \psi N_t} \quad (4.22)$$

According to equation (4.22), we know that the interest rate is relatively higher in countries with negative net foreign asset positions ($N_t > 0$).

4.2.2 Households sector

There is a continuum of homogeneous households in the $[0,1]$ interval in each country. Domestic households only receive wages from domestic firms, trade shares of domestic firms (total amount of shares is 1 in each country), and hold noncontingent bonds issued by domestic firms in every period. They are not allowed to engage in foreign transactions. All households have the goal of maximizing their lifetime utility as follows:

$$E_t \sum_{t=0}^{\infty} \beta^t [\ln(c_t - \alpha l_t)]$$

s.t

$$w_t l_t + s_{t-1}(d_t + p_t) + b_{t-1}^h = \frac{b_t^h}{1 + r_t} + s_t p_t + c_t \quad (4.23)$$

where c_t is private consumption; l_t is labor supply; and β is the household's time discount factor. Because we assume firms are less patient than households, we therefore can state

⁶It helps focus on the effect of productivity shocks and financial shocks.

that $\beta > m$. Household have a Greenwood-Hercowitz-Huffman (GHH) preference, which is chosen because the wealth effect can be abstracted from the labor supply. Therefore, changes in labor supply closely react to output fluctuations. In the utility function, α is a parameter representing the disutility of labor. Equation (4.23) represents the household's budget constraint. b_t^h represents domestic corporate bonds purchased by households; s_t and p_t , respectively, are the amount of equity shares and the share price. Then we derive first-order conditions as follows:

$$1 = \lambda_t^h (c_t - \alpha l_t^\nu) \quad (4.24)$$

$$w_t = \alpha \nu l_t^{\nu-1} \quad (4.25)$$

$$1 = \beta \frac{\lambda_{t+1}^h}{\lambda_t^h} (1 + r_t) \quad (4.26)$$

$$1 = \beta \frac{\lambda_{t+1}^h}{\lambda_t^h} \left(\frac{d_{t+1} + p_{t+1}}{p_t} \right) \quad (4.27)$$

where λ_t^h is the Lagrangian multiplier of a household's budget constraint. Equation (4.25) is the household's decision rule on labor supply, and equation (4.26) is the key condition for deciding the risk-free interest rate. Comparing equation (4.8) and equation (4.26), reveals that the assumption of less patient firm is important for ensuring stationary equilibrium with the binding constraint; the effect of such an assumption is the similar to Jermann and Quadrini's (2012) assumption of tax benefits. Following the exact same logic, we can present the household's foreign country problem as follows:

$$E_t \sum_{t=0}^{\infty} \beta_t^* [\ln(c_t^* - \alpha^* l_t^{*\nu^*})]$$

s.t

$$w_t^* l_t^* + s_{t-1}^* (d_t^* + p_t^*) + b_{t-1}^{h*} = \frac{b_t^{h*}}{1 + r_t^*} + s_t^* p_t^* + c_t^* \quad (4.28)$$

Then we derive first-order conditions as follows:

$$1 = \lambda_t^{h*} (c_t^* - \alpha^* l_t^{*\nu^*}) \quad (4.29)$$

$$w_t^* = \alpha^* \nu^* l_t^{*\nu^*-1} \quad (4.30)$$

$$1 = \beta^* \frac{\lambda_{t+1}^{h*}}{\lambda_t^{h*}} (1 + r_t^*) \quad (4.31)$$

$$1 = \beta^* \frac{\lambda_{t+1}^{h*}}{\lambda_t^{h*}} \left(\frac{d_{t+1}^* + p_{t+1}^*}{p_t^*} \right) \quad (4.32)$$

4.2.3 International financial markets

We assume that bonds can be transacted in international financial markets, and are dominated in the "home" country's currency. International financial market equilibrium can therefore be written as

$$N_t + N_t^* = 0 \quad (4.33)$$

This is a key condition for exploring possible international spillover effect from shocks. Any shocks affecting the enforcement constraints' tightness in one country would influence the foreign asset position and therefore this condition would affect tightness of enforcement constraints, financial decisions, and even production plans in the other country.

4.2.4 Competitive equilibrium of a two country economy

A competitive equilibrium is defined as a set of functions for

- Households' policies c_t, l_t, b_t^h in the home country, and c_t^*, l_t^*, b_t^{h*} in the foreign country.
- Firms' policies $d_t, l_t, b_t^f, n_t, i_t$ in the home country, and $d_t^*, l_t^*, b_t^{f*}, n_t^*, i_t^*$ in the foreign country.
- Aggregate prices w_t, r_t, p_t in the home country, and w_t^*, r_t^*, p_t^* in the foreign country, and $\tilde{r}_t$ in the international financial market.

Such that

- Households' policies in each country satisfy conditions (24)-(27) and (29)-(32) given aggregate prices $w_t, r_t, p_t, w_t^*, r_t^*$, and p_t^* , respectively.
- Firms' policies in each country are optimal, given $w_t, r_t, k_{t-1}, b_{t-1}, N_{t-1}, z_t, \xi_t, w_t^*, r_t^*, k_{t-1}^*, b_{t-1}^*, N_{t-1}^*, z_t^*, \xi_t^*$ and $\tilde{r}_t$, respectively.
- Goods markets clear

$$Y_t + \frac{N_t}{1 + \tilde{r}_t} = I_t + C_t + N_{t-1}(1 + \psi N_{t-1}) + \kappa(D_t - \bar{D})^2 \quad (4.34)$$

$$Y_t^* + \frac{e_t N_t^*}{1 + \tilde{r}_t} = I_t^* + C_t^* + e_t N_{t-1}^*(1 + \psi^* N_{t-1}^*) + \kappa^*(D_t^* - \bar{D}^*)^2 \quad (4.35)$$

- Local bond markets in each country clear $B_t^f + B_t^h = 0$ and $B_t^{f*} + B_t^{h*} = 0$.
- Equity markets in each country clear $S = 1$ and $S^* = 1$.

- International financial market clear $N_t + N_t^* = 0$.
- Wage and interest rates clear the labor and bond markets, and $\tilde{r}_t = \frac{\psi r_t^* + \psi^* r_t}{\psi + \psi^*}$.

4.3 Quantitative analysis

4.3.1 Data

In this section, we apply seasonally-adjusted quarterly macro data from the US and Japan to the two country model, taking the US as the home country and Japan as the foreign country. Our study covers the period from 2001Q1 to 2010Q4. We chose 2001Q1 as the beginning period of our study because we use real value data in our simulations, and most macro data (including real GDP, GDP deflators and others) adjusted in constant (2005) prices was released from 2001Q1. We choose 2010Q4 as the ending year because official labor data from 2011Q1 to 2011Q3 is unavailable. Nominal data except interest rates are deflated by the price index (base = 2005). Data used in the simulation are detrended by Hodrick-Prescott filters with a default smoothing parameter of 1600. We will now present more detailed information regarding each data resource.

4.3.1.1 US Data

For the US, we obtained financial data from the Federal Reserve Board's Flow of Funds Accounts. Debt stock is that given in "Credit Market Instruments of Nonfinancial Business" (LA144104005.Q), which we seasonally adjusted and deflated by "Price Indexes for Gross Value Added in the Business Sector" (National Income and Product Accounts, NIPA, Table 1.3.4). Debt repurchases are the flow of "Credit Market Instruments of Nonfinancial Business" (FA144104005.Q). The debt repurchase to output ratio is computed by dividing debt repurchases by the Gross Value Added for the Business Sector (NIPA Table 1.3.5), adjusted by "Price Indexes for Gross Value Added in the Business Sector" (NIPA, Table 1.3.4). Dividend flow is computed by Net Dividends Paid in Nonfinancial Corporate Business (FA106121075.Q) plus Undistributed Corporate Profits excluding IVA and CCAdj in Nonfinancial Corporate Business (FA106006405.Q) minus Proprietors' Equity in Non-corporate business (FA112090205.Q) minus 'Net New Equity Issue' in the Nonfinancial Corporate (FA103164103.Q). Dividend output ratio is the dividend flow divided by the Gross Value Added for the Business Sector (NIPA Table 1.3.5), adjusted by the price index. The foreign asset position is constructed from totaling the current account adjusted by the price index. The initial position value (end of 2000) is taken from the International Investment Position of the United States at year-end (Table B-107), adjusted

by the price index. Current account output ratio is computed by current account divided by the Gross Value Added for the Business Sector (NIPA Table 1.3.5).

Capital Stock is constructed from totaling Capital Expenditures of the Nonfinancial Business (FA145050005.Q) minus Consumption of Fixed Capital of Nonfinancial Corporate Business (FA106300083.Q) and Consumption of Fixed Capital of Nonfinancial Non-corporate Business (FA116300001.Q). Initial stock values are taken from the Fixed Asset Table (Table 4.1, Current-Cost Net Stock of Nonresidential Fixed Assets by Industry Group and Legal Form of Organization) for the Nonfinancial Corporate Businesses, Sole Proprietorships and Partnerships, including the stock of inventory from (NIPA Table 5.7.5) at the end of 1991. We deflated nominal values by the Price Index for Gross Private Domestic Investment (NIPA Table 1.1.9). Investment is defined as Capital Expenditures of Nonfinancial Business (FA145050005.Q) and deflated by the price index (NIPA Table 1.1.9). Labor is taken from the Index of Aggregate Weekly Hours from the Current Employment Statistics national survey. Consumption includes nondurables and services (NIPA Table 1.1.5) and is deflated by the price index for nondurables and services (NIPA Table 1.1.9) respectively. Output is Gross Value Added for the Business Sector (NIPA Table 1.3.5.) deflated by the Price Indexes for Gross Value Added in the Business Sector (NIPA, Table 1.3.4). We construct all interest series from the monthly data by 3 month average. The interest rate used to compute firms' discount factor is the average majority prime rate published by the Federal Reserve Board that banks charge on short-term loans to businesses. The rate used to compute households' discount factor is the average rate offered on 3-month negotiable certificates of deposit.

4.3.1.2 Japanese Data

Financial data such as interest rate and debt stock are taken from the Bank of Japan, while other data such as corporate dividends, real gross domestic product, corporate gross capital formation, and household domestic final consumption expenditure are taken from Cabinet Office data⁷. All data are seasonally adjusted by Census X12 (except interest rate) and measured at constant 2005 prices. Debt stock is computed from Stock of Loans Liabilities of Nonfinancial Corporations (FF'FOFFFAS410L200) plus Securities other than Equity of Nonfinancial Corporations (FF'FOFFFAS410L300) plus Financial Derivatives of Nonfinancial Corporations (FF'FOFFFAS410L340) minus External Securities Issued by Residents of Nonfinancial Corporations (FF'FOFFFAS410L316), adjusted by GDP deflator in constant 2005 prices (fixed-based method). Debt repurchases are

⁷Data from the Cabinet Office are obtained from the Office Portal Site of Official Statistics of Japan, developed by Statistics Japan.

constructed from nonfinancial corporations' net decrease in debt stock. Debt repurchase to output ratio is computed by dividing the quarterly series of debt repurchase by GDP. Dividend output ratio is calculated from dividends provided by the Secondary Distribution of Income Account published by Office Portal Site of Official Statistics of Japan, divided by GDP. The foreign asset position is constructed by totaling changes of external assets published by the Cabinet Office, deflated by the GDP deflator in constant 2005 prices (fixed-based method). The initial position value (end of 2000) is taken from Japan's International Investment Position (IMF Balance of payments Manual 5th base). Current account output ratio is computed by change in foreign assets divided by GDP.

Average working hour per week is computed as follows: (average working hour per week in all industries multiplied by working population in all industries) divided by (labor force $\times$ 24hours $\times$ 7days). Capital stock is calculated by totaling the corporate businesses' real gross capital formation⁸ minus fixed capital real consumption (excluding the government). The initial value is corporate businesses' net wealth at the end of 2000. Investment is real gross capital formation at constant 2005 prices. Consumption is real final household consumption at constant 2005 prices. The average monthly Average Contracted Interest Rates on Loans and Discounts was used to compute the discount factor for Japanese firms. The Average Interest Rates on Certificates of Deposit by Maturity (New Issues) is used to compute households' discount rate.

4.3.2 Parametrization

Using the US empirical series, we calibrate the model as described in Table 4.3.1. Because the foreign asset position is dominated in home country currency, we take Japan as the foreign country and the US as the home country, as US dollars are commonly considered an international currency. For home country parameters, firms' discount factor is set to correspond to the average majority prime rate charged by banks (5.38 percent). Households' discount factor is set to match the average rate on 3-month negotiable certificates of deposit (2.59 percent). Labor's disutility is set to 1.898, corresponding to a labor supply of 0.33. The inverse elasticity of labor supply is set to 1.6 to match the Frisch labor elasticity of 0.6, which is in line with Greenwood, Hercowitz, and Huffman (1988). The production technology parameter follows the assumption in Jermann and Quadrini (2012). The depreciation rate is set to 0.039, which is nonfinancial businesses' approximate average depreciation rate. The steady state enforcement parameter value of 0.588 is the average level calculated by the empirical series. The equity payout parameter

⁸This is calculated by subtracting government gross fixed capital formation and government inventory from gross capital formation.

of 0.555 matches the dividend output ratio's standard deviation of 0.0248. The foreign transaction cost parameter is set to 0.0025 to match the current account to output ratio's standard deviation. We assume the capital adjustment parameter is 0.5, which lies within the reasonable range implied by the literature.

Foreign country parameters are calibrated following the same steps as given above for the home country. Firms' discount factor is set to match the average contracted interest rates on loans and discounts (1.44 percent), while households' discount factor is set to match average interest rates on certificates of deposit by maturity (0.19 percent). Labor's disutility is set to 3.163, corresponding to a labor supply of 0.33. The inverse elasticity of labor supply is set to 2 to match a Frisch labor elasticity of 1, which satisfies Kuroda and Yamamoto (2008)'s estimate of 0.7 to 1.0 for both females and males in Japan. The Cobb-Douglas parameter in the production function follows Hayashi (2002). The depreciation rate is set to 0.039, which corresponds to an average depreciation rate (excluding the government). The equity payout parameter is set to 6.1 to match the standard deviation of dividend output ratio (0.006). The steady state enforcement constraint parameter is calculated as 0.371, which implies that financial friction in Japan's credit market is more serious than in the US. The foreign transaction cost parameter is set to 0.005 to indicate that Japanese firms face higher costs to engage in the international bond trade. We assume the parameter of capital adjustment cost is 0.5, which is standard in the literature. The exchange rate is 110, approximately the historical average level of the USD to JPY exchange rate.

After calibrating the above parameters, we construct productivity and financial shocks. First, we follow the standard Solow residuals approach, computing productivity shocks for both home and foreign countries from the linearized forms of production functions as follows:

$$\begin{aligned}\hat{z}_t &= \hat{y}_t - \theta \hat{k}_{t-1} - (1 - \theta) \hat{l}_t, \\ \hat{z}_t^* &= \hat{y}_t^* - \theta^* \hat{k}_{t-1}^* - (1 - \theta^*) \hat{l}_t^*,\end{aligned}$$

where variables with hats denote percentage deviations from deterministic trends, or long-run targets. We use series linearly detrended by the Hodrick-Prescott filter as their empirical counterparts. Next we conduct linear regression on time series $\hat{z}_t$ and $\hat{z}_t^*$ respectively:

$$\begin{aligned}\hat{z}_{t+1} &= \rho_z \hat{z}_t + \epsilon_{z,t+1} \\ \hat{z}_{t+1}^* &= \rho_z^* \hat{z}_t^* + \epsilon_{z^*,t+1}.\end{aligned}$$

We now obtain innovations $\epsilon_{z,t}$ and $\epsilon_{z^*,t}$, the residuals generated by the regression, which

Table 4.3.1: Parametrization

<i>Home country</i>	
Discount factor of home firm	0.9489
Discount factor of home household	0.9748
Disutility of labor	1.898
Inverse elasticity of labor supply	1.6
Production technology	0.36
Depreciation rate	0.039
Enforcement parameter	0.588
Payout cost parameter	0.555
Cost of foreign transaction	0.0025
Capital adjustment cost	0.5
<i>Foreign country</i>	
Discount factor of home firm	0.9858
Discount factor of home household	0.9981
Disutility of labor	3.163
Inverse elasticity of labor supply	2
Production technology	0.362
Depreciation rate	0.039
Enforcement parameter	0.371
Payout cost parameter	6.1
Cost of foreign transaction	0.005
Capital adjustment cost	0.5
Exchange rate	110

we refer to as productive shocks.

Similarly, we derive innovations of the enforcement constraint parameters. We begin by computing $\hat{\xi}_t$ and $\hat{\xi}_t^*$ using a method similar to the Solow residuals approach:

$$\hat{\xi}_t = \hat{y}_t - \frac{\xi K}{Y} \hat{k}_t + \frac{\xi B}{Y} \hat{b}_t^e + \frac{\xi N}{Y} \hat{n}_t^e$$

$$\hat{\xi}_t^* = \hat{y}_t^* - \frac{\xi^* K^*}{Y^*} \hat{k}_t^* + \frac{\xi^* B^*}{Y^*} \hat{b}_t^{e*} + \frac{\xi^* N^*}{Y^*} \hat{n}_t^{e*},$$

where large characters without time scripts denote the steady-state value of aggregate variables. It is shown that fluctuation of the constructed $\hat{\xi}_t$ and $\hat{\xi}_t^*$ are always less than 100 percent. Since we assume enforcement constraints are binding at the steady state, it seems reasonable to therefore assume that enforcement constraints were binding during the entire simulation period. The end-of-period values for domestic and foreign liabilities are represented by $\hat{b}_t^e = \hat{b}_t^h / (1+r_t)$ and $\hat{n}_t^e = \hat{n}_t / (1+\tilde{r}_t)$ respectively. Following construction of productivity shocks, we derive innovations $\epsilon_{\xi,t}$ and $\epsilon_{\xi^*,t}$ by the following equations:

$$\hat{\xi}_{t+1} = \rho_{\xi} \hat{\xi}_t + \epsilon_{\xi,t+1}$$

$$\hat{\xi}_{t+1}^* = \rho_{\xi^*} \hat{\xi}_t^* + \epsilon_{\xi^*,t+1}$$

We summarize the properties of constructed series in Table 4.3.2. In the next section, we use the innovation series $\epsilon_{z,t}$, $\epsilon_{z^*,t}$, $\epsilon_{\xi,t}$ and $\epsilon_{\xi^*,t}$ to replicate continuous exogenous shocks, which allows our model to simulate real external environments.

Table 4.3.2: Shocks

<i>Home country</i>	
Std of productivity innovations	0.011
Std of financial innovations	0.034
Autocorrelation of TFP	0.850
Autocorrelation of enforcement parameter	0.929
<i>Foreign country</i>	
Std of productivity innovations	0.019
Std of financial innovations	0.048
Autocorrelation of TFP	0.782
Autocorrelation of enforcement parameter	0.718

4.4 Findings

First, we would like to examine the constructed series of productivity and financial shocks in the US and Japan. Figure 4.4.1 shows that productivity shocks in both the US and Japan experienced peaks and troughs in 2003-04 and 2008-09 respectively, while financial shocks, which had experienced recovery beginning in 2001, suddenly deteriorated rapidly after 2005. The trough in 2009 can be considered as corresponding to the recent financial crisis. For Japan, we find serious financial tightness during 2005-06 and 2009. Both productivity and financial shocks are the out-of-expectation aspect of market forecasts, since we suppose those conducting market analysis use auto-aggressive processes to forecast z_t , z_t^* , ξ_t , and ξ_t^* . In the following subsections, we attempt to model a real economy world in a two country model by using these unexpected components. First, we will analyze the impulse response functions (IRFs) of productivity and financial shocks and explain the model's mechanism; second, we will show the simulation results for major real and financial variables and compare the moments generated by the two country model.

4.4.1 Impulse response

In this section, I analyze how the two-country economy responds to a one-standard-deviation negative shock in one country. We refer to the home country as the borrowing country because its foreign assets position⁹ is positive in the steady state. Correspondingly, the foreign country is considered the lending country due to its negative foreign assets position.

4.4.1.1 Productivity shocks originating in borrowing country

First, we examine how the economy reacts to a one-standard-deviation negative productivity shock originating in the borrowing country. As shown in figure 4.4.2, a negative home country productivity shock lowers the capital's marginal efficiency, which in turn causes a decline in capital investment. A fall in revenue generated by production activities implies a lower amount of intra-period loans in the home country and further alleviates enforcement constraints, causing a fall in the enforcement constraint's Lagrangian multiplier. As the marginal benefits of intertemporal debt relatively increase, equations (4.8) and (4.9) imply that firms will increase their amounts of both domestic and foreign debt, and that such demands will lead to a higher equilibrium interest rate. Since the return on foreign bonds becomes higher than their steady state value, the lending country will increase its domestic intertemporal borrowing to finance foreign lending. Conversely, because firms reduce dividend payouts so as to fund foreign lending, budget constraints' Lagrangian multiplier increases, resulting in the marginal cost of capital investment in the lending country also rising. Because the marginal efficiency of capital investment is not affected by productivity shocks originating in the borrowing country, the equilibrium investment level falls. According to figure 4.4.2, enforcement constraints in the lending country tighten shortly after the shocks' occurrence and therefore domestic borrowing in the lending country suddenly decreases. Consequently, the international interest rate drops and foreign lending also begins to drop. Furthermore, a tighter enforcement constraint increases labor costs, resulting in declining foreign output and demand for labor. Therefore, a negative productivity shock originating in the borrowing country exerts an immediate "crowding out" on investment and a negative effect on the lending country's output and employment soon after the shock.

⁹Remember we assume a positive foreign assets position means borrowing from international financial markets.

4.4.1.2 Productivity shocks originating in the lending country

Figure 4.4.3 illustrates the result of a one-standard-deviation negative productivity shock in the lending country: capital's lower marginal efficiency causes capital investment to fall. The decline in production revenue, in turn, leads firms to decrease dividend payouts, causing the budget constraints' Lagrangian multipliers to rise. Furthermore, demand for intra-period loans will decrease, which helps alleviate enforcement constraints faced by firms. Therefore, the marginal cost of foreign lending increases, leading to a decrease in foreign lending. On the other hand, a smaller labor wedge will boost demand for labor. As the supply of foreign funds decreases, the borrowing country sees falls in the position of external debts, and the firms' Lagrangian multiplier of enforcement constraints become smaller. Although capital's marginal return is unaffected, its marginal cost becomes higher, which leads to reduced capital investment. Furthermore, demand for labor in the borrowing country increases in response to a higher marginal benefit, and output rises slightly. Therefore, from figure 4.4.3, we conjecture that a negative productivity shock in the lending country immediately exerts a "crowding out" effect on investment, but has an immediate positive effect on output and employment within the borrowing country.

4.4.1.3 Financial shocks originating in the borrowing country

Figure 4.4.4 illustrates the impact of financial shocks originating in the borrowing country. The financial shock directly tightens enforcement constraints in the borrowing country, forcing firms to reduce both their domestic and foreign intertemporal debts so as to relieve this tightness. This de-leveraging also leads to a fall in the equilibrium interest rate as well as demand for capital. Furthermore, a higher Lagrangian multiplier for enforcement constraints also causes a larger labor wedge, with a concomitant fall in demand for labor. On the other hand, declining firm demand for foreign funds leads to a drop in foreign funds' equilibrium amount. Consequently, firms in the lending country reduce their domestic intertemporal borrowing, replacing their purchases of foreign bonds with increased capital investment. Booming capital investment and shrinking intertemporal borrowing alleviates firms' enforcement constraints, stimulating a rise in hiring and output shortly after a shock's occurrence. Therefore, a negative financial shock in the borrowing country has an immediate "stimulating" effect on investment and a positive effect on output and employment in the lending country shortly after the shock's occurrence.

4.4.1.4 Financial shocks originating in the lending country

Figure 4.4.5 show how an economy reacts to a negative financial shock originating in the lending country. After a negative financial shock, firms in the lending country face tightened enforcement constraints. The Lagrangian multipliers of the lending country's enforcement constraints increase, forcing firms to reduce demand for labor. As a consequence, output falls instantly. Meanwhile, firms in the lending country begin to reduce intertemporal debt to relieve these constraints, causing a fall in the equilibrium domestic interest rate. Given lower expected returns and a shrinking source of funds, firms begin to reallocate their assets from foreign assets to domestic capital. The borrowing country, on the other hand, faces a fall in the supply of low-cost foreign funds, which forces firms to increase domestic intertemporal debt to cover this reduction. Figure 4.4.5 reveals that enforcement constraints become slightly tighter than those in the steady state, which causes a temporal decline in both equilibrium labor and output. Notice that enforcement constraints in the borrowing country become looser after a shock's occurrence due to a continuing depression in the foreign assets market. As a result, capital's marginal cost grows higher than marginal efficiency, resulting in falling investment. Therefore, our model indicates that negative financial shocks originating in the lending country have a "crowding out" effect on investment shortly after a shock's occurrence and a negative immediate effect on the borrowing country's output and employment.

4.4.2 Simulation

To study how shocks influence the model's dynamics, we feed the series of innovations constructed into the model and compute responses for both real and financial variables. Figures 4.6-4.17 plot the detrended series for output, labor, consumption, investment, current account, and debt repurchases in both the US and Japan. In order to assess whether financial or productivity shocks are more important in accounting for real business cycles, we conduct simulations covering several different aspects, including plotting series by US (Japanese) productivity shocks only, US (Japanese) financial shocks only, and series generated by shocks originating in the US or Japan. Furthermore, in order to determine the existence of international spillover effects from country-specific shocks, we also plot series for the US (Japan) with shocks originating in Japan (the US). In order to analyze the result quantitatively, we show the moments of simulated series and the data in Table 4.4.1.

4.4.2.1 Accounting for the US economy

As shown in figure 4.4.6, since 2001, domestic productivity shocks provide a good explanatory paradigm that accounts for most US output fluctuations. In particular, the observed deterioration of output after 2001 and the recovery after 2003 can be captured well by productivity shocks. On the other hand, the series generated only by financial shocks during this period show a general uptrend, a pattern quite different from reality. Furthermore, the US economy after 2007 declined after peaking in the fourth quarter, a trend that has also been generally replicated by the modeled productivity shocks. However, if we examine the series generated by financial shocks, we find that the US's output should have declined prior to 2007. The moments shown in Table 4.4.1 also prove our findings. As shown, the correlation between data and simulated productivity shock series is 0.7421, higher than the 0.6815 correlation generated by financial shocks. In addition, the standard deviation of the productivity shock simulated series is 0.0189, quite close to its 0.0175 empirical counterpart. By contrast, the standard deviation of the financial shock simulated series is only 0.0092, significantly smaller than that in the data. However, during 2007-09 financial crisis, even though the series generated by both shocks simultaneously are more volatile than the data, it does capture well the timings of both the drop and recovery of US output. Therefore, it is important to consider financial shocks when analyzing the dynamic of output during the 2007-09 financial crisis. This conjecture is also been proved by the moments revealed in Table 4.4.1, which shows that correlation improves to 0.7733 when both types of shocks are considered simultaneously.

In terms of other real variables, figure 4.4.7 indicates that financial shocks provide a stronger explanation of labor compared to productivity shocks, especially during the 2007-09 financial crisis. The simulation's performance improves further if we consider financial and productivity shocks simultaneously. The standard deviation of the simulated labor series generated by both shocks is 0.0229, quite close to the 0.0216 level in the data. For consumption, the series generated by productivity shocks are closer to the data during 2003-07, while consumption's decline during the 2007-09 financial crisis is obviously better captured by financial shocks. An interesting finding is revealed by figure 4.4.9, which reveals that the investment series generated by US-originating financial shocks displays very weak fluctuations, significantly smaller than that in the data. On the other hand, investment movements generated in response to productivity shocks generally capture the trends in the data, especially during 2001-03. According to figure 4.4.10, financial shocks only can replicate the current account data quite well, a finding that is unexpected. The correlation between real data and simulated data reaches 0.6063, and the standard deviations for the data and simulated series are 0.0016 and 0.0017 respectively. Especially

during the 2007-09 financial crisis, the current account peak is exactly replicated by financial shocks alone. By contrast, a substantial divergence opened between the data and the current account series generated by productivity shocks. For debt repurchases, although the 2003-06 downturn and the peak during the 2007-09 financial crisis can be explained well by both shocks, both shocks failed in explaining the 2007-08 trough. For spillover effects, we find shocks originating in Japan were only marginally helpful in accounting for US business cycles.

Therefore, overall, productivity shocks have been more influential in explaining output and investment dynamics, and financial shocks can capture well trends in consumption, current accounts, and labor. Furthermore, it is clear that the observed troughs of output, labor, and consumption, as well as the peaks of current accounts and debt repurchases are deeply related to financial shocks during 2007-09 financial crisis.

4.4.2.2 Accounting for the Japanese Economy

Figure 4.4.12-4.4.17 illustrates the simulated series and empirical counterparts for Japan. Figure 4.4.12 shows that domestic productivity shocks alone can well explain Japan's output dynamics. The correlation between simulated series and the data reaches 0.9597, and the standard deviations of the simulated series and their empirical counterparts are 0.0227 and 0.0208. Output explained by financial shocks implies that the economy should have quickly recovered after the financial crisis; however, negative productivity shocks delayed the recovery. Although it is widely believed that the US financial crisis should have more or less impacted the Japanese economy, at least according to our simulation, financial shocks originating in the US turned out to have no obvious effect on the Japanese economy.

In terms of labor in Japan, although the correlation between the simulated series and the data is only 0.2216, according to figure 4.4.13, we can see that before 2005, productivity shocks can capture well labor's dynamics. Furthermore, the figure indicates that the labor market should recover from the 2010 trough if productivity shocks alone are considered. However, after incorporating financial shocks in addition to productivity shocks, the timing of recovery after the 2007-09 financial crisis becomes consistent with the empirical counterparts. Therefore, our findings reveal that the looser domestic financial environment helped accelerate Japan's economic recovery. The simulation covering consumption shows similar results. Figure 4.4.14 reveals that financial shocks are important in accounting for the trough seen at the beginning of 2009. Figure 4.4.15 shows that productivity shocks can account for most Japanese investment fluctuations. The correlation between the simulated series and the data is 0.6286, and standard deviation is also quite close to

that of the data. In contrast with the US, neither shock could explain well Japan's current account. Figure 4.4.17 shows that financial shocks alone can capture well debt repurchase fluctuations; the correlation shown in Table 4.4.1 reaches 0.7561. In addition, the correlation further increases to 0.8483 if we consider both types of shocks simultaneously. In terms of the spillover effect, Japan's debt repurchases are the only variable vulnerable to shocks originating in the US. Furthermore, financial shocks occurring during the 2007-09 financial crises served to amplify fluctuations in debt repurchases.

In summary, productivity shocks alone can account for most dynamics of output and investment during the past 10 years, as well as for partial fluctuations in labor before 2005. While Japan's financial shocks captured well the changes in debt repurchases, and have been helpful in explaining troughs of output, labor, and consumption during the 2007-09 financial crisis. The obvious spillover effect from the US to Japan only appeared in debt repurchases, and turned out to be insignificant in terms of other variables during the past decades.

Figure 4.4.1: Estimates of Shocks

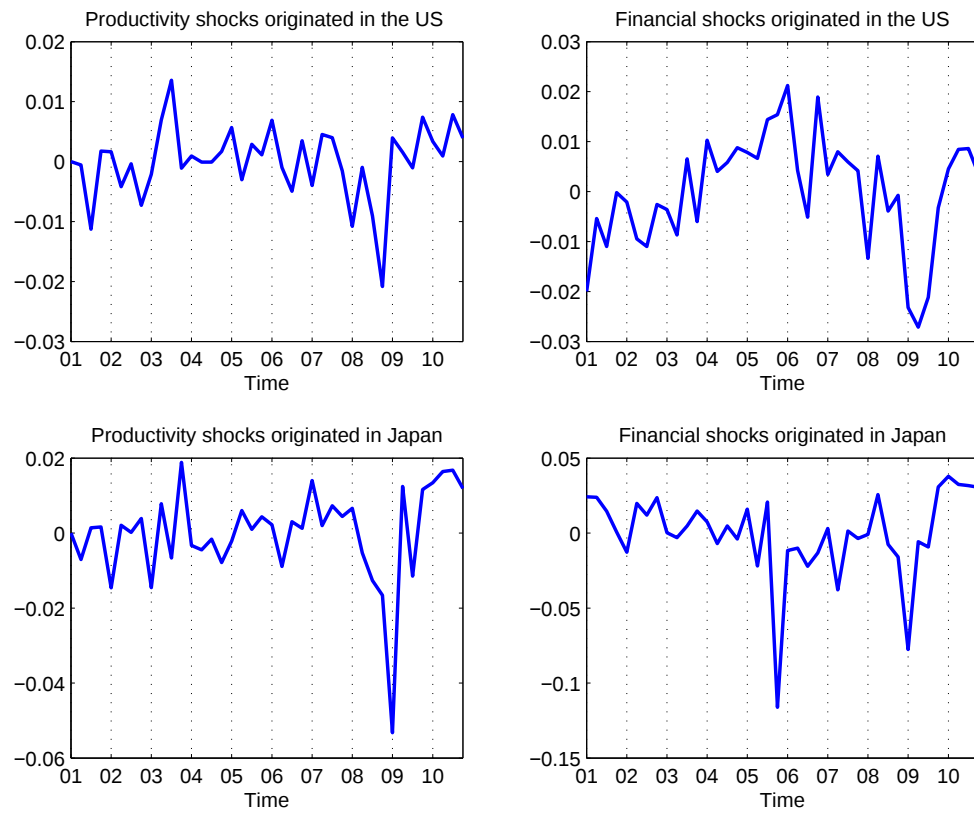
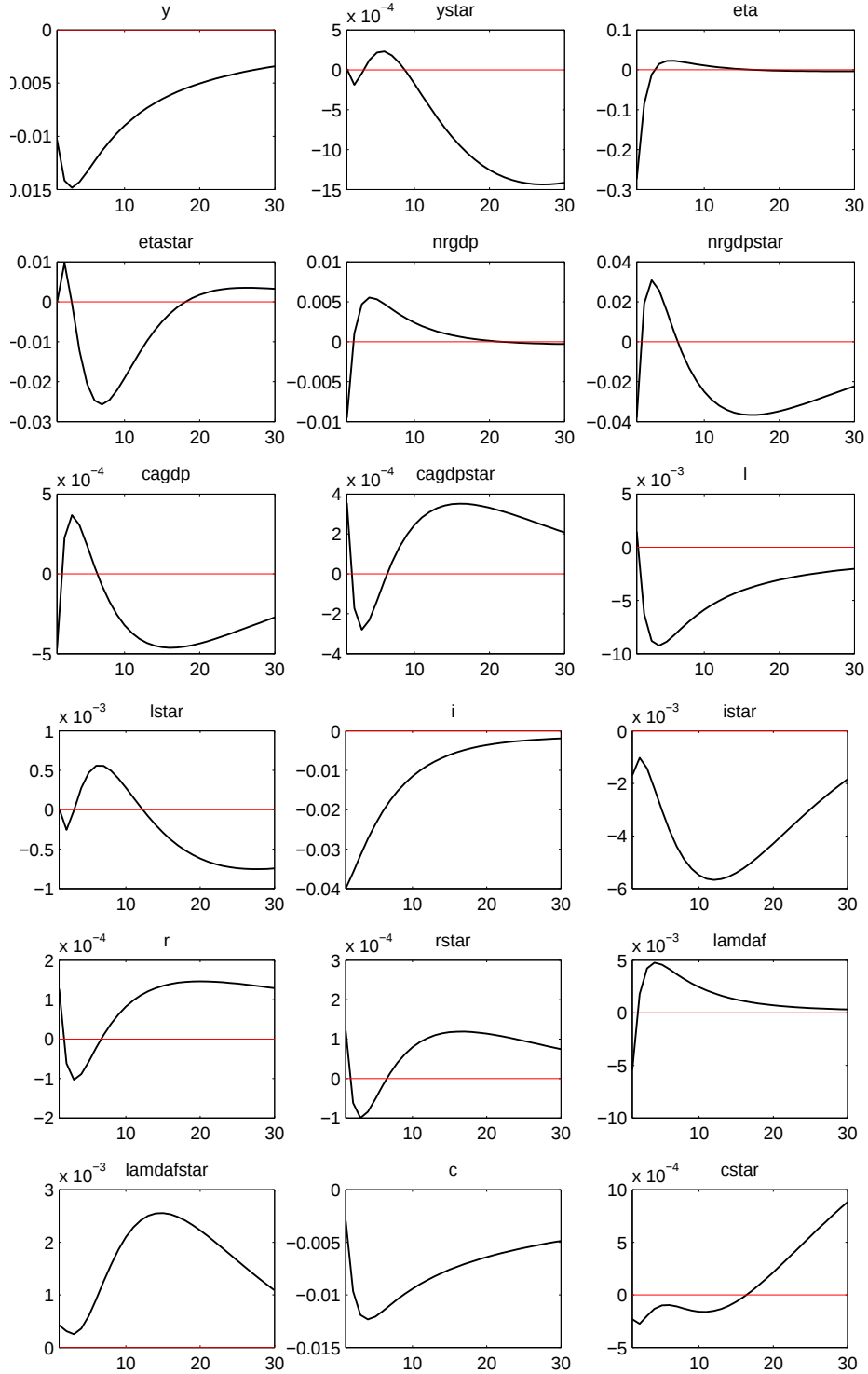


Figure 4.4.2: Response to one-standard-deviation negative productivity shock originated in borrowing country



Notes: y , η , $nrgdp$, $cagdp$, l , i , r , $lamdaf$, c indicate output, Lagrangian multiplier of enforcement constraint, debt repurchase, labor, investment, interest, Lagrangian multiplier of budget constraint and consumption in home country. $ystar$, $etastar$, $nrgdpstar$, $cagdpstar$, $lstar$, $istar$, $rstar$, $lamdafstar$, $cstar$ indicate output, Lagrangian multiplier of enforcement constraint, debt repurchase, labor, investment, interest, Lagrangian multiplier of budget constraint and consumption in foreign country.

Figure 4.4.3: Response to one-standard-deviation negative productivity shock originated in lending country

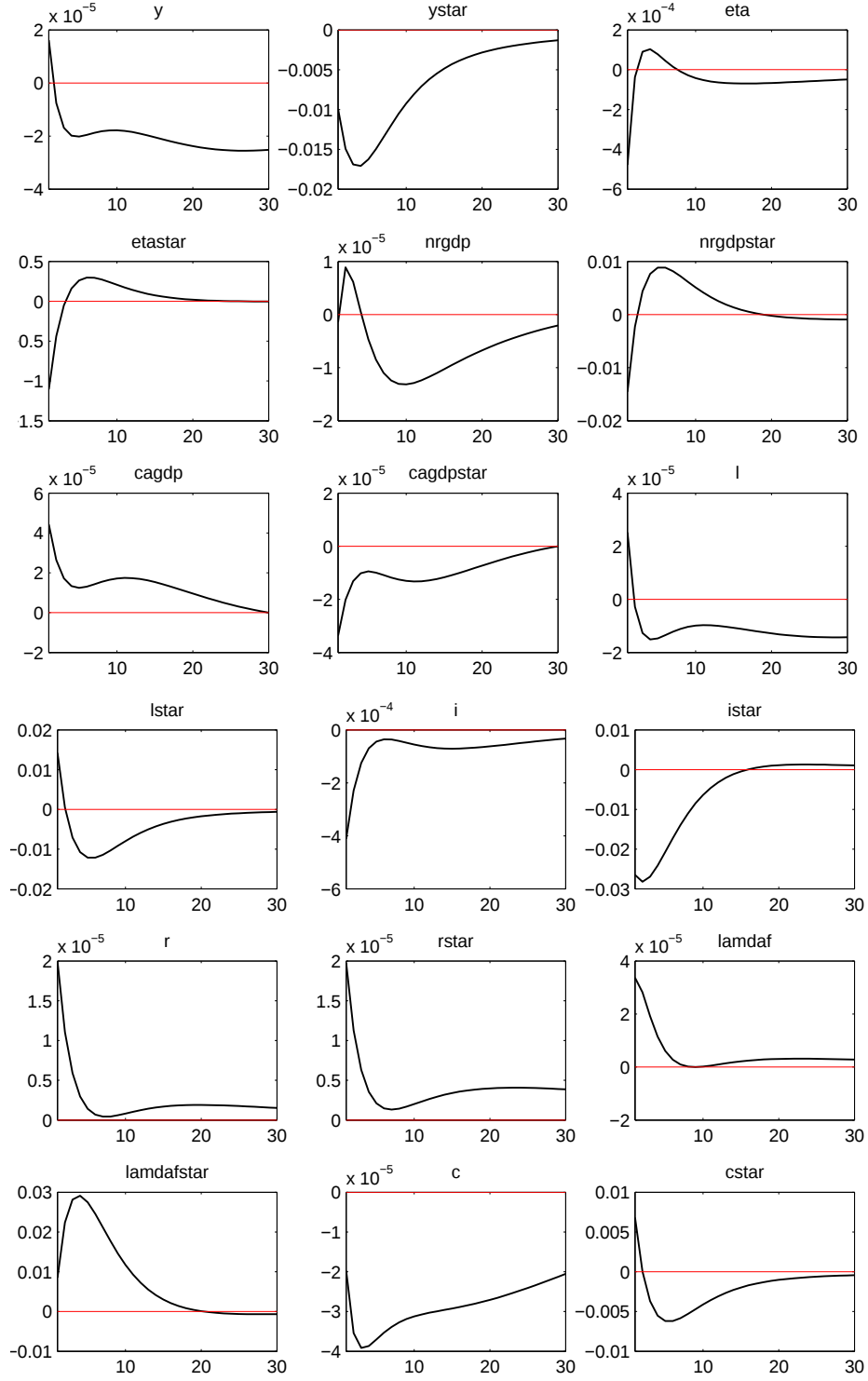


Figure 4.4.4: Response to one-standard-deviation negative financial shock originated in borrowing country

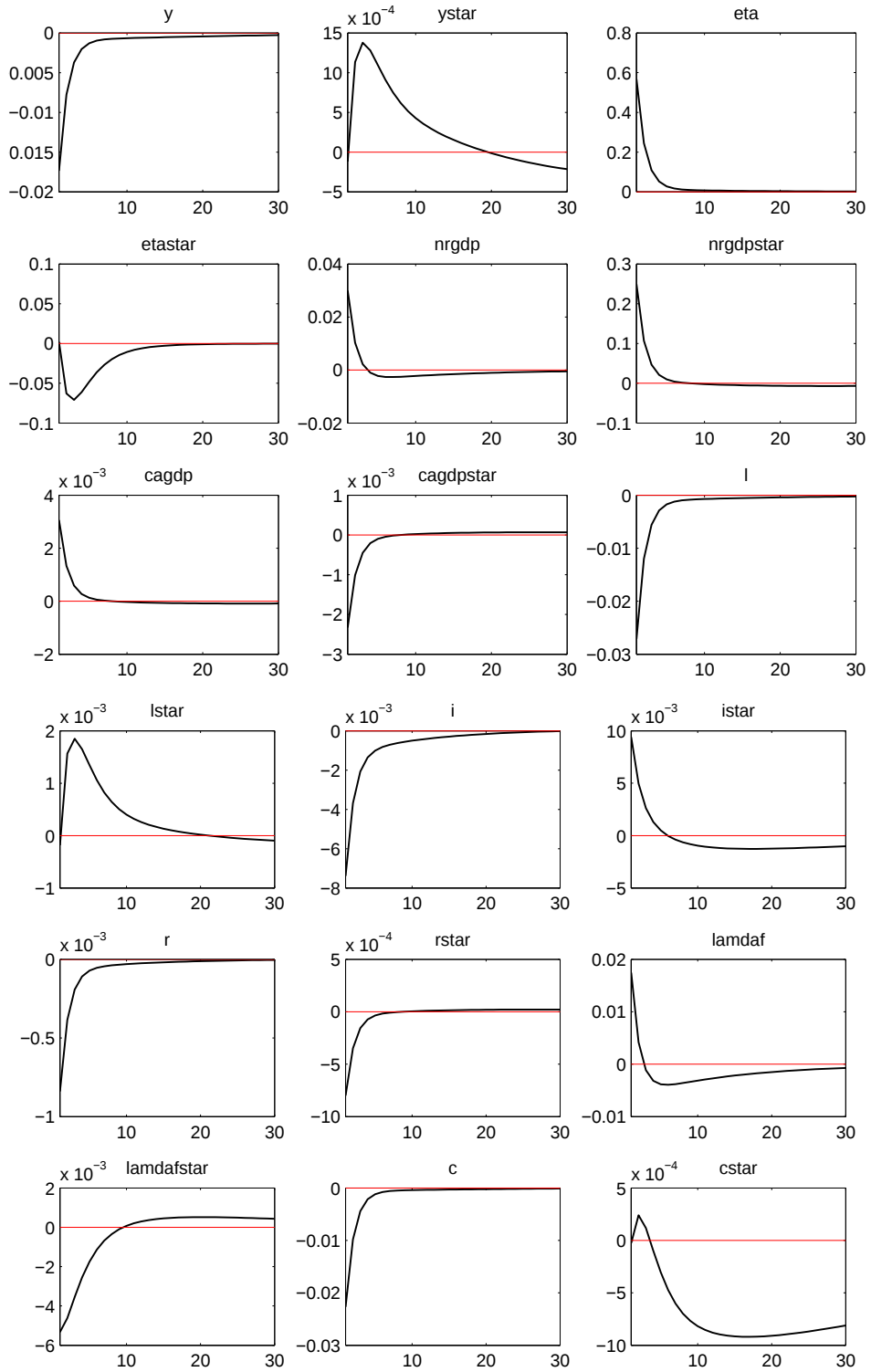


Figure 4.4.5: Response to one-standard-deviation negative financial shock originated in lending country

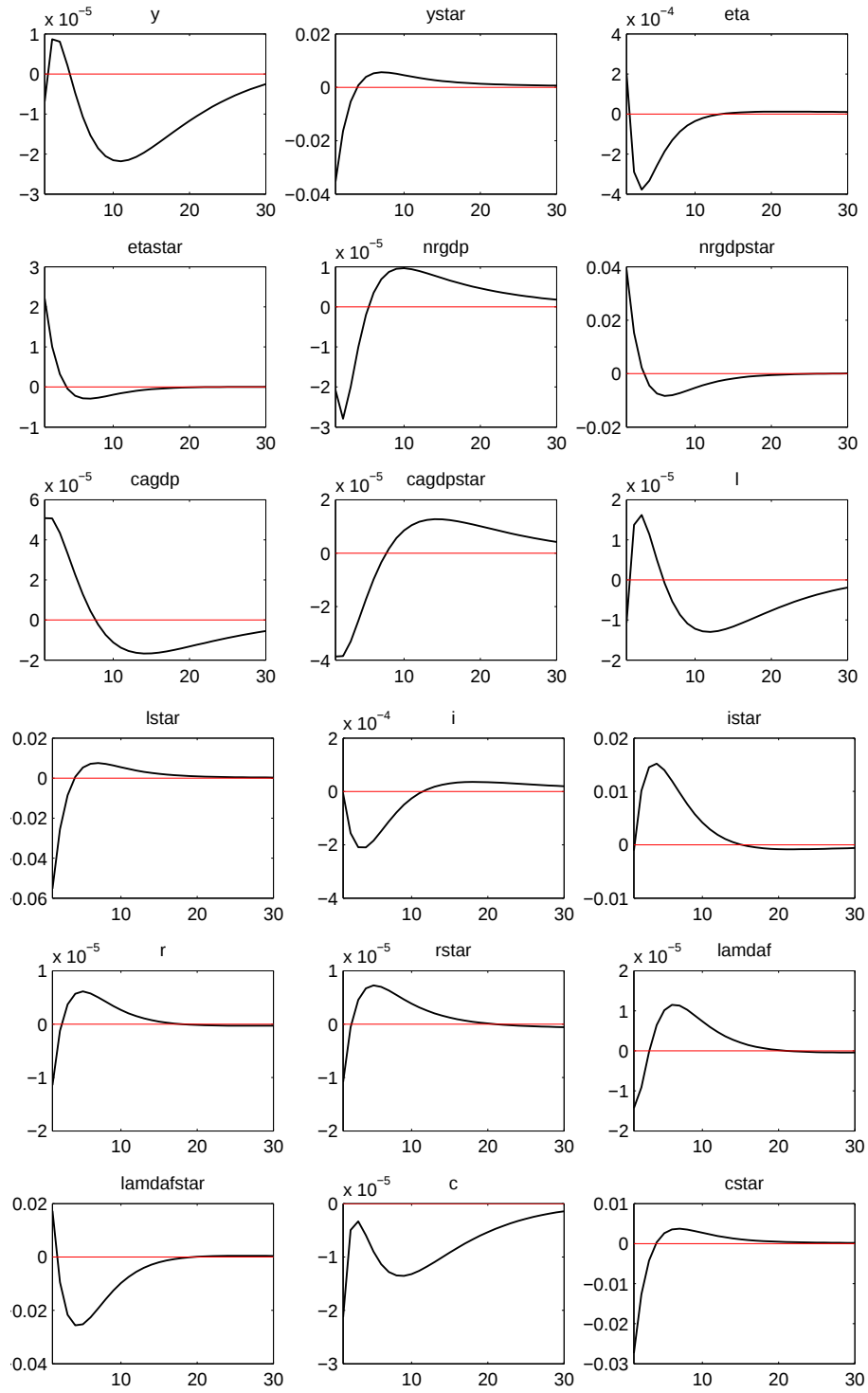


Figure 4.4.6: Output in the US (- - -: simulated data ; — : real data)

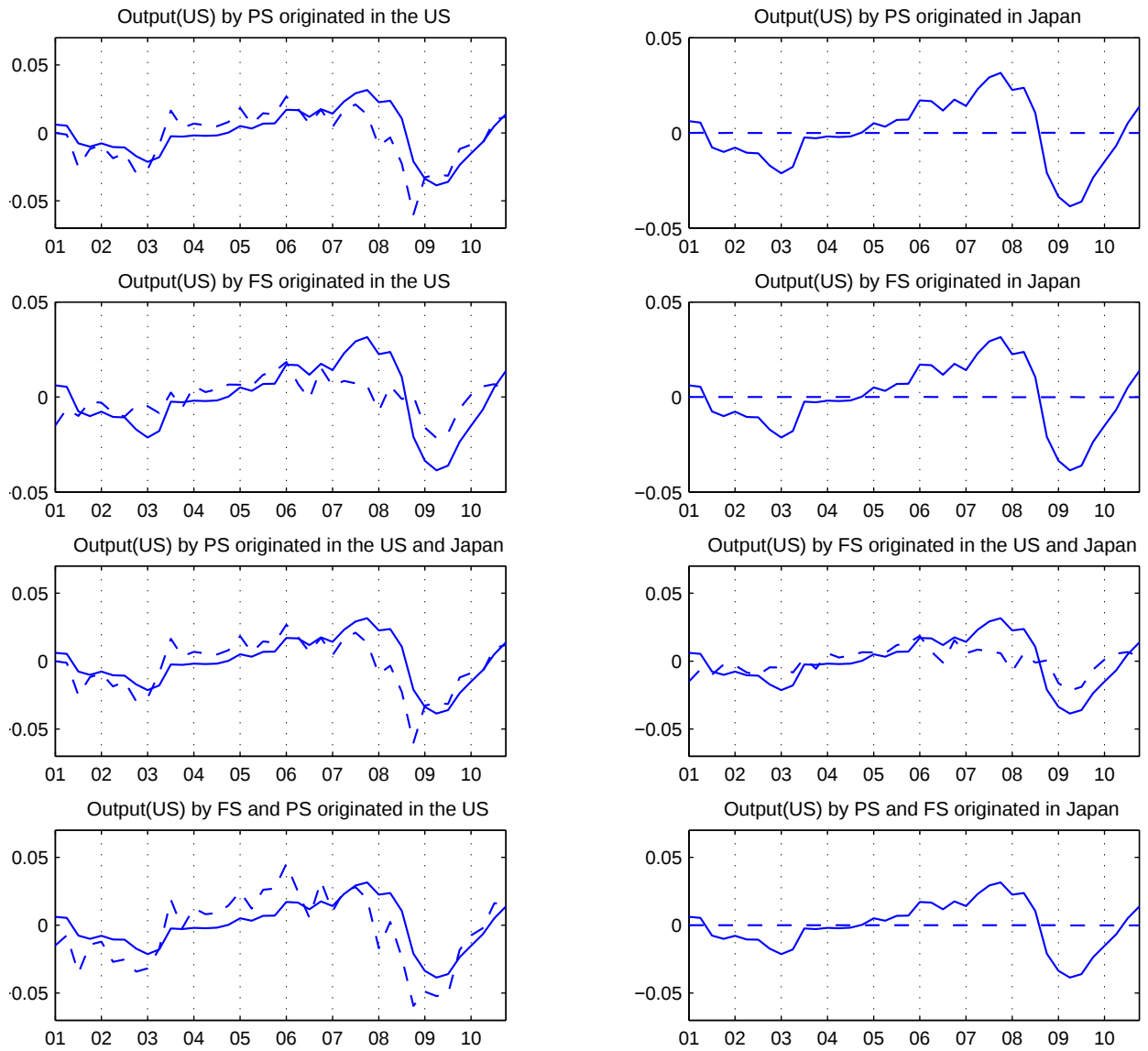


Figure 4.4.7: Labor in the US (- - -: simulated data ; — : real data)

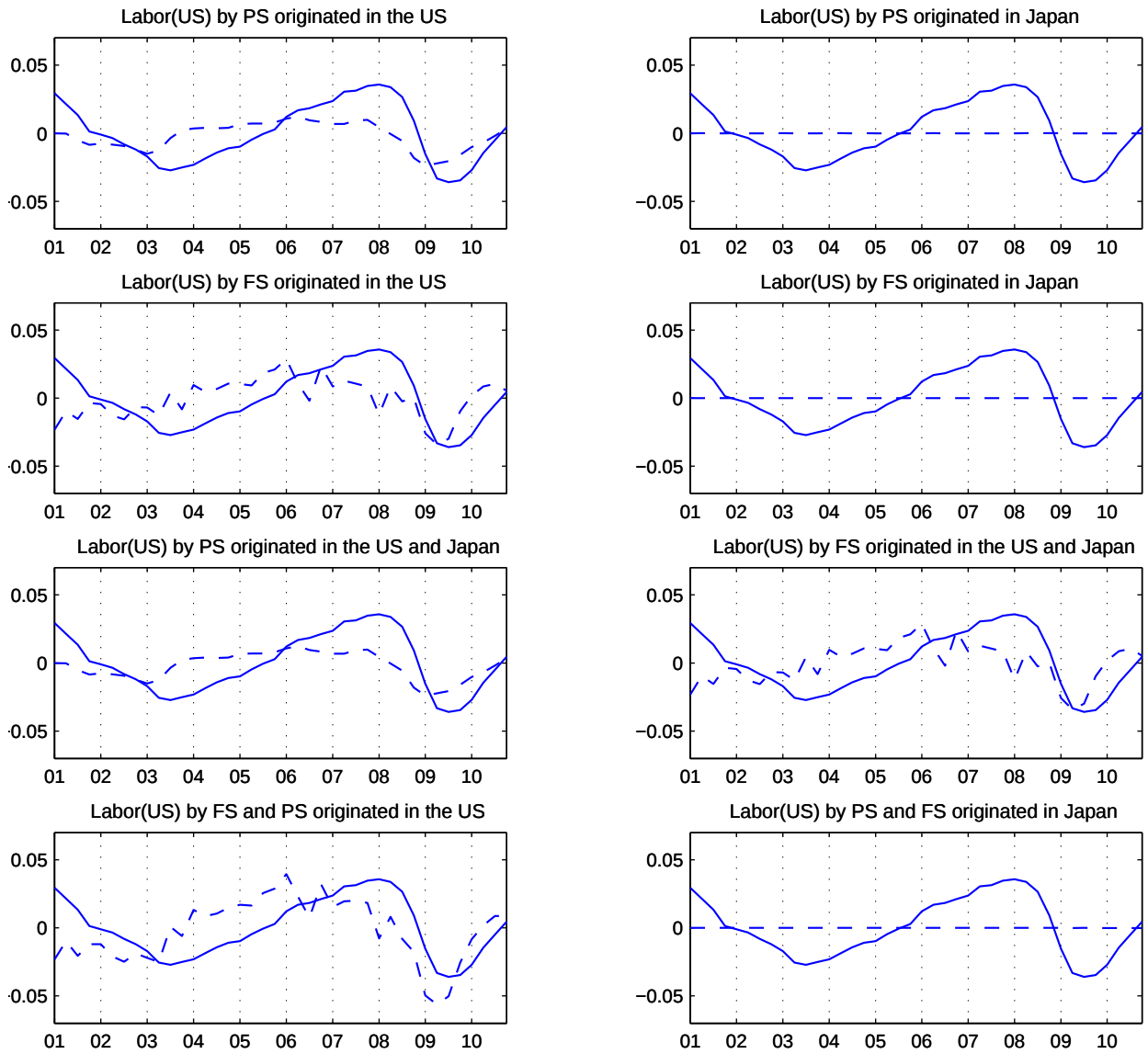


Figure 4.4.8: Consumption in the US (- - -: simulated data ; — : real data)

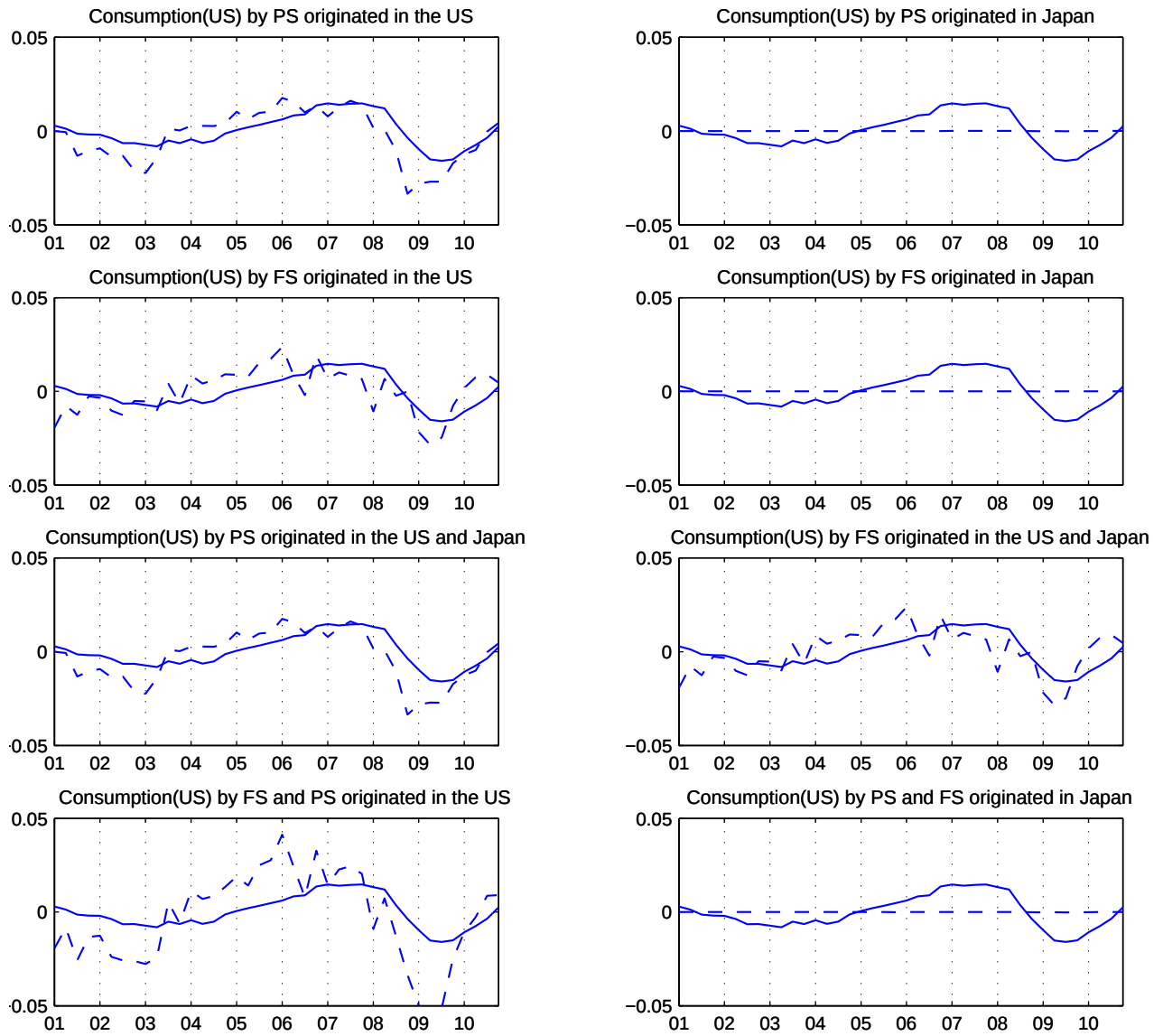


Figure 4.4.9: Investment in the US (- - -: simulated data ; — : real data)

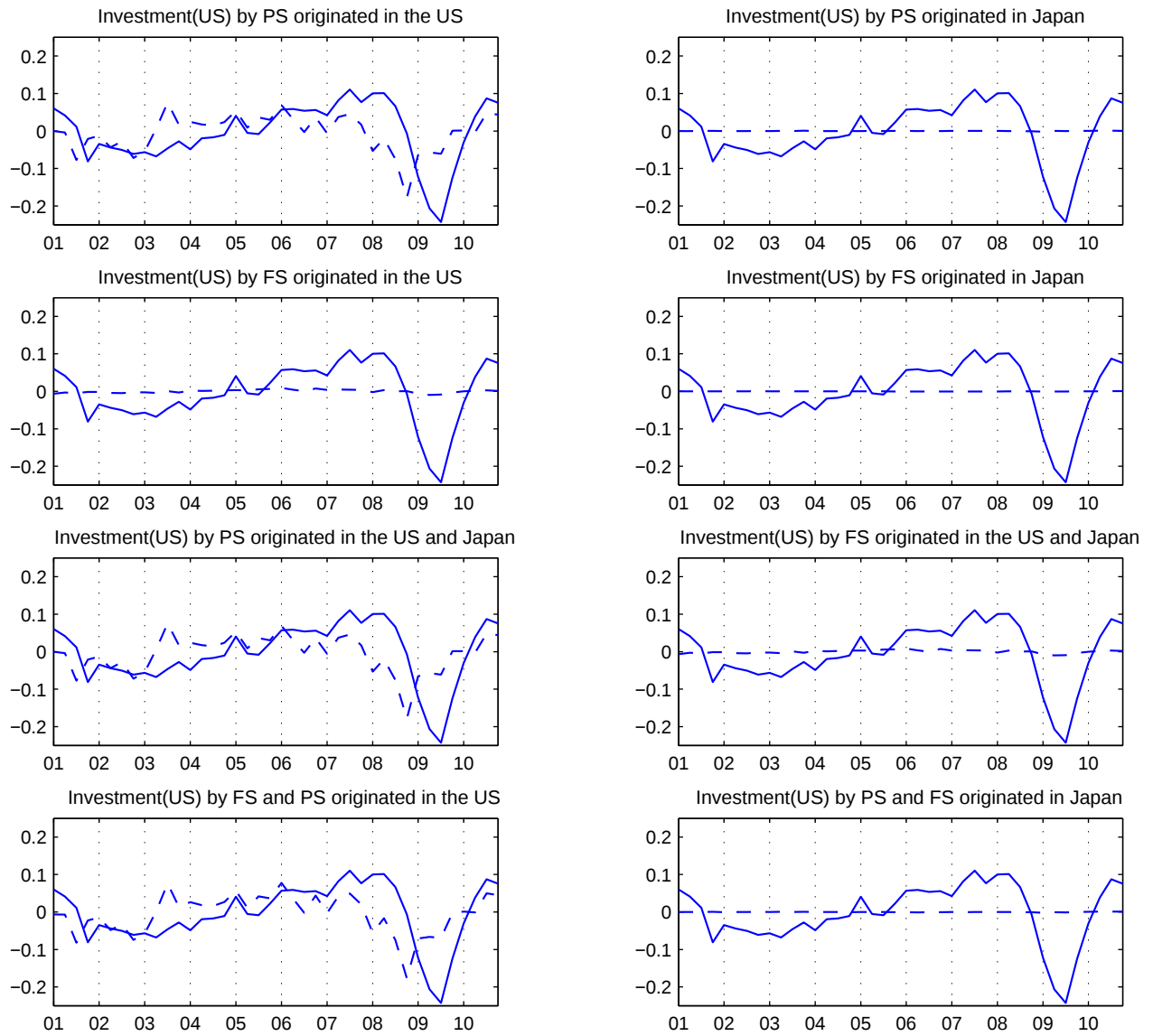


Figure 4.4.10: Current account in the US (- - -: simulated data ; — : real data)

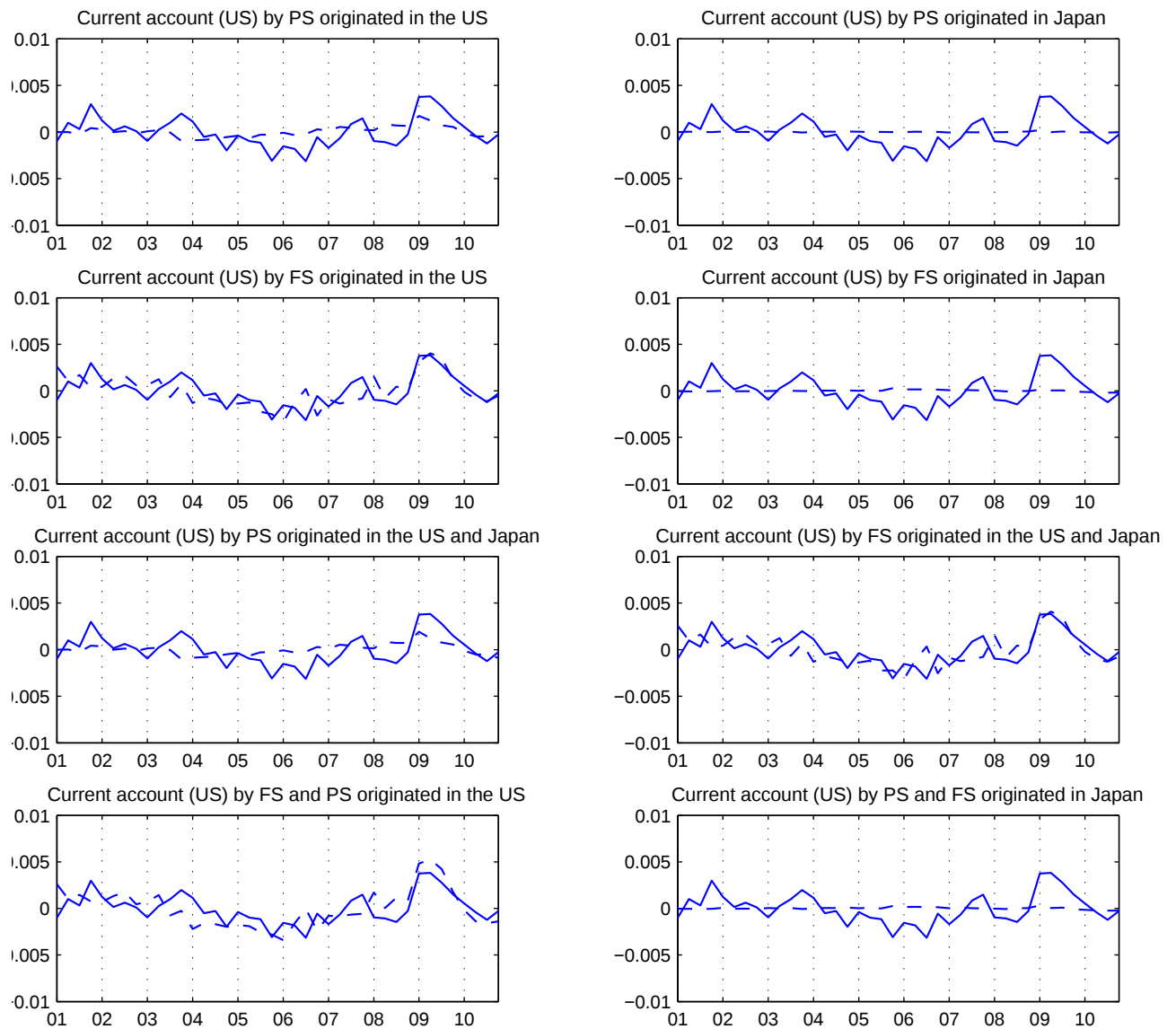


Figure 4.4.11: Debt repurchase in the US (- - -: simulated data ; — : real data)

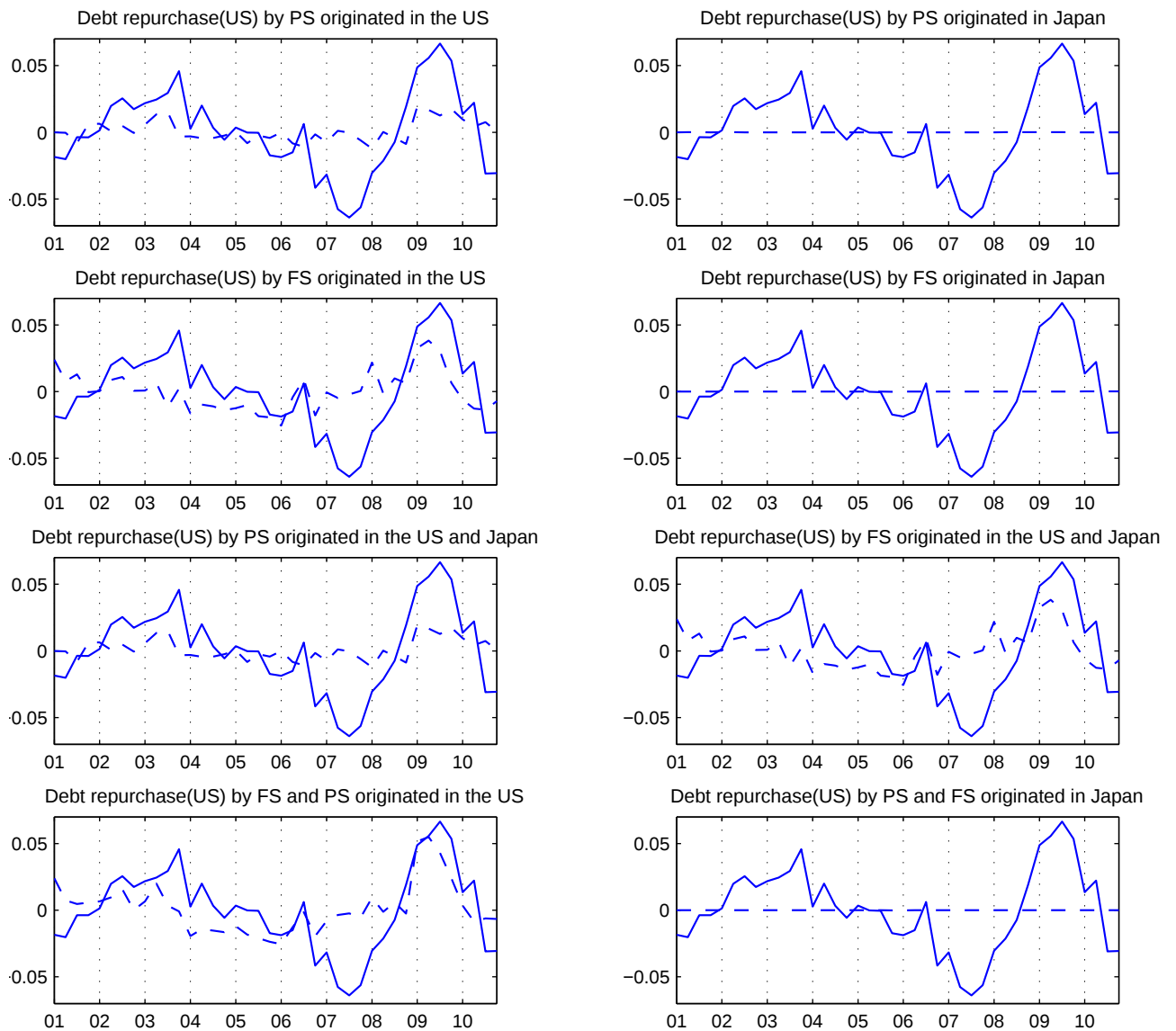


Figure 4.4.12: Output in Japan (- - -: simulated data ; — : real data)

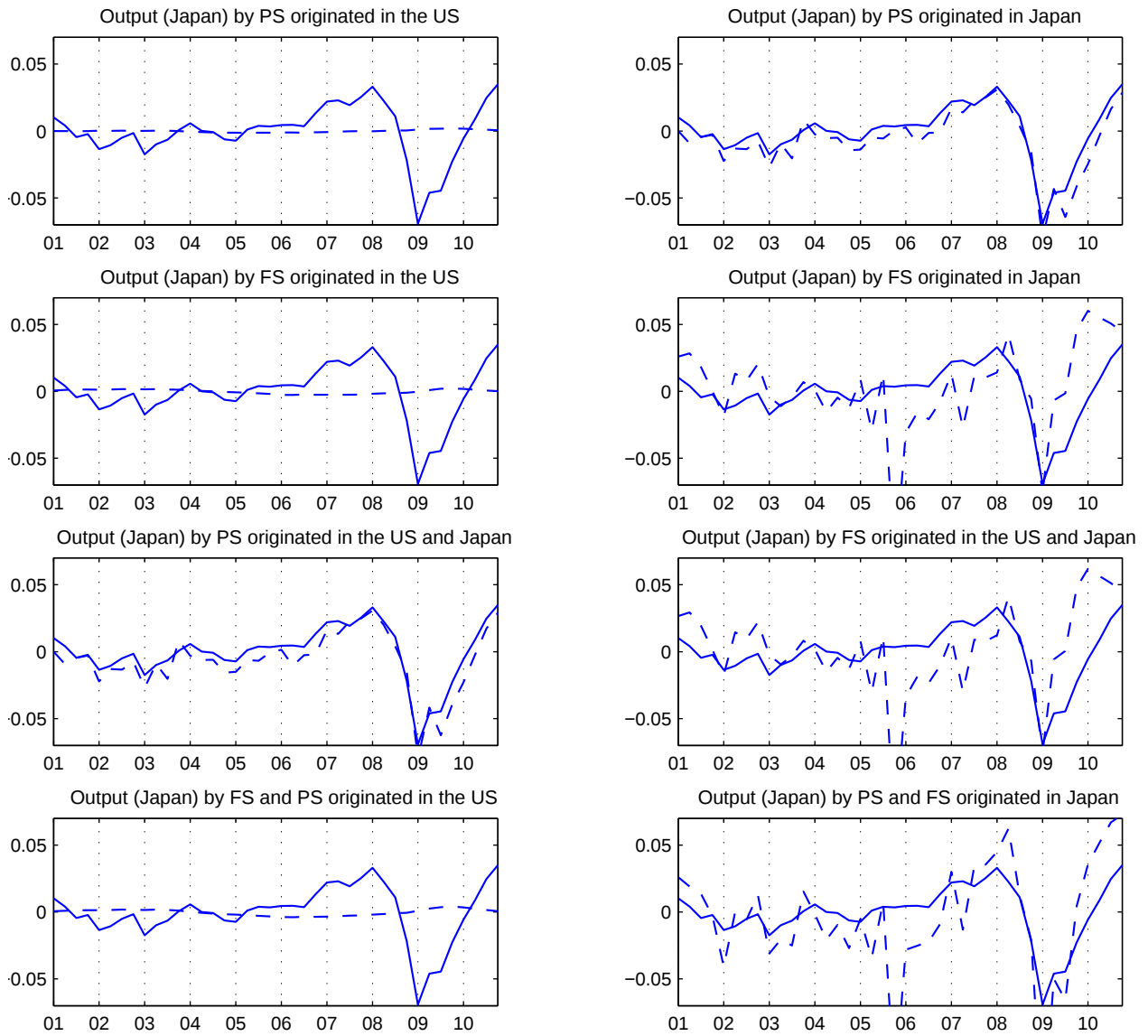


Figure 4.4.13: Labor in Japan (- - -: simulated data ; — : real data)

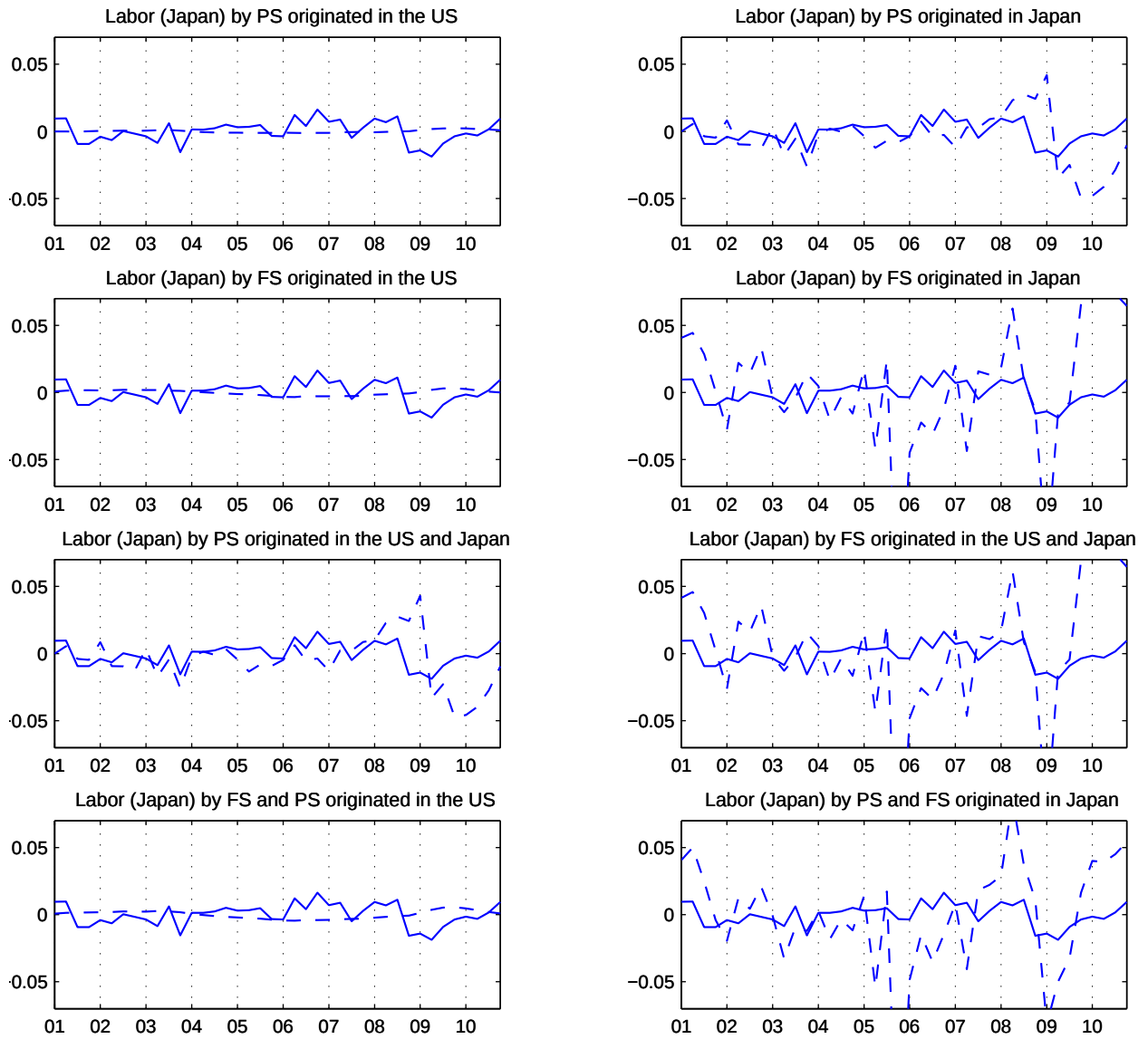


Figure 4.4.14: Consumption in Japan (- - -: simulated data ; — : real data)

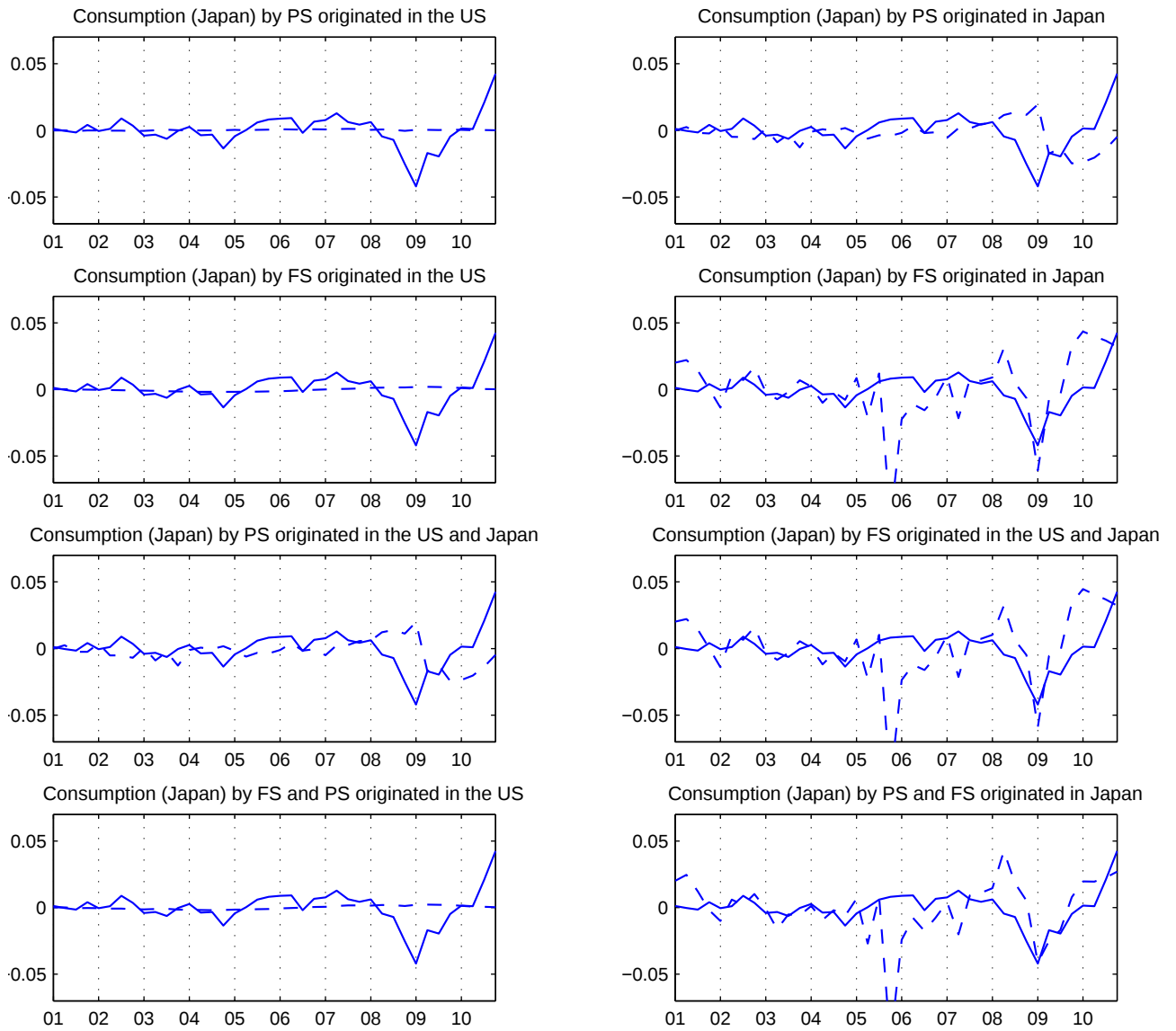


Figure 4.4.15: Investment in Japan (- - -: simulated data ; — : real data)

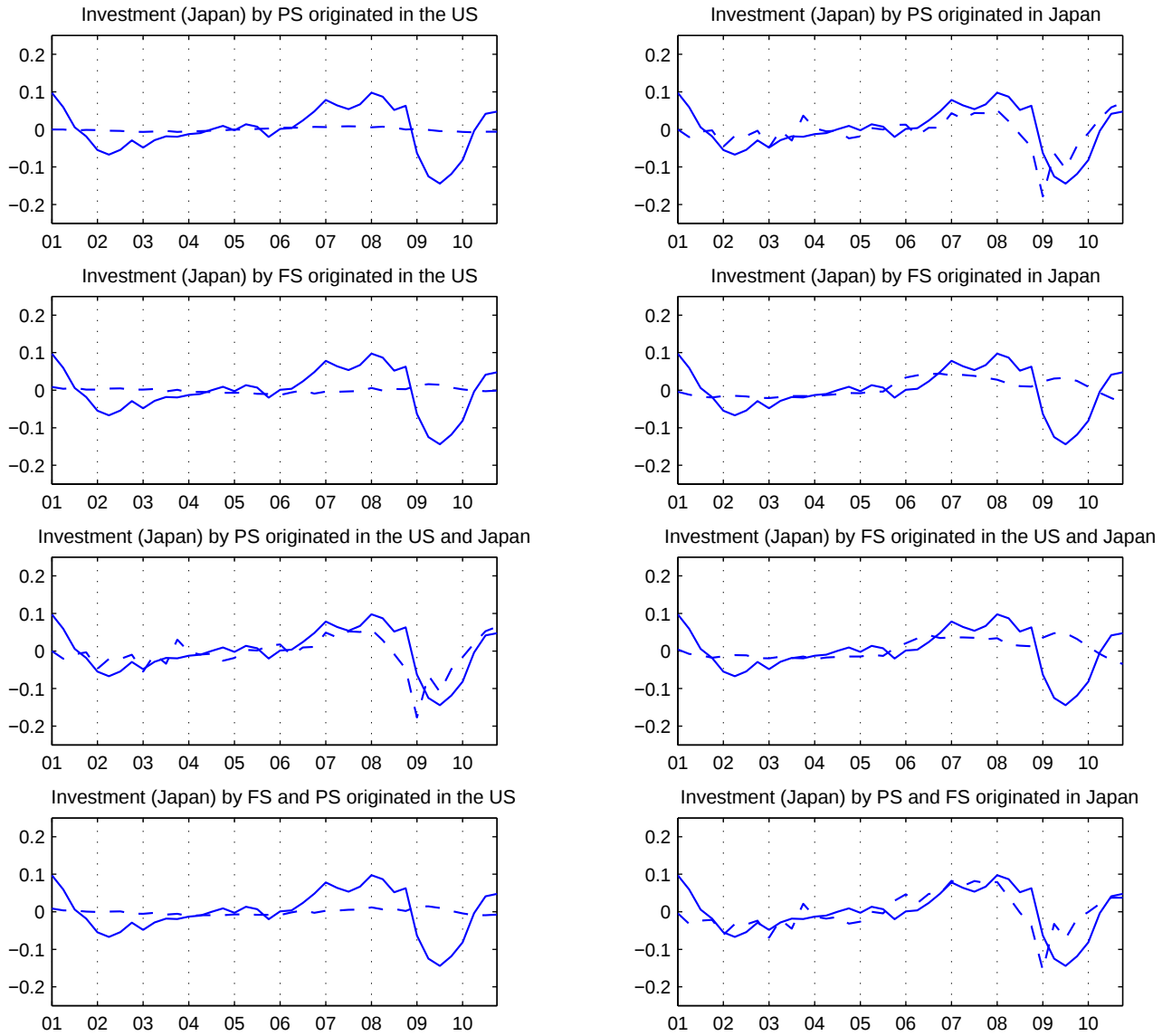


Figure 4.4.16: Current account in Japan (---: simulated data ; — : real data)

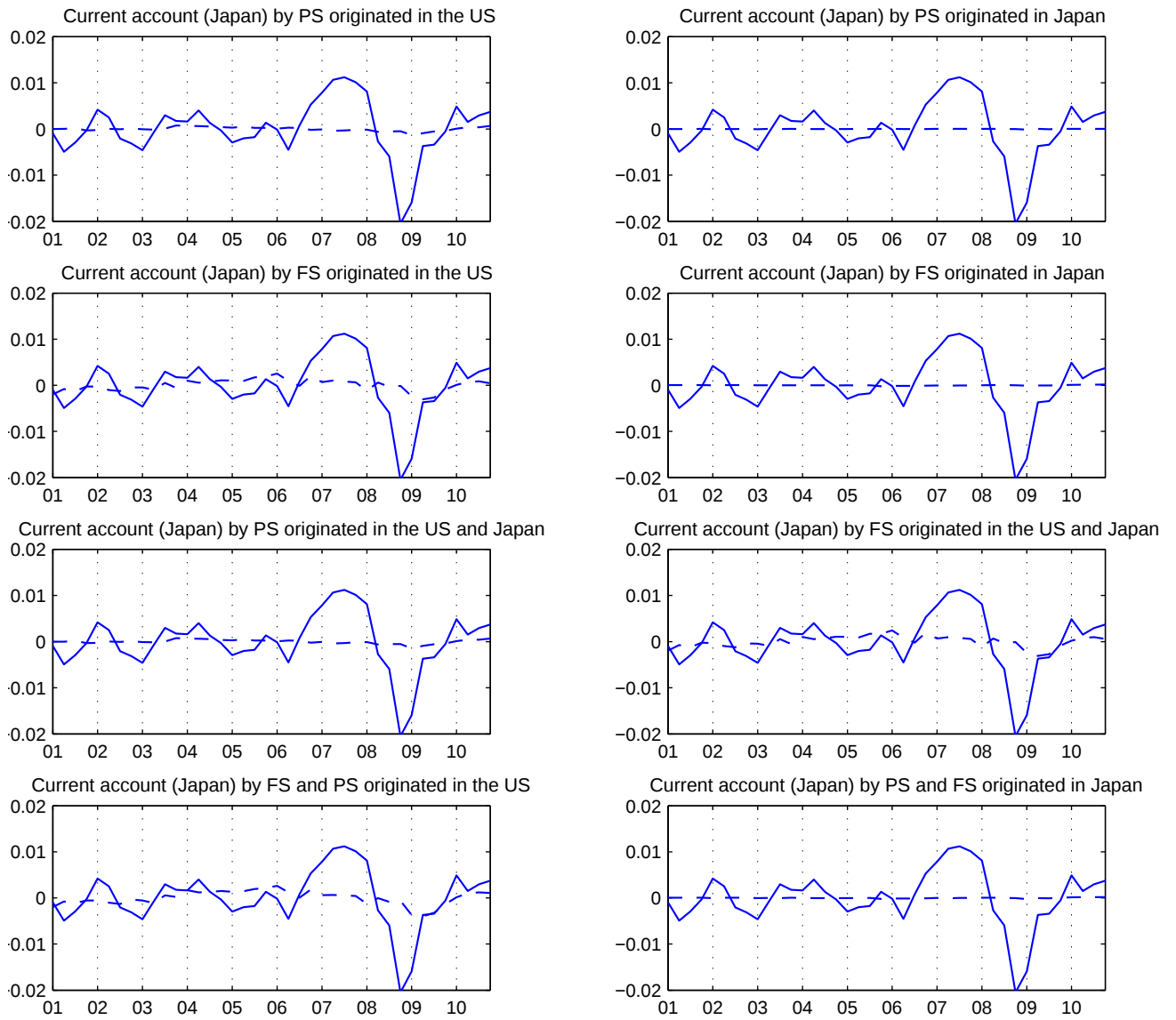


Figure 4.4.17: Debt repurchase in Japan (---: simulated data ; — : real data)

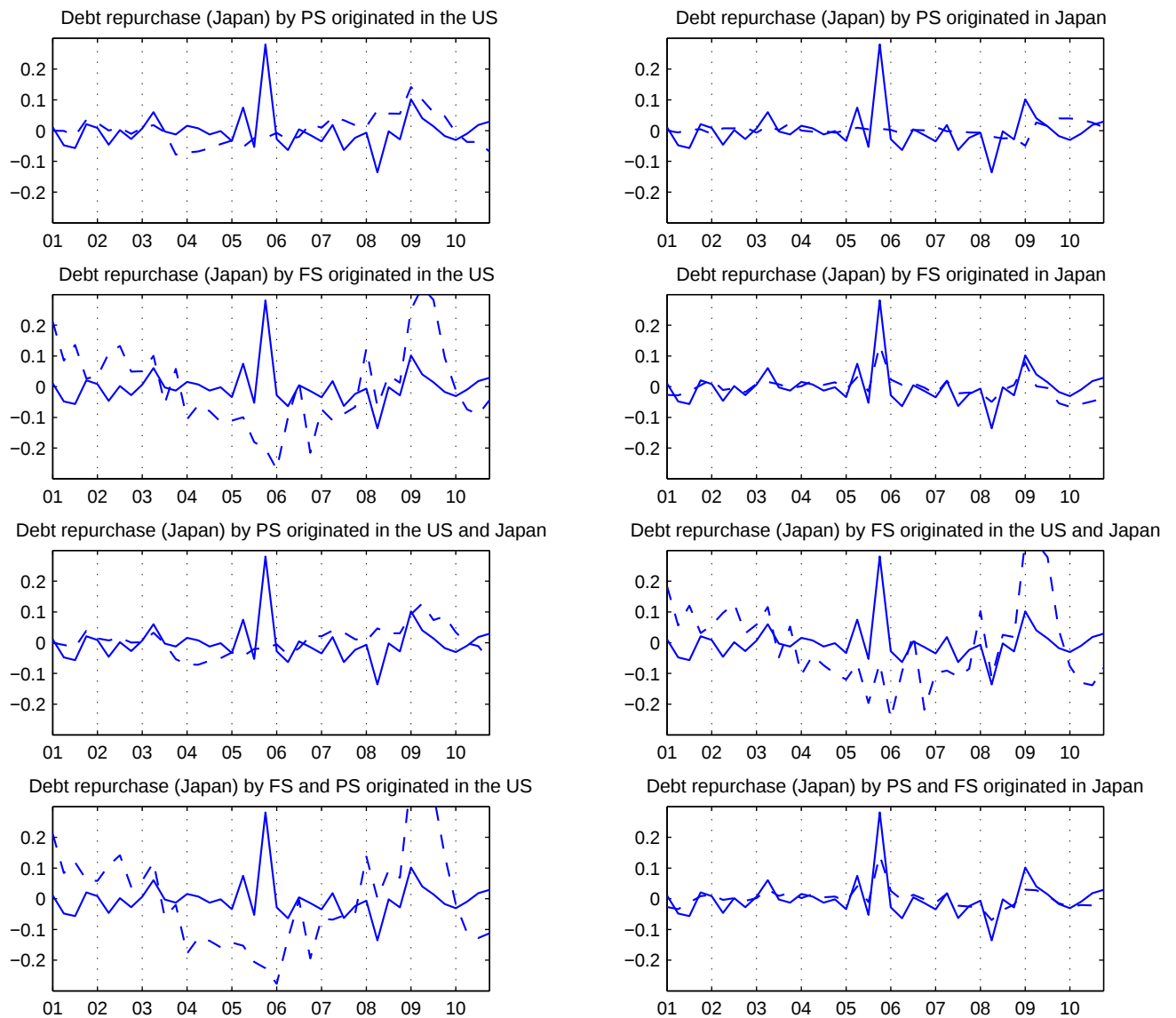


Table 4.4.1: Moments

	Data	PS(US only)	PS(Japan only)	FS(US only)	FS(Japan only)	PS(Both)	FS(Both)	PS(US) and FS(US)	PS(JPN) and FS(JPN)
Corr. with output(US)	1	0.7421	0.4623	0.6815	0.1286	0.7426	0.6812	0.7733	0.2925
Std.of output(US)	0.0175	0.0189	2.2967e-05	0.0092	4.8264e-05	0.0189	0.0092	0.0263	5.7511e-05
Corr. with output(JPN)	1	-0.4146	0.9597	-0.4662	0.3298	0.9600	0.3023	-0.4928	0.7274
Std.of output(JPN)	0.0208	9.1862e-04	0.0227	0.0016	0.0340	0.0223	0.0346	0.0023	0.0454
Corr. with Labor(US) data	1.0000	0.5608	0.4762	0.3130	0.0402	0.5617	0.3128	0.4431	0.3041
Std.of Labor(US)	0.0216	0.0101	2.3823e-05	0.0144	3.2103e-05	0.0101	0.0144	0.0229	4.1545e-05
Corr. with Labor(JPN) data	1	-0.4674	0.2216	-0.4863	0.1972	0.2020	0.1763	-0.4999	0.3029
Std.of Labor(JPN) data	0.0084	0.0010	0.0190	0.0020	0.0518	0.0184	0.0525	0.0029	0.0476
Corr. with Consumption(US)	1	0.7578	0.6843	0.5448	-0.1871	0.7586	0.5441	0.7057	0.4371
Std.of Consumption(US)	0.0088	0.0138	4.6602e-05	0.0119	3.1145e-05	0.0139	0.0119	0.0240	5.9625e-05
Corr. with Consumption(JPN)	1	0.1654	-0.2574	-0.2763	0.3107	-0.2498	0.2943	-0.1971	0.2350
Std.of Consumption(JPN)	0.0129	3.9816e-04	0.0093	0.0012	0.0256	0.0094	0.0259	0.0013	0.0236
Corr. with Investment(US)	1	0.3519	0.3567	0.6669	-0.1378	0.3538	0.6717	0.3901	0.1872
Std.of Investment(US)	0.0799	0.0496	4.3321e-04	0.0044	3.3389e-04	0.0497	0.0043	0.0522	5.7975e-04
Corr. with Investment(JPN)	1.0000	0.5753	0.6286	-0.4033	0.1266	0.6743	0.0136	0.0265	0.6318
Std.of Investment(JPN)	0.0596	0.0049	0.0446	0.0066	0.0236	0.0458	0.0244	0.0071	0.0491
Corr. with Current account(US)	1	0.4435	0.2718	0.6053	-0.2243	0.4490	0.6003	0.6271	-0.0808
Std.of Current account(US)	0.0016	5.8248e-04	4.3969e-05	0.0017	9.5172e-05	6.0199e-04	0.0016	0.0020	1.1630e-04
Corr. with Current account(JPN)	1	0.3259	0.6541	0.3589	-0.0177	0.3631	0.3626	0.3900	0.2328
Std.of Current account(JPN)	0.0061	4.4300e-04	3.3445e-05	0.0013	7.2370e-05	4.5784e-04	0.0013	0.0015	8.8444e-05
Corr. with Debt repurchase(US)	1.0000	0.5467	0.2950	0.4115	-0.0114	0.5472	0.4114	0.5575	0.1159
Std.of Debt repurchase(US)	0.0312	0.0080	1.7475e-05	0.0147	4.3333e-05	0.0080	0.0147	0.0188	4.0228e-05
Corr. with Debt repurchase(JPN)	1	0.0031	0.0220	0.0322	0.7561	0.0118	0.2294	0.0273	0.8483
Std.of Debt repurchase(JPN)	0.0613	0.0474	0.0172	0.1345	0.0354	0.0445	0.1354	0.1639	0.0320

4.5 Conclusion

This chapter developed a simple two-country model incorporating an international bond market and enforcement constraints within countries, and attempted to quantify the role of productivity and financial shocks in the presence of financial integration. Quantitative results show that for both the US and Japan, productivity shocks, rather than financial shocks, can account for most dynamics observed in the real variables such as output and investment. On the other hand, financial shocks have tracked US trends of consumption, current accounts, and labor, and succeeded in replicating Japan's debt repurchases. Nevertheless, it is still worth noting that financial shocks serve as key factors accounting for the observed troughs of output, labor, and consumption, and peaks of debt repurchases and US current accounts during the 2007-09 financial crisis.

Our results imply that it is difficult to isolate which types of shocks dominated the real business cycles during the past decades because different shocks played different roles in different times. For example, although productivity shocks seem to exert a larger influence on output during normal periods, during a financial crisis, financial shocks become critical factors that account for fluctuations or output turning points. Second, we encountered the unexpected result that an observable international spillover effect only appeared in Japan's debt repurchases. As it is widely considered that the Japanese economy have been deeply influenced by US economic fluctuations, our quantitative results raise questions about this opinion. Moreover, such a two country model can be extended and applied to other countries or regions, such as the EU and China, and further comparative studies employing this model can enrich the literature examining the role played by financial and productivity shocks.

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