Financial Market Integration and Spillover Effects

Kyunghun Kim*

University of California, Davis

JOB MARKET PAPER

October 28, 2014

Abstract

The 2007 - 2009 financial crisis shows the importance of financial shocks and financial market integration as a transmission mechanism. This paper finds that transmission of financial shocks can differ dramatically depending on the type of financial market integration. I classify financial market integration into three categories: the short-term debt, long-term debt, and equity markets. Empirical estimates show that short-term debt market integration is associated with a negative spillover effect on output in other countries, whereas long-term debt market integration is associated with a positive spillover effect on foreign output. This result explains the ambiguous result of past empirical works that did not distinguish between different types of assets. To explain this finding, I develop a two-country DSGE model. A financial accelerator operating in the short term debt market leads to a negative spillover, while efficient allocation of investment working through the long term debt market leads to positive spillovers.

Keywords: market integration, spillover effect, financial market, long-term debt market, short-term debt market, financial accelerator effect, efficient allocation effect

*Address: Ph.D. Candidate, Department of Economics, University of California, Davis, One Shields Avenue, Davis, CA, 95616, USA, Telephone: 1-530-304-9579, E-mail: *hunkim@ucdavis.edu*.

1 Introduction

The recent financial crisis originating from the U.S. subprime mortgage market resulted in a global macroeconomic downturn. As GDP in the U.S. declined, GDPs in many other countries also fell, but the impact from the U.S. financial crisis differed across countries. GDPs in some countries fell as much as or more than the U.S GDP. However, GDPs in other countries fell less. The global recession of 2007 - 2009 has highlighted the importance of financial shocks and the potential for international financial market integration to transmit them from one country to another[1].

Depending on how shocks are transmitted to other countries, international business cycles can either move together or move in the opposite direction. In the international business cycle literature, many papers have emphasized the role of financial market integration, but the conclusions have not agreed on whether financial market integration promotes the business cycle comovement or divergence across countries[2]. It is ambiguous because the effect of financial market integration on the international business cycle is affected by many factors including characteristics of shocks[3], boom-bust cycles[4], and other macro-variables.

This paper helps us get a much clear understanding of the relationship between financial market integration and the international business cycle if we appropriately distinguish different types of financial market integration. Financial markets have been integrated rapidly during the last two decades as the integration measure of the financial market indicates. This conventional single index[5] can capture "how much" the financial markets have been integrated, but it cannot capture "how" the financial markets have become integrated. Economists have placed less emphasis on the types of financial market integration, which is a key factor to resolve the ambiguity.

In order to consider different types of financial market integration, I divide the financial market by kind of security: short-term debt, long-term debt, and equity. This is because I

[1]The related graphs are presented in Appendix A1.

[2]Some papers argue that financial market integration leads to business cycle convergence(Imbs (2004), Imbs (2006), Kose et al. (2003), Kose et al. (2008a), Kose et al. (2008b)). Others, however, argue that financial market integration leads to business cycle divergence(Heathcote and Perri (2003), Heathcote and Perri (2004), Kalemli-Ozcan et al. (2012)).

[3]If shocks are common shocks such as global uncertainties and self-fulfilling expectations, there will be simultaneous global economic downturn (Bacchetta and Van Wincoop (2012)). If a shock is a financial shock rather than a productivity shock, it is more likely to transmit easily to other economies in the integrated financial market. This is because the financial market tends to be more efficient.

[4]Abiad et al. (2013) and Kalemli-Ozcan et al. (2012) show empirical evidence that financial crises induce output comovement among more financially integrated countries. In periods without financial crises, however, the increased financial market integration is associated with more divergent output cycles.

[5]The conventional financial market integration measure (Abiad et al. (2013), Imbs (2006)) is normally constructed based on the amount of foreign securities or differences in returns of securities.

expect that there is a meaningful distinction between equity and long-term/short-term debt which is related to the effect of trade involving ownership, and this will affect the international business cycle. There is another significant difference between equity/long-term debt and short-term debt which is related to the effect of trade involving maturity structure, and this will also affect the international business cycle. Short-term debt represents bonds of which the term to maturity is one year or less, and long-term debt indicates bonds of which the term to maturity is more than one year. Equity includes the ordinary shares and stocks. I construct integration measures for these three markets separately. Each market integration plays a different role in transmitting a country-specific financial shock to output in other countries. This allows us to see the the varying effects of different types of financial market integration on the international business cycle. I find empirical evidence from the 2008 U.S. financial crisis and develop a theoretical model to explain the empirical findings.

The empirical result shows that a country whose short-term debt market is more integrated with the U.S. is more likely to have negative output spillovers from the 2008 U.S. financial shock, whereas a country whose long-term debt market is more integrated with the U.S. is more likely to have positive output spillovers from the shock. While short-term debt market integration leads to usual transmission of financial shocks, long-term debt market integration surprisingly plays a role as a buffer in transmitting financial shocks. Thus, short-term debt market integration is associated with business cycle convergence, while long-term debt market integration is associated with business cycle divergence. This empirical result is robust to different market integration measures, U.S. financial shocks, and model specifications. The empirical result also shows that equity market integration is associated with business cycle divergence, but this is not robust to different model specifications.

In response to the country-specific financial shock, two opposite effects take place in the integrated financial market: the financial accelerator effect[6] and the efficient allocation effect. The financial accelerator effect represents that the financial condition such as the ratio of borrowers' net worth to total assets, affects the external finance premium which determines investment. In the integrated financial market, the country-specific financial shock alters financial market condition in the home and foreign countries. This leads to a decline in home and foreign investment. On the other hand, the country-specific financial shock causes returns on capital to differ across countries and resources move to a place with higher returns. This is the efficient allocation effect. Which effect is dominant differs across the short-term debt, long-term debt, and equity markets.

In the model, the credit contract is subject to a financial friction representing monitoring cost that arises due to asymmetric information between borrower and lender. Because the

[6]This is similar to the international finance multiplier, balance sheet effect, and common lender effect.

contract has to be renewed every period in the short-term debt market, it is more subject to the financial friction. Therefore, the financial accelerator effect is more likely to dominate the efficient allocation effect in the short-term debt market. In contrast, long-term bonds are traded based on a long-term relationship (long-term contract)[7], and are less subject to the financial friction. The efficient allocation effect is more likely to dominate the financial accelerator effect in the long-term debt market.

It is important for policy makers to figure out how different types of financial market integration have different transmission of the country-specific financial shock from other countries. In the period of financial crisis, the risk associated with the volatility of capital flows rises. To dampen the impact of the volatile capital flows on investment and output, policy makers should implement capital controls such as exchange controls and transaction taxes. Restrictions given to the financial market should be different depending on the types of financial market integration to properly regulate the impact of capital flows on investment and output.

Davis (2014) also addresses different types of financial market integration to explain international business cycles. Davis (2014) looks at the different effects of equity market integration and debt market integration using a simultaneous equation empirical model. Contrary to Davis (2014), I focus on the different effects of short-term debt and long-term debt market integration on output spillovers. The empirical model that is used in this paper is similar to the model used by Abiad et al. (2013), however, they do not consider different types of financial market integration.

Ueda (2012) develops a two-country DSGE model with the chained credit contract, and shows how the globalization of the banking system affects the international business cycle. Instead of looking at only banking globalization, I develop a two-country DSGE model incorporating the short-term debt and long-term debt markets to investigate the effect of each market integration on the international business cycle.

Section 2 gives the empirical results, section 3 sets out the theoretical model, section 4 presents the simulation result, and I conclude in section 5.

2 Empirical Analysis

This chapter discusses the empirical model and presents the empirical results with robustness checks. The data used for the integration measures of the financial market are from the Coordinated Portfolio Investment Survey (CPIS) conducted by the IMF. GDP growth

[7]This is because the maturity of the long-term bonds is longer than the short-term bonds.

rates, and other explanatory variables are collected from various sources[8]. The dataset used in the empirical analysis is the unbalanced panel. It covers from 2002:Q1 to 2013:Q4, and includes 41 countries[9].

2.1 Empirical Model

Equation (1) shows the basic specification. i denotes the country i. m denotes the U.S which is the base country. w denotes the world, and t denotes time. The dependent variable is the GDP growth rate, Δy_{it}. The explanatory variables are integration measures, the U.S. financial shock, and other control variables. These are denoted as $\text{Link}_{im,t}$, Shock_t^m, and Control_t, respectively. There are 4 integration measures: the short-term debt, long-term debt, equity, and financial market integration measures. Financial market integration is the conventional integration measure. Types of financial market integration are considered using a set of short-term debt, long-term debt, and equity market integration measures. In addition to these integration measures, there is trade linkage which implies the integration of the goods market. In the basic model specification, the Lehman crisis is used for the U.S. financial shock. This is a dummy variable whose value is one in 2008:Q3 and zero otherwise.

$$\Delta y_{it} = \alpha_i + d_t + \beta t + \gamma_1(l)\text{Shock}_t^m + \gamma_2(l)(\text{Shock}_t^m \times \text{Link}_{im,t}) + \gamma_3(l)\text{Link}_{im,t} + \gamma_4(l)\text{Control}_t + \epsilon_{it} \quad (1)$$

The main explanatory variable is the product of the 2008 U.S. financial shock and integration measure, $\text{Shock}_t^m \times \text{Link}_{im,t}$. This variable implies how each market integration plays a role in transmitting the 2008 U.S. financial shock[10] to output in other countries. Other control variables refer to global macro-variables which include the oil price and the S&P 100 Volatility Index. α_i denotes the country fixed effects and d_t denotes the time fixed effects. These are used for the basic specification along with the time trend, βt, to capture the common trend of growth rates across countries. l denotes the lag polynomial. The lags of explanatory variables are also included in the empirical model and the number of lags in the basic model specification is 7[11].

[8] See Appendix A1.

[9] The country list is presented in Appendix A1.

[10] The effect of other U.S. specific shocks such as the U.S. GDP growth surprises, U.S. fiscal policy shocks, and U.S. monetary policy shocks are also analyzed in Appendix A5.

[11] This is because the dataset used in this paper shows that the shock lasted about for 8 quarters in the recent financial crisis (Appendix A1). The number of lags in the basic model specification is set to 7 so that we look at the impact of the shock for 8 quarters including the impact of the current variable on the GDP

2.2 Integration Measure

To construct integration measures, I use data on bilateral portfolio assets of short-term debt, long-term debt, and equity[12]. Short-term debts denote treasury bills, commercial paper, financial paper, certificates of deposit with original maturity of one year or less, etc. These are the securities of which the original term to maturity is one year or less than one year. Long-term debts represent treasury bonds, asset-backed securities, certificates of deposits with contractual maturity of more than one year, other long-term debt securities, etc. These are the securities of which the original term to maturity is more than one year. Equity denotes ordinary shares and stocks. Equity holders claim to the residual values of enterprises after the claims of all creditors have been met[13]. However, long-term and short-term debts give the holders the unconditional right to receive a contractually determined sum of money on a specified date.

Equation (2), (3), and Equation (4) are the integration measures for the short-term debt, long-term debt, and equity markets. These are denoted as Short-term Debt Link$_{im,t}$, Long-term Debt Link$_{im,t}$, Equity Link$_{im,t}$, respectively. The short-term debt market integration measure of country i implies the sum of country i's assets of short-term debt in relation to the U.S. and the U.S.'s assets of short-term debt in relation to country i normalized by the sum of both countries' GDPs. The way to construct integration measures for long-term debt and equity markets are the same as the short-term debt market, with the exception of the securities used. All Integration measures are constructed vis-a-vis the U.S.

$$\text{Short-term Debt Link}_{im,t} = \frac{\text{short-term debt}_{im,t} + \text{short-term debt}_{mi,t}}{\text{GDP}_{i,t} + \text{GDP}_{m,t}} \tag{2}$$

$$\text{Long-term Debt Link}_{im,t} = \frac{\text{long-term debt}_{im,t} + \text{long-term debt}_{mi,t}}{\text{GDP}_{i,t} + \text{GDP}_{m,t}} \tag{3}$$

$$\text{Equity Link}_{im,t} = \frac{\text{equity}_{im,t} + \text{equity}_{mi,t}}{\text{GDP}_{i,t} + \text{GDP}_{m,t}} \tag{4}$$

The financial market integration measure, Financial Link$_{im,t}$, is the conventional index. Financial market integration of country i represents the sum of country i's assets of all

growth rate. The regression result with different numbers of lags is also presented in Appendix A2.

[12]Quarterly data is used in the empirical analysis to look at the business cycle. However, only yearly data are available in the CPIS. Thus, I use the previous year's assets of short-term debt, long-term debt, and equity for all quarters of the specified year. For example, the CPIS data collected at the end of 2007 is used to construct integration measures for 2008:Q1 - 2008:Q4.

[13]Details about the definitions of securities can be found in the CPIS manual.

securities in relation to the U.S. and U.S. assets of all securities in relation to country i normalized by both countries' GDPs. Because integration measures are normalized by the same GDPs, financial market integration is the sum of the integration measures for the short-term debt, long-term debt, and equity markets. Using these three measures, we can see whether the conventional index masks different effects of short-term debt, long-term debt, and equity market integration on spillover effects.

$$\text{Financial Link}_{im,t} = \text{Short-term Debt Link}_{im,t} + \text{Long-term Debt Link}_{im,t} + \text{Equity Link}_{im,t} \tag{5}$$

An integration measure for the goods market, which is trade linkage, is also constructed in the same way as above. $\text{export}_{im,t}(\text{export}_{mi,t})$ denotes country i(U.S.)'s exports in relation to the U.S.(country i) in time t. Trade linkage represents the sum of the bilateral exports normalized by both countries' GDPs. The trade linkage between country i and the U.S. is constructed as follows.

$$\text{Trade Link}_{im,t} = \frac{\text{export}_{im,t} + \text{export}_{mi,t}}{\text{GDP}_{i,t} + \text{GDP}_{m,t}} \tag{6}$$

2.3 Empirical Result

The sum of estimated coefficients of the main explanatory variable, $\text{Shock}_t^m \times \text{Link}_{im,t}$, and its lags are reported in Table 1. This implies the cumulative impact of the U.S. financial shock for 8 quarters on the GDP growth rates in other countries. I compare the result using the conventional financial market integration measure with the result of using the set of integration measures for short-term debt, long-term debt, and equity markets. Trade linkage is included to consider the real channel. The joint F statistics are reported in parentheses.

Table 1. (1) is the baseline result. It shows the total spillover effects on output via the integrated financial market which is estimated by -3.47. As the financial market integration measure increases by 10%, the GDP growth rate decreases by 0.35% [14]. For example, calculated financial integration measures for the U.K. and Canada in 2008 are 0.12 and 0.06,

[14]Integration measures are log-transformed. The expected mean difference in GDP growth rate at Financial Link_1 and Financial Link_2, holding the other explanatory variables constant, is Δy_2 - Δy_1 = -3.465*(log(Financial Link_2) - log(Financial Link_1)) = -3.465*log(Financial Link_2/Financial Link_1)=-3.465*log(1.1)=-0.347.

respectively. The U.K's financial market integration is about 2 times as big as Canada's financial market integration. This is associated with the U.K's GDP growth rate decreasing more than Canada by 2.4% from the 2008 U.S. financial crisis[15].

Table 1: Impact of the 2008 U.S. Financial Shock on the GDP Growth Rate

	(1) Link_t		(2) Link_{2002}	
Financial Link× Shock	-3.47***		-6.83***	
	(4.64)		(36.4)	
Short-term Debt Link × Shock		-4.54***		-6.39***
		(3.55)		(25.1)
Long-term Debt Link × Shock		0.64***		4.35*
		(5.48)		(13.7)
Equity Link × Shock		3.30***		-1.29
		(7.82)		(8.32)
Trade Link× Shock	3.86***	1.53**	6.45**	4.47**
	(3.43)	(2.33)	(41.6)	(18.3)
Observation(N)	801	801	786	786
R Squared	0.47	0.48	0.57	0.56

Note: The impact of the shock on output is estimated based on the equation $\Delta y_{it} = \alpha_i + d_t + \beta t + \gamma_1(l)\text{Shock}_t^m + \gamma_2(l)(\text{Shock}_t^m \times \text{Link}_{im,t}) + \gamma_3(l)\text{Link}_{im,t} + \gamma_4(l)\text{Control}_t + \epsilon_{it}$. Shock = Lehman crisis. Links are the integration measures for short-term debt, long-term debt, equity, financial, and goods markets. The number of lags is 7. All regressions include country fixed effects, time(year) fixed effects, and control variables. The F statistics based on robust standard errors are in parentheses. *,**,*** denote joint significance at the 10 %, 5%, and 1% levels, respectively. In (2), integration measures constructed based on initial values are used and the chi-square statistics are in parentheses.

The role of short-term debt and long-term debt market integration in transmitting the U.S. financial shock is different. Short-term debt market integration is associated with negative output spillovers to other countries. For example, the U.K.'s short-term debt market integration is 0.009, which is 5.6 times as large as Canada's short-term debt market integration. This is associated with the U.K's GDP growth rate decreasing more than Canada's by -7.8% due to the 2008 U.S. financial crisis. However, long-term debt market integration is associated with positive output spillovers. The calculated long-term debt market integration measures for the U.K. and Canada in 2008 are 0.044 and 0.017, respectively. The U.K's

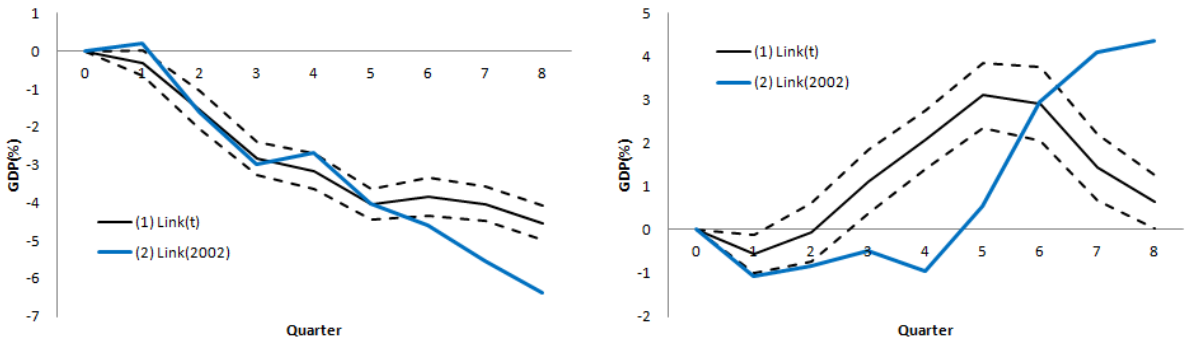
[15] Δy_{UK} - Δy_{CAN} = -3.465*(log(Financial Link_{UK}) - log(Financial Link_{CAN})) = -3.465*log(Financial Link_{UK}/Financial Link_{CAN})=-3.465*log(2)=-2.4.

long-term debt market integration is about 2.5 times as big as Canada's long-term debt market integration. This is associated with the U.K's GDP growth rate increasing more than Canada's by 0.6% from the 2008 U.S. financial crisis. Equity market integration is associated with positive spillover effects. Equity market integration measures for the U.K. and Canada in 2008 are 0.062 and 0.042, respectively. This is associated with the U.K's GDP growth rate increasing more than Canada's by 1.3% from the 2008 U.S. financial crisis.

It is possible that less financially developed countries borrow short-term debt more than other securities in response to the adverse shock. This causes an endogeneity bias. To control for this reverse causality, I run a regression using an integration measures constructed based on the initial values of 2002 portfolio assets. The result is presented in Table 1. (2). The impact of the U.S. financial shock through the integrated equity market becomes statistically insignificant. However, the impact of the shock through the integration short-term debt and long-term debt markets is consistent with the baseline result. Table 1 also shows that the trade linkage is associated with positive spillover effects on output.

Figure 1 is the impulse response function drawn based on the result in Table 1. This shows how the cumulative impact of the 2008 U.S. financial shock on output varies over time in the integrated short-term debt and long-term debt markets. The black solid line represents the cumulative impact of the shock on output using current integration measures and the dotted line is the one-standard-error band. The blue solid line indicates the cumulative impact of the shock on output using initial integration measures.

Figure 1: Impact of the 2008 U.S. Financial Shock on the GDP Growth Rate Over Time



(a) Short-term Debt Market

(b) Long-term Debt Market

Note: The output spillovers from the U.S. financial shock through the integrated short-term debt and long-term debt markets are drawn based on Table 1. The horizontal-axis units are quarters. The vertical-axis units are the GDP growth rates. The black solid line is drawn based on (1), and dashed lines demonstrate the one-standard-error bands. The blue solid line is drawn based on (2).

Figure 1 and Table 1 show that a country whose short-term debt market is more integrated with the U.S. is more likely to have negative output spillovers from the 2008 U.S. financial crisis, however, a country whose long-term debt market is more integrated with the U.S. is more likely to have positive output spillovers from the shock.

2.4 Robustness Test

There are three robustness checks: integration measure, U.S. financial shock, and model specification. I introduce another integration measure developed by Abiad et al. (2013)[16] for the robustness check of the integration measure used in this paper. I use the excess bond premium taken from Gilchrist and Zakrajek (2012)[17] for the robustness check of U.S. financial shocks, and run a regression with the dynamic model including lagged dependent variables[18] for the robustness check of model specification. Table 2 shows that the role of short-term debt and long-term debt market integration in transmitting U.S. financial shock is consistent with Table 1. Short-term debt market integration is associated with the negative spillover effects on output in other countries, however, long-term debt market integration is associated with the positive impact on foreign output. The role of equity market integration is not robust to different U.S. financial shocks.

[16] See Appendix A3.
[17] See Appendix A4.
[18] This is the ArellanoBond linear dynamic panel-data estimation

Table 2: Robustness Test

	(1) Integration Measure		(2) U.S. Financial Shock		(3) Model Specification	
Financial Link × Shock	-3.74***		-0.56***		-0.94***	
	(4.23)		(5.36)		(39.5)	
Short-term Debt Link× Shock		-4.72***		-0.57*		-2.65**
		(3.15)		(1.99)		(17.8)
Long-term Debt Link× Shock		0.62***		0.04***		0.34***
		(5.16)		(3.37)		(43.4)
Equity Link × Shock		3.31***		0.48		2.62***
		(8.47)		(0.79)		(33.6)
Trade Link × Shock	4.20***	1.69***	0.59***	0.25***	1.53***	0.96***
	(3.13)	(3.83)	(3.68)	(3.48)	(30.1)	(36.0)
Observation(N)	801	801	668	668	758	758
R Squared	0.45	0.41	0.39	0.56	n/a	n/a

Note: The impact of the shock on output is estimated based on the equation $\Delta y_{it} = \alpha_i + d_t + \beta t + \gamma_1(l)\text{Shock}_t^m + \gamma_2(l)(\text{Shock}_t^m \times \text{Link}_{im,t}) + \gamma_3(l)\text{Link}_{im,t} + \gamma_4(l)\text{Control}_t + \epsilon_{it}$. Integration measures developed by Abiad et al. (2013) are used in (1). The shock is the Lehman crisis, but excess bond premium is used in (2). (3) uses the ArellanoBond dynamic panel model $\Delta y_{i,t} = \alpha_i + d_t + \beta t + \gamma_1(l)\Delta y_{i,t-1} + \gamma_2(l)Shock_t^m + \gamma_3(l)Link_{im,t} + \gamma_4(l)Shock_t^m Link_{im,t} + \gamma_5(l)Control_t + \epsilon_{i,t}$. Links are the integration measures for short-term debt, long-term debt, equity, financial, and goods markets. The number of lags is 7. All regressions include country fixed effects, time(year) fixed effects, and control variables. The F statistics based on robust standard errors are in parentheses in (1) and (2). The chi-square statistics are in parenthesis in (3). *,**,*** denote joint significance at the 10 %, 5%, and 1% levels, respectively.

3 Model

To explain the mechanism behind the empirical findings, I develop a DSGE model. This is a two-country model which includes the home and foreign countries. There are three markets[19]: the short-term debt market, long-term debt market, and goods market. There are seven agents: households, investors, financial intermediaries (hereafter FIs), entrepreneurs, final goods producers, capital goods producers, and the government.

Households, investors, FIs, and entrepreneurs are economic agents involved in the financial market. A household is a lender-saver who is an ultimate lender, and an entrepreneur is a borrower-spender who is an ultimate borrower. The funds are transferred from households to entrepreneurs through the entire financial market which consists of the long-term debt and short-term debt markets. In the long-term debt market, households and investors are engaged and long-term bonds (consols) are traded. Households purchase long-term bonds that investors issue[20]. Investors raise funds from households and deposit to FIs. Investors, FIs and entrepreneurs are engaged in the short-term debt market. FIs make loans to entrepreneurs using deposits from investors and their own net worth. Entrepreneurs' net worth is not enough to conduct investment projects, they issue short-term bonds to raise funds.

There are two important features of the financial market structure. First, short-term debt market sits in the middle of the capital flows from households to entrepreneurs. The total amount of funds are determined in the long-term debt market. While funds move from ultimate lenders to ultimate borrowers, the funds are transferred in the form of short-term debt to lower the opportunity cost of holding idle funds. This financial market structure promotes economic efficiency. An agent who connects the long-term debt market to short-term debt market is an investor. Investors participate the short-term debt market on behalf of households as financial agents. They decrease the opportunity cost of holding long-term debt by participating short-term debt market, and resolve maturity mismatches between long-term debt and short-term debt.

Second, the credit contracts are subject to a financial friction. The financial friction arises from asymmetric information between borrower and lender in the credit contracts, and this prevents efficient allocation of funds from lenders who own excess of available funds to borrowers who have a shortage of funds. To motivate for this financial friction, I follow the costly state verification (CSV) model developed by Townsend (1979). When the borrower

[19]Since the empirical results show that the effect of equity market integration on output in other countries is not robust, the equity market is not taken into consideration in the theoretical model.

[20]Households are relatively more patient than other agents in the financial market. A relationship between households and investors is just like the gatherer-farmer relationship in Kiyotaki and Moore (1997). Since a household who corresponds to the gatherer in Kiyotaki and Moore (1997) is relatively patient (higher discount factor, β), households are lenders and investors are borrowers in the long-term debt market.

declares default, the lender has to pay the monitoring cost to observe defaulted borrower's realized return. This allows us to motivate why external finance is more expensive than internal finance. Due to the monitoring cost, the lender must be compensated for higher monitoring cost by a larger premium. This external finance premium depends inversely on borrowers' net worth.

The credit contracts in the short-term debt market are more subject to a financial friction than those in the long-term debt market, because the credit contracts in the short-term debt market have to be renewed every period. This increases the external finance premium which affects investment and output. In the integrated short-term debt market, domestic financial condition affects not only domestic output but also foreign output. This is called the financial accelerator effect in a two-country model. The financial accelerator effect is the dominant effect in the integrated short-term debt market. In the long-term debt market, the long-term bonds are traded based on a long-term relationship (long-term contract) between borrower and lender because the maturity of long-term bonds is longer than short-term bonds. Since the credit contracts are not renewed every period, the long-term debt market is less subject to the financial friction. In the integrated long-term debt market, resources move to a country where the return on assets is higher. This is called the efficient allocation effect and it dominates the financial accelerator effect in the long-term debt market. This chapter discusses the model by markets: the short-term debt, long-term debt, and goods markets.

3.1 Short-term Debt Market

There are two contracts in which investors, FIs, and entrepreneurs are involved in the short-term debt market. One is agreed on between FIs and entrepreneurs (hereafter FE contract). The other contract is agreed on between investors and FIs (hereafter IF contract). This is the chained credit contract taken from Ueda (2012)[21]. In this chained credit contract, FIs play an important role. The adverse shock to the FIs' net worth affects investment decision which in turn influences output. It improves the amplification mechanism, and provides sensible predictions about real and financial variables.

FIs are borrowers in the IF contract, but lenders in the FE contract. Entrepreneurs are borrowers in the FE contract, and the ultimate borrowers in the financial market. Borrowers are subject to idiosyncratic productivity shocks. If the productivity shock is greater than a cut-off value, borrowers repay debts. But, if the productivity shock is less than a cut-off value, borrowers declare default. When the borrower declares default, the lender pays

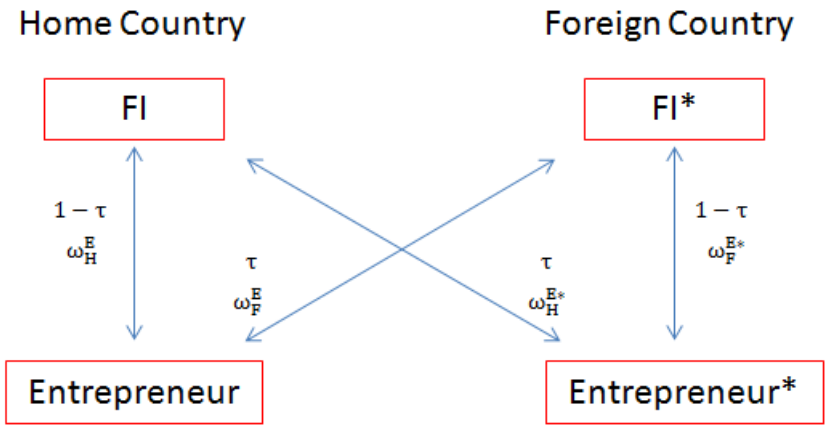
[21]Compared to Bernanke et al. (1999), the external finance premium is determined by the net worth of entrepreneurs and the net worth of FIs. Thus, the wealth distribution between FIs and entrepreneurs is important to pin down the external finance premium which affects the investment decision.

the monitoring cost to confirm whether the borrower really defaults or not and collects the capital of defaulted borrowers. Lenders diversify the idiosyncratic productivity shocks that borrowers face by lending to an infinite number of borrowers.

Figure 2 describes the market structure of the short-term bonds. The short-term bonds are traded between FIs and entrepreneurs in the form of working capital. FIs make loans to entrepreneurs using deposits from investors and their own net worth. Entrepreneurs' net worth is not enough to conduct investment, they issue short-term bonds. Integration of the short-term debt market allows FIs to lend funds to both domestic entrepreneurs and foreign entrepreneurs. However, FIs lend only to domestic entrepreneurs in the short-term debt market autarky. The parameter of the short-term debt market integration[22] is τ, which determines what fraction of funds FIs lend to foreign entrepreneurs. Entrepreneurs borrow $(1-\tau)$ of external funds from home FIs and τ of external funds from foreign FIs. Superscript E represents entrepreneurs. Subscript H and F represent the home and foreign countries. The asterisk denotes the foreign country. $\omega^E_{H,t}$ is the idiosyncratic productivity shock to domestic entrepreneurs in the FE contract agreed on between domestic FIs and domestic entrepreneurs. $\omega^E_{F,t}$ is the idiosyncratic shock to domestic entrepreneurs in the FE contract agreed on between foreign FIs and domestic entrepreneurs.

We obtain the entrepreneurs' participation constraint in the FE contract and the investor's participation constraint in the IF contract. Subject to these two participation constraints, FIs maximize their profit by lending funds to entrepreneurs.

Figure 2: Short-term Debt Market



Note: τ: short-term debt market openness. Superscript E represents entrepreneurs. Subscript H and F represent the home and foreign countries. The asterisk denotes the foreign country. ω: the idiosyncratic productivity shocks.

[22]We can think of this as the short-term debt market openness.

3.1.1 Participation Constraint for Entrepreneurs

In the FE contract, domestic FIs lend funds to domestic entrepreneurs and foreign entrepreneurs. The net worth of domestic entrepreneurs, N_t^E, is used as leverage to purchase capital of $(1-\tau)Q_tK_{H,t}$ where Q_t denotes the price of capital in units of the household consumption index in the home country, and $K_{H,t}$ denotes entrepreneurial total asset in the home country. Domestic FIs lend an amount of $(1-\tau)(Q_tK_{H,t} - N_t^E)$ to domestic entrepreneurs. Foreign entrepreneurs also use their net worth, N_t^{E*}, as leverage to purchase capital of $\tau Q_t^*K_{H,t}^*$. Domestic FIs lend an amount of $\tau(Q_t^*K_{H,t}^* - N_t^{E*})$ to foreign entrepreneurs.

Home and foreign entrepreneurs are subject to idiosyncratic productivity shocks, $\omega_{H,t+1}^E$ and $\omega_{H,t+1}^{E*}$. A domestic entrepreneur repays debts if an idiosyncratic productivity shock is greater than a cut-off value, $\overline{\omega}_{H,t+1}^E$. If the shock is less than a cut-off value, a domestic entrepreneur declares default. The same is applied to foreign entrepreneurs. The cut-off value for foreign entrepreneurs is $\overline{\omega}_{H,t+1}^{E*}$. When an entrepreneur declares default, domestic FIs pay the monitoring cost to confirm whether the entrepreneur defaults or not, and collect the net worth of defaulted entrepreneurs. Z_{t+1}^E and Z_{t+1}^{E*} denote a loan rate that home and foreign entrepreneurs pay when they do not default. The cut-off values of entrepreneurs in the home and foreign countries are determined by Equation (7) and (8).

$$\overline{\omega}_{H,t+1}^E R_{t+1}^E Q_t K_{H,t} = Z_{t+1}^E \left(Q_t K_{H,t} - N_t^E \right) \tag{7}$$

$$\overline{\omega}_{H,t+1}^{E*} R_{t+1}^{E*} Q_t^* K_{H,t}^* = Z_{t+1}^{E*} \left(Q_t^* K_{H,t}^* - N_t^{E*} \right) \tag{8}$$

Equation (9) represents the participation constraint for home entrepreneurs in the FE contract, where the entrepreneurs are the borrowers and the lenders are FIs. $G(\overline{\omega}_{t+1})$ denotes the expected productivity of borrowers who declare default. $\Gamma(\overline{\omega}_{t+1})$ indicates the share of earnings that goes to lenders before monitoring costs are paid[23]. $\left[1 - \Gamma^E(\overline{\omega}_{H,t+1}^E)\right]$ represents the share of earnings that goes to borrowers in the FE contract, who are home entrepreneurs. R_{t+1}^E denotes the return on capital (entrepreneurial total assets). The left hand side of Equation (9) is the earnings that go to home entrepreneurs from the FE contract. The right hand side of the inequality is the return on entrepreneur's net worth, which is the opportunity cost of borrowing. The left hand side of Equation (9) has to be greater than or equal to the

[23] $G(\overline{\omega}_{t+1})$ and $\Gamma(\overline{\omega}_{t+1})$ are calculated based on the distribution of the idiosyncratic productivity shock. The idiosyncratic productivity shocks to the FIs and entrepreneurs follow the log-normal distribution with different means and standard deviations. Thus, the analytical expressions of $G(\overline{\omega}_{t+1})$ and $\Gamma(\overline{\omega}_{t+1})$ for FIs and entrepreneurs are the same, but the parameter values for the means and standard deviations are different. See Appendix A7.

right hand side of Equation (9) in order for domestic entrepreneurs to participate the FE contract. Equation (10) represents the participation constraint for foreign entrepreneurs.

$$\left[1-\Gamma^{E}(\overline{\omega}^{E}_{H,t+1})\right] R^{E}_{t+1} Q_t K_{H,t} \geq R^{E}_{t+1} N^{E}_{t} \tag{9}$$

$$\left[1-\Gamma^{E*}(\overline{\omega}^{E*}_{H,t+1})\right] R^{E*}_{t+1} Q^{*}_t K^{*}_{H,t} \geq R^{E*}_{t+1} N^{E*}_{t} \tag{10}$$

where

$$\Gamma(\overline{\omega}_{t+1}) \equiv G(\overline{\omega}_{t+1}) + \overline{\omega}_{t+1} \int_{\overline{\omega}_{t+1}}^{\infty} dF(\omega)$$

$$G(\overline{\omega}_{t+1}) \equiv \int_{0}^{\overline{\omega}_{t+1}} \omega dF(\omega)$$

Equation (11) represents FI's expected earnings from the FE contract with domestic entrepreneurs and foreign entrepreneurs. $\Phi(\overline{\omega}_{t+1})$ indicates the share of earnings that goes to the lender after monitoring costs are paid. μ denotes the monitoring cost that lenders pay due to defaulted borrowers[24]. $e(s^t)$ denotes the real exchange rate.

$$\Phi^{E}(\overline{\omega}^{E}_{H,t+1}) R^{E}_{t+1}(1-\tau) Q_t K_{H,t} + \Phi^{E*}(\overline{\omega}^{E*}_{H,t+1}) e_{t+1} R^{E*}_{t+1} \tau Q^{*}_t K^{*}_{H,t} \tag{11}$$

where

$$\Phi(\overline{\omega}_{t+1}) \equiv \Gamma(\overline{\omega}_{t+1}) - \mu G(\overline{\omega}_{t+1})$$

R^{F}_{t+1} is the return on loans to entrepreneurs, which is defined by Equation (12). The terms in square brackets on the left hand side of Equation (12) represent the total amount of loans to home entrepreneurs and foreign entrepreneurs expressed in units of the household consumption index. The terms on the right hand side are the returns from the domestic FIs' FE contracts with domestic entrepreneurs and foreign entrepreneurs. ji denotes entrepreneurs who borrow funds from the FI i.

$$\begin{aligned} & R^{F}_{t+1}\left[(1-\tau)(Q_t K_{H,t} - N^{E}_{t}) + \tau e_t (Q^{*}_t K^{*}_{H,t} - N^{E*}_{t})\right] \\ & \equiv \int_{j_i} \Phi^{E}(\overline{\omega}^{E}_{H,t+1}) R^{E}_{t+1}(1-\tau) Q_t K_{H,t} dj_i + \int_{j_i} \Phi^{E*}(\overline{\omega}^{E*}_{H,t+1}) e_{t+1} R^{E*}_{t+1} \tau Q^{*}_t K^{*}_{H,t} dj_i \end{aligned} \tag{12}$$

[24]The parameter of the FI's monitoring cost, μ^E is different from the parameter of the investor's monitoring cost, μ^F. I follow the parameter values of the monitoring cost from Ueda (2012). $\mu^E = 0.013$, and $\mu^F = 0.033$. See Appendix A7.

3.1.2 Participation Constraint for Investors

Investors are the lenders and the FI is the borrower in the IF contract. Investors are the financial agents working for households in the home and foreign countries. Since investors have the monitoring technologies, whenever FIs are hit by the financial shock, investors confirm if FIs become default on behalf of a household in the short-term debt market. There is no cross-border lending or borrowing in the IF contract[25]. Since a FI's net worth, N_t^F, is not enough to lend to entrepreneurs, he has to borrow funds from an investor.

ω_{t+1}^F represents the idiosyncratic productivity shock. R_{t+1}^F denotes the return on loans to entrepreneurs. The participation constraint for an investor specifies a cut-off value for the idiosyncratic shock $\overline{\omega}_{t+1}^F$. A FI repays his debt if the idiosyncratic productivity shock is greater than the cut-off value and declares default if the idiosyncratic productivity shock is less than the cut-off value. If FIs declare default, an investor pays the monitoring costs to observe FIs' realized returns, and collects the net worth of defaulted FIs. Z_{t+1}^F denotes a borrowing rate that FIs pay when they do not default. $\overline{\omega}_{t+1}^F$ is determined by Equation (13).

$$\begin{aligned} &\overline{\omega}_{t+1}^F \cdot R_{t+1}^F \left[(1-\tau)\left(Q_t K_{H,t} - N_t^E\right) + \tau e_t \left(Q_t^* K_{H,t}^* - N_t^{E*}\right) \right] \\ &= Z_{t+1}^F \left[(1-\tau)\left(Q_t K_{H,t} - N_t^E\right) + \tau e_t \left(Q_t^* K_{H,t}^* - N_t^{E*}\right) - N_t^F \right] \end{aligned} \tag{13}$$

Equation (14) shows the participation constraint for an investor. $\Phi^F(\overline{\omega}_{t+1}^F)$ represents the share of earnings that goes to the lender, who is a domestic investor in the IF contract. The terms in square brackets on the left hand side of Equation (14) indicate the amount of funds that the home FIs lend to the home entrepreneurs and the foreign entrepreneurs. The left hand side of Equation (14) is the expected earnings that a home investor gets from loans to entrepreneurs. The right hand side of Equation (14) is the expected earnings that a domestic investor gets from their own net worth, which is the opportunity cost of lending. In order for an investor to participate the IF contract, the left hand side of Equation (14) has to be greater than or equal to the right hand side of Equation (14).

[25] FIs borrow funds only from the domestic investors. This is different from Ueda (2012). FIs borrow funds from an investor in the home country by a portion of $(1-\tau_H^F)$ and an investor in the foreign country by a portion of τ_H^F in Ueda (2012). This is unnecessary under the assumption of long-term debt market integration. For simplicity, the short-term bonds are traded only between FIs and entrepreneurs in this paper.

$$\begin{aligned}
&\Phi^F(\overline{\omega}^F_{t+1}) \cdot R^F_{t+1}\Big[(1-\tau)\left(Q_t K_{H,t} - N^E_t\right) + \tau e_t\left(Q^*_t K^*_{H,t} - N^{E*}_t\right)\Big] \\
&\geq R_t\Big[(1-\tau)\left(Q_t K_{H,t} - N^E_t\right) + \tau e_t\left(Q^*_t K^*_{H,t} - N^{E*}_t\right) - N^F_t\Big]
\end{aligned} \tag{14}$$

3.1.3 FI's Maximization Problem

The domestic FIs maximize their profit, Equation (15), subject to the participation constraints as well as Equation (9), (10), and (14). The choice variables are $\overline{\omega}^F, \overline{\omega}^E_H, \overline{\omega}^{E*}_H, K_H$, and K^*_H. After solving the FI's profit maximization problem, we obtain FOCs which are given by Equations Equation (16) and (17).

$$\max_{\left\{\overline{\omega}^F, \overline{\omega}^E_H, \overline{\omega}^{E*}_H, K_H, K^*_H\right\}} \mathbb{E}_t\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right] R^F_{t+1}\left[(1-\tau)(Q_t K_{H,t} - N^E_t) + \tau e_t(Q^*_t K^*_{H,t} - N^{E*}_t)\right] \tag{15}$$

subject to Equation (9), (10), and (14).

$$\begin{aligned}
0 = &\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]\Phi^E(\overline{\omega}^E_{H,t+1})R^E_{t+1} \\
&+ \frac{\Gamma^{F'}(\overline{\omega}^F_{t+1})}{\Phi^{F'}(\overline{\omega}^F_{t+1})}\left\{\Phi^F(\overline{\omega}^F_{t+1})\Phi^E(\overline{\omega}^E_{H,t+1})R^E_{t+1} - R_t\right\} \\
&+ \frac{\Phi^{E'}(\overline{\omega}^F_{t+1})}{\Gamma^{E'}(\overline{\omega}^E_{H,t+1})}\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right] R^E_{t+1}\left[1-\Gamma^E(\overline{\omega}^E_{t+1})\right] \\
&+ \frac{\Gamma^{F'}(\overline{\omega}^F_{t+1})}{\Phi^{F'}(\overline{\omega}^F_{t+1})} \cdot \frac{\Phi^{E'}(\overline{\omega}^E_{H,t+1})}{\Gamma^{E'}(\overline{\omega}^E_{H,t+1})}\Phi^F(\overline{\omega}^F_{t+1})R^E_{t+1}\left[1-\Gamma^E(\overline{\omega}^E_{H,t+1})\right]
\end{aligned} \tag{16}$$

$$\begin{aligned}
0 = &\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]\Phi^{E*}(\overline{\omega}^{E*}_{H,t+1})e_{t+1}R^{E*}_{t+1} \\
&+ \frac{\Gamma^{F'}(\overline{\omega}^F_{t+1})}{\Phi^{F'}(\overline{\omega}^F_{t+1})}\left\{\Phi^F(\overline{\omega}^F_{t+1})\Phi^{E*}(\overline{\omega}^{E*}_{H,t+1})e_{t+1}R^{E*}_{t+1} - R_t\right\} \\
&+ \frac{\Phi^{E*'}(\overline{\omega}^F_{t+1})}{\Gamma^{E*'}(\overline{\omega}^{E*}_{H,t+1})}\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right] e_{t+1}R^{E*}_{t+1}\left[1-\Gamma^{E*}(\overline{\omega}^{E*}_{H,t+1})\right] \\
&+ \frac{\Gamma^{F'}(\overline{\omega}^F_{t+1})}{\Phi^{F'}(\overline{\omega}^F_{t+1})} \cdot \frac{\Phi^{E*'}(\overline{\omega}^{E*}_{H,t+1})}{\Gamma^{E*'}(\overline{\omega}^{E*}_{H,t+1})}\Phi^F(\overline{\omega}^F_{t+1})e_{t+1}R^{E*}_{H,t+1}\left[1-\Gamma^{E*}(\overline{\omega}^{E*}_{H,t+1})\right]
\end{aligned} \tag{17}$$

The external finance premium, $\frac{\mathbb{E}_t R^E_{H,t+1}}{R_t}$, can be simplified as a function of FIs' and entrepreneurs' net worth ratios in the home and foreign countries using Equation (12) and (14). The external finance premium is decreasing in each of the four ratios. The higher cost-of-funds, R^E_{t+1}, lowers the price of capital, Q_t, and decreases investment.

$$\frac{\mathbb{E}_t R^E_{t+1}}{R_t} = F\left(\frac{N^F_t}{Q_t K_{H,t}}, \frac{N^E_t}{Q_t K_{H,t}}, \frac{N^{F*}_t}{Q^*_t K^*_{H,t}}, \frac{N^{E*}_t}{Q^*_t K^*_{H,t}}\right) \tag{18}$$

3.1.4 Dynamic Behavior of Net Worth

The net worth of the FIs and entrepreneurs depends on their earnings from the credit contracts and their labor income. FIs and entrepreneurs inelastically supply a unit of labor to final goods producers. γ^F and γ^E represent the survival rate for each one, respectively. The following are the aggregate net worths of FIs and entrepreneurs. ε_t denotes the net worth shocks to FIs. ε_t follows the process described in Equation (21).

$$N^F_t = \gamma^F V^F_t + W^F_t - \varepsilon_t \tag{19}$$

$$N^E_t = \gamma^E V^E_t + W^E_t \tag{20}$$

where

$$\varepsilon_t = \rho_n \varepsilon_{t-1} + \xi_t \tag{21}$$

$$V^F_t \equiv \left[1 - \Gamma^F(\overline{\omega}^F_t)\right] R^F_t \left\{(1-\tau)(Q_{t-1}K_{H,t-1} - N^E_{t-1}) + \tau e_{t-1}(Q^*_{t-1}K^*_{H,t-1} - N^{E*}_{t-1})\right\} \tag{22}$$

$$V^E_t \equiv \left[1 - \Gamma^E(\overline{\omega}^E_{H,t})\right] R^E_t (1-\tau) Q_{t-1}K_{H,t-1} + \left[1 - \Gamma^E(\overline{\omega}^E_{F,t})\right] R^E_t \tau Q_{t-1}K_{F,t-1} \tag{23}$$

3.2 Long-term Debt Market

The long-term bonds are based on a perpetuity contract with coupon payments. The stock of the long-term bonds depreciates at a rate of δ_b[26]. Integration of the long-term debt market allows a household to hold domestic and foreign long-term bonds. But, a household cannot hold foreign long-term bonds in the long-term debt market autarky. Thus, the budget constraints that a household is subject to are different in the long-term debt market autarky and the integrated long-term debt market[27].

[26] The market structure of the long-term bond is similar to Arellano and Ramanarayanan (2012).
[27] We will see this in a household utility maximization problem in Section 3.3.1.

In the long-term debt market autarky, a household purchases only domestic long-term bonds, d_t, which are newly issued by a domestic investor in period t. This is added to the domestic bonds stock, D_{t-1}. In the integrated long-term debt market, a household purchases not only domestic long-term bonds, d_t, but also foreign long-term bonds, b_t. Domestic bonds stock, D_t, and foreign bonds stock, B_t, evolve as follows.

$$D_t = \delta_b D_{t-1} + d_t \tag{24}$$

$$B_t = \delta_b B_{t-1} + b_t \tag{25}$$

where

$$D_{t-1} = \sum_{j=1}^{\infty} \delta_b^{j-1} d_{t-j} = d_{t-1} + \delta_b d_{t-2} + \delta_b^2 d_{t-3} + \delta_b^3 d_{t-4} + \cdots \tag{26}$$

$$B_{t-1} = \sum_{j=1}^{\infty} \delta_b^{j-1} b_{t-j} = b_{t-1} + \delta_b b_{t-2} + \delta_b^2 b_{t-3} + \delta_b^3 b_{t-4} + \cdots \tag{27}$$

In terms of risk sharing, it is important whether a household is able to hold foreign long-term bonds or not. In the presence of negative shocks in the home country, a household can smooth their consumption over time by holding foreign long-term bonds[28]. Resources move to a country in which the return on assets is higher so that the foreign country produces more output[29]. This is the efficient allocation effect which leads to business cycle divergence. If the risk sharing condition is not fulfilled due to the long-term debt market autarky, the efficient allocation effect does not take place. In this case, the international business cycle is more likely to convergence.

3.3 Goods Market

For the goods market, I follow the two-country international business cycle model of Backus et al. (1995). Different final goods are produced in each country and those are tradable goods. Labor that a household, FIs, and entrepreneurs provide is immobile. Capital goods producers yield investment goods using final goods, and sell them to entrepreneurs. Entrepreneurs rent capital to final goods producers. Final goods producers provide final goods for a household and capital goods producers.

[28] A household hedges country-specific shocks by holding foreign long-term bonds.

[29] This refers to a tendency to "make hay where the sun shines." If an unfavorable productivity shock rises in the home country, output falls in the home country but output rises in the foreign country. Output moves in opposite directions in the home and foreign countries(Backus et al. (1995)).

3.3.1 Households

A representative household maximizes lifetime utility, Equation (28), subject to the budget constraint. In the integrated long-term debt market, a household's maximization problem is subject to Equation (29). In the long-term debt market autarky, a household's maximization problem is subject to Equation (30).

$$\max_{\{C_t, H_t, d_t, b_t\}} \sum_{l=0}^{\infty} \beta^{t+l} \mathbb{E}_t \left\{ \frac{C_{t+l}^{1-\sigma}}{1-\sigma} - \chi_2 \frac{H_{t+l}^{1+\frac{1}{\chi_1}}}{1+\frac{1}{\chi_1}} \right\} \tag{28}$$

subject to

$$C_t + d_t + e_t b_t \leq W_t H_t + R_{t-1}^{l} D_{t-1} + R_{t-1}^{l*} B_{t-1} - T_t \tag{29}$$

or

$$C_t + d_t \leq W_t H_t + R_{t-1}^{l} D_{t-1} - T_t \tag{30}$$

Parameters β, χ_1, and χ_2 denote the discount factor, the elasticity of leisure, and the utility weight on leisure. d_t and b_t are new domestic and foreign long-term bonds that a household purchases in period t. These are added to the long-term bonds stock, D_{t-1} and B_{t-1}. C_t is consumption in period t. R_t^l and R_t^{l*} are long-term bond (risk-free) returns to D_t and B_t paid in period $t+1$. H_t is hours worked and W_t is the real wage in terms of the household consumption index. T_t is the lump-sum tax.

Under the integrated long-term debt market, combining Euler equations from foreign bonds in both countries yields $C_t^{-\sigma} e_t = C_t^{*-\sigma}$. The ratio of the marginal utility of consumption in the home country to the marginal utility of consumption in the foreign country becomes proportional to the real exchange rate. This represents the risk sharing condition which leads to the efficient allocation effect. Under long-term debt market autarky, however, the risk sharing condition no longer holds. The final goods consumption is given by Equation (31). $C_H(s^t)$ and $C_F(s^t)$ denote the consumption of home-produced goods and the consumption of foreign-produced goods. γ_T represents the trade openness. P_t is the aggregate price of the final goods defined by Equation (32).

$$C_t = \left((1-\gamma_T)^{1/\eta} C_{H,t}^{(\eta-1)/\eta} + \gamma_T^{1/\eta} C_{F,t}^{(\eta-1)/\eta} \right)^{\eta/(\eta-1)} \tag{31}$$

$$P_t = \left((1-\gamma_T) P_{H,t}^{1-\eta} + \gamma_T P_{F,t}^{1-\eta} \right)^{1/(1-\eta)} \tag{32}$$

3.3.2 Final Goods Producers

The final goods producers produce final goods, Y_t, and sell them to domestic and foreign households with the price of $p_{H,t}$ and $p^*_{H,t}$[30]. Labor inputs are H_t, H^F_t, and H^E_t supplied by households, FIs, and entrepreneurs. Ω_F denotes the share of FIs' labor inputs and Ω_E denotes the share of entrepreneurial labor inputs. Final goods producers rent capital, $K_{H,t}$ from domestic FIs and $K_{F,t}$ from foreign FIs, with the rental rate of R^E_t. δ denotes the depreciation rate of capital. At the end of each period, the amount of capital after depreciation is sold back to the entrepreneurs at price Q_t. The maximization problem for a final goods producer is the following.

$$\max_{\{Y_t, K_{t-1}, H_t, H^F_t, H^E_t\}} \quad Y_t + Q_t K_{t-1}(1-\delta) - R^E_t Q_{t-1} K_{t-1} - W_t H_t - W^F_t H^F_t - W^E_t H^E_t \tag{33}$$

where

$$Y_t = K^{\alpha}_{t-1}(H^{1-\Omega_E-\Omega_F}_t H^{F\Omega_F}_t H^{E\Omega_E}_t)^{(1-\alpha)} \tag{34}$$

$$K_{t-1} = (1-\tau)K_{H,t-1} + \tau K_{F,t-1} \tag{35}$$

3.3.3 Capital Goods Producers

The capital goods producers convert final goods to capital goods. They purchase final goods from final goods producers, I_t. They also purchase $K_{t-1}(1-\delta)$ from the entrepreneurs at price Q_t[31]. They produce K_t, using the technology F_I, and sell them in the competitive market at price Q_t. The capital goods producers maximize the following profit function.

$$\max_{\{I_t\}} \sum_{l=0}^{\infty} \beta^{t+l} \left(\frac{C^{-\sigma}_{t+l}}{C^{-\sigma}_t}\right) \Big(Q_{t+l}(1 - F_I(I_{t+l}, I_{t+l-1}))I_{t+l} - I_{t+l}\Big) \tag{36}$$

where

$$F_I(I_{t+l}, I_{t+l-1}) \equiv \frac{\kappa}{2}\left(\frac{I_{t+l}}{I_{t+l-1}} - 1\right)^2 \tag{37}$$

[30] $p_{H,t} = \frac{P_{H,t}}{P_t}$, $p^*_{H,t} = \frac{P^*_{H,t}}{P^*_t}$

[31] Following Bernanke et al. (1999), the capital goods producer's maximization problem does not include the purchase of K_{t-1}, because the price of used capital is close to the price of the newly produced capital goods around the steady state.

κ denotes a parameter related to the investment technology with an adjustment cost. K_t evolves according to Equation (38)

$$K_t = (1 - F_I(I_t, I_{t-1}))I_t + (1 - \delta)K_{t-1} \tag{38}$$

3.3.4 Resource Constraint

Equation (39) is the resource constraint for final goods. Final goods are consumed by domestic and foreign households, domestic capital goods producers, and domestic and foreign entrepreneurs. $C^E_{H,t}$ and $C^{E*}_{H,t}$ denote consumption of home-produced goods by domestic entrepreneurs and foreign entrepreneurs, respectively. G_t denotes the government spending, and the government keeps the government budget balanced ($G_t = T_t$).

$$Y_t = C_{H,t} + C^*_{H,t} + I_t + G_t + C^E_{H,t} + C^{E*}_{H,t} \tag{39}$$

The home entrepreneurs consume home-produced goods and foreign produced goods which are defined by Equation (40) and (41).

$$C^E_{H,t} = 0.5 p^{-\eta}_{H,t} Y^E_t \tag{40}$$

$$C^E_{F,t} = 0.5 p^{-\eta}_{F,t} Y^E_t \tag{41}$$

Y^E_t represents the monitoring costs and net worths of FIs and entrepreneurs that fail to survive in the home country. The first two terms on the right-hand side of Equation (42) represent the monitoring costs spent by Fis on defaulted entrepreneurs. The third term represents the monitoring costs spent by an investor on defaulted FIs. The last two terms represent the net worths of FIs and entrepreneurs that fail to survive in the home country. Y^E_t is used as a resource for entrepreneurs' consumption.

$$\begin{aligned} Y^E_t =& \mu^E G^E(\overline{\omega}^E_{H,t}) R^E_t (1-\tau) Q_{t-1} K_{H,t-1} + \mu^E G^E(\overline{\omega}^{E*}_{H,t}) e_{t-1} R^{E*}_t \tau Q^*_{t-1} K^*_{H,t-1} \\ &+ \mu^F G^F(\overline{\omega}^F_{H,t}) R^F_t \left\{ (1-\tau)\left(Q_{t-1}K_{H,t-1} - N^E_{t-1}\right) + \tau e_{t-1}\left(Q^*_{t-1}K^*_{H,t-1} - N^{E*}_{t-1}\right)\right\} \\ &+ (1-\gamma^E)V^E_t + (1-\gamma^F)V^F_t \end{aligned} \tag{42}$$

4 Simulation

I simulate the economic response to the financial shock, which is a decline of the domestic FIs' net worth by one percent of the steady-state GDP following Ueda (2012)[32]. The benchmark is the equilibrium response of the economy with integrated short-term debt and integrated long-term debt markets. In the integrated short-term debt market in which the parameter of the short-term debt market openness is greater than zero, the financial accelerator effect takes place in the home and foreign countries. In the integrated long-term debt market in which foreign long-term bonds are available to the domestic household, the efficient allocation effect works. Thus, the financial accelerator effect and efficient allocation effect occur in the benchmark.

The equilibrium response of the model with the segmented short-term debt market (Short-term debt market autarky) and the segmented long-term debt market (long-term debt market autarky) are compared to the benchmark in 4.2 and 4.3, respectively. To see the effect of the short-term debt market integration, I shut down the financial accelerator channel from the benchmark by setting the short-term debt market openness to zero in 4.2. To see the effect of the long-term debt market integration, I shut down the efficient allocation channel from the benchmark by preventing the household to hold foreign long-term bonds in 4.3.

4.1 Calibration

I follow Ueda (2012) for parameter values. These include the discount factor β, depreciation rate δ, capital share α, and labor elasticity χ_1, utility weight on leisure, χ_2. η represents elasticity of substitution between home-produced goods and foreign-produced goods, which is set equal to 1. δ_b denotes the risk-free long-term bond depreciation rate, which is set equal to 0.936 following Arellano and Ramanarayanan (2012). τ denotes the short-term debt market openness. The ratio of non-financial firms' foreign claims to their total liabilities are approximately 15% for the U.S. (Ueda (2010)), and the ratio of short-term debt to total liabilities for other sectors including non-financial firms[33] is about 30%[34] in the U.S. The ratios of foreign short-term claims to total liabilities, $0.5 \times \tau$ are about 5%. Thus, τ is calibrated to 0.1 in the benchmark where the short-term debt market is integrated at the

[32]There are empirical studies which suggest that a decrease in the net worth of financial intermediaries generates a macroeconomic downturn in the recent financial crisis(Peek and Rosengren (1997), Calomiris and Mason (2003), Ashcraft (2005)), Helbling et al. (2011), Kollmann et al. (2011).

[33]"Other sectors" can be disaggregated into (1) nonbank financial corporations, (2) nonfinancial corporations, and (3) households (SDDS).

[34]See Special Data Dissemination Standard (SDDS) offered by IMF

current integration level, and 0 in the short-term debt market autarky. The trade openness, γ_T, is 0.15 following Faia (2007). The parameter values are symmetric in the home and foreign countries.

The standard error of the idiosyncratic productivity shock to FIs, σ_F is 0.107. The standard error of the idiosyncratic productivity shock to entrepreneurs, σ_E is 0.313. Investor's monitoring cost in the IF contract, μ^F is 0.033. FIs' monitoring cost in the FE contract, μ^F is 0.013. The survival rate of FIs is 0.963 and the survival rate of entrepreneurs is 0.984.

In the steady state, the share of government spending in total output is set to 0.2. The risk-free rate is 1.0101 which is equal to $1/\beta$ in the steady state. Parameters related to the short-term debt market in the steady state are calibrated to satisfy the following conditions: (1) the return on long-term bond, $R^l - 1 + \delta_b = R$, (2) the risk spread, $R^E - R = 0.02$, (3) the annualized failure rate of FIs is 2%, (4) the annualized failure rate of entrepreneurs is 2%, (5) the ratio of net worth held by FIs to capital, $N^F/QK = 0.1$, (6) the ratio of net worth held by entrepreneurs to capital, $N^E/QK = 0.5$. Details regarding the remaining parameter values are presented in Appendix A7.

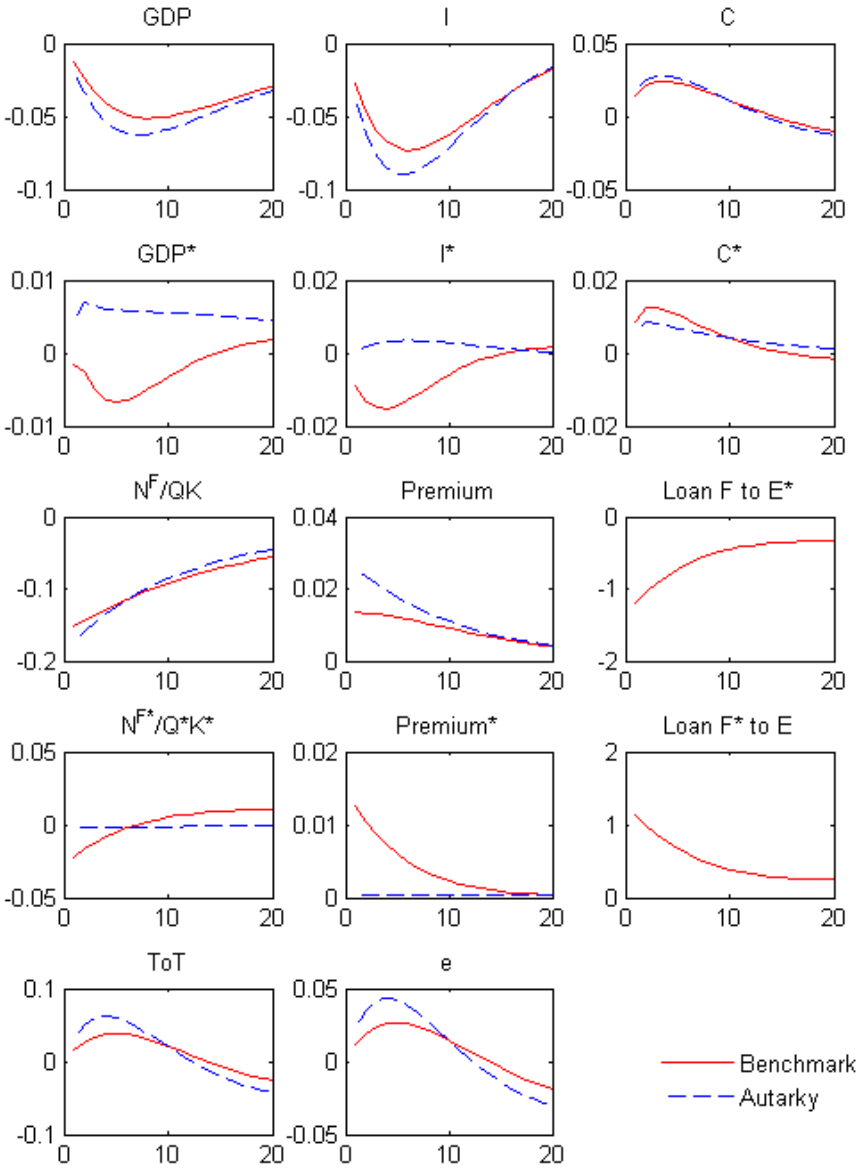
4.2 Effect of Short-term Debt Market Integration

In the benchmark, the ratio of FIs' net worth to total assets, N^F/QK declines due to the shock in the home country. The external finance premium rises and cost-of-funds increases. The price of capital, Q falls and it discourages investment. This is the financial accelerator effect which also occurs in the foreign country in the integrated short-term debt market. The external finance premium rises and cost-of-funds increases in the foreign country. Thus, the price of capital, Q^* falls and investment decreases in the foreign country.

Figure 3 shows the effect of short-term debt market integration. In the short-term debt market autarky, the financial accelerator effect does not take place in the foreign country. The external finance premium and the FIs' net worth ratio, N^{F*}/Q^*K^* stays at around the steady-state level in the foreign country. Investment and GDP in the foreign country increase rather than fall.

Compared to the benchmark, investment and GDP in the foreign country increase in the short-term debt market autarky. There is no trade of loans between foreign FIs and domestic entrepreneurs and between domestic FIs and foreign entrepreneurs in the short-term debt market autarky. We can see that the short-term debt market integration (from dotted line to solid line in Figure 3) leads to international business cycle convergence in the presence of the adverse financial shock. This is consistent with the empirical finding.

Figure 3: Effect of Short-term Debt Market Integration



Note: The shock is a decrease in the domestic FIs' net worth by one percent of the steady-state GDP. τ denotes the short-term debt market openness which is set to 0.1 in the integrated short-term debt market, and 0 in the short-term debt market autarky. The asterisks represent the foreign country. Premium denotes the external finance premium. The impulse responses are drawn in logarithmic deviations from the steady-state, except for net worth ratios and premiums. All responses are multiplied by 100.

4.3 Effect of Long-term Debt Market Integration

Figure 4 illustrates the effect of long-term debt market integration. The impulse responses of the model with long-term debt market autarky are compared to the benchmark. In the benchmark, the efficient allocation effect works. Resources move to a country where the return on capital is higher through the integrated long-term debt market. Though investment and GDP fall in the foreign country due to the financial accelerator effect, the efficient allocation effect dampens the negative spillovers from the home country to the foreign country.

In the long-term debt market autarky, the financial accelerator effect still takes place in the foreign country through the integrated short-term debt market, though the efficient allocation channel is shut down. The external finance premium rises and the FIs' net worth ratio falls in the foreign country. This leads to a decline in foreign investment. The real exchange rate is not pinned down by the risk sharing condition in which the real exchange rate is tied to the ratio of marginal utility of consumption in the foreign country to marginal utility of consumption in the home country. In the long-term debt market autarky, the real exchange rate fluctates more and GDP and investment fall more dramatically in the foreign country compared to the benchmark[35].

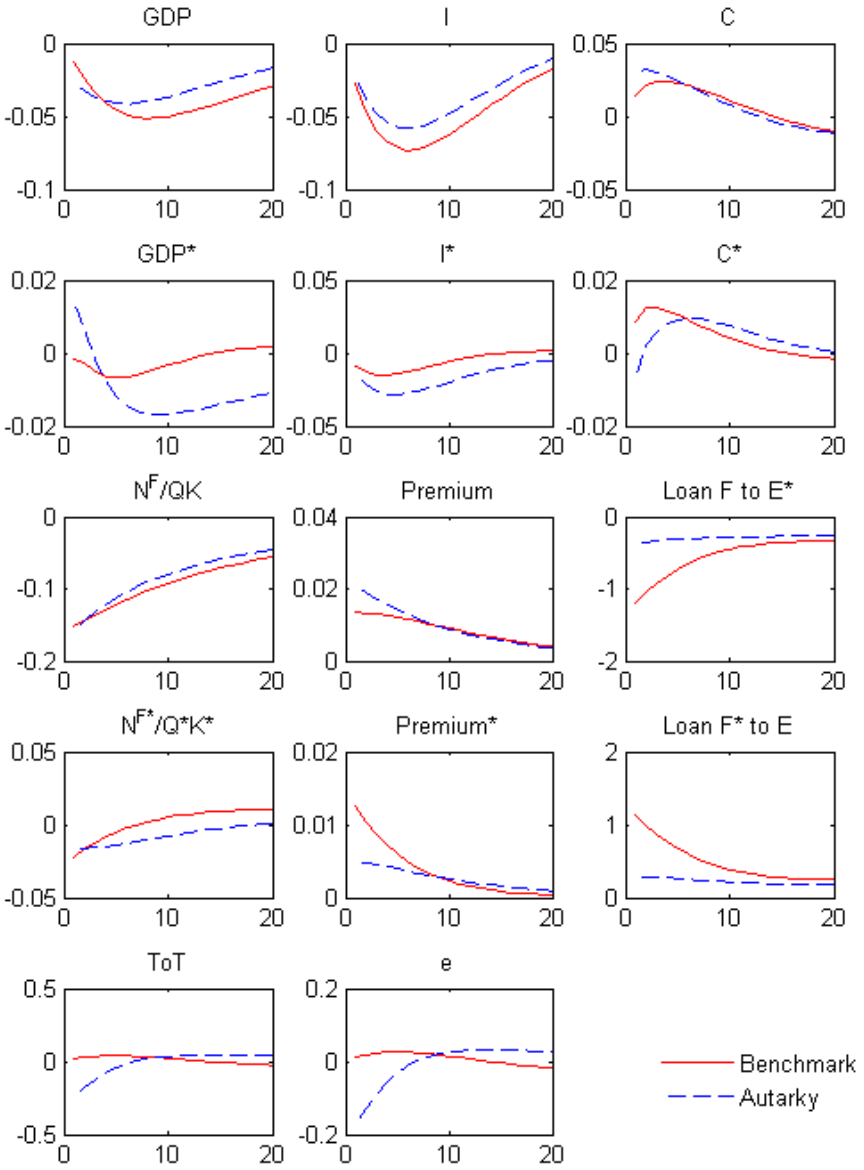
4.4 Types of Financial Market Integration and International Cross Correlations

Table 3 shows the standard deviations of endogenous variables and international cross correlations of GDP, investment and consumption generated from the model simulations. Backus et al. (1995) is a workhorse model of the International Real Business Cycle. Compared to data, it relatively explains well about the standard deviation of investment. Investment is much more volatile than consumption and output. This result is consistent with what we can observe in data. But, correlations from Backus et al. (1995) do not fit to data very well. The correlation of consumption is too large, whereas that of GDP and investment are negative.

In this paper, the model incorporating the financial accelerator effect and the reallocation effect generates four types of international business cycles: (3) - (6) in Table 3. The standard deviations and the correlations of (5) Long-term Debt Market Integration and $\tau = 0$ can be considered as the Backus et al. (1995), where there is the efficient allocation effect, but no

[35]In response to the negative financial shock, consumption in the home and foreign countries rises. This is common feature of the DSGE model incorporating the financial accelerator effect though this is not consistent with what we can observe in the recent financial crisis.

Figure 4: Effect of Long-term Debt Market Integration



Note: The shock is a decrease in the domestic FIs' net worth by one percent of the steady-state GDP. τ denotes the short-term debt market openness which is set to 0.1 in the integrated short-term debt market, and 0 in the short-term debt market autarky. The asterisks represent the foreign country. Premium denotes the external finance premium. The impulse responses are drawn in logarithmic deviations from the steady-state, except for net worth ratios and premiums. All responses are multiplied by 100.

Table 3: Summary Statistics

Variable	(1) Data[a]	(2) BKK[b]	Long-term Debt Market Autarky		Long-term Debt Market Integration	
			$\tau = 0$	$\tau = 0.1$	$\tau = 0$	$\tau = 0.1$
			(3)	(4)	(5)	(6)
Standard deviation[c](%)						
GDP_H[d]	1.00	1.00	1.00	1.00	1.00	1.00
	(1.91)	(1.17)	(0.79)	(0.20)	(0.34)	(0.29)
GDP_F			0.63	0.65	0.12	0.14
I	3.27	10.99	1.03	1.45	1.21	1.21
I*			0.53	0.44	0.03	0.21
C	0.75	0.42	0.48	0.75	0.47	0.48
C*			0.34	0.40	0.09	0.14
International cross correlation						
GDP	0.66	-0.21	-0.98	0.66	-0.95	0.23
Investment	0.53	-0.94	-0.99	0.95	-0.96	0.82
Consumption	0.51	0.88	-0.20	0.23	0.57	0.84

[a] Data statistics in Backus et al. (1995)

[b] Statistics of endogenous variables generated from the model in Backus et al. (1995)

[c] These are standard deviations relative to GDP_H.

[d] Numbers in parentheses are standard deviations for GDP_H.

financial accelerator effect. Because the risk-sharing condition holds, there is a tendency to "make hay where the sun shines". Output and investment move opposite in the home and foreign countries. In (6) Long-term Debt Market Integration and $\tau = 0.1$, however, correlations of GDP and investment increase, but those are still less than the correlation of consumption. In (3) and (4), we can see that the international cross correlations of consumption decrease because the risk-sharing conditions no longer hold in the long-term debt market autarky. In (4) Long-term Debt Market Autarky and $\tau = 0.1$, the correlations of GDP and investment are positive and higher than that of consumption which is consistent with the data. When the short-term debt market becomes autarky (3), the correlations of GDP, investment, and consumption become negative.

5 Conclusion

This paper investigates the types of financial market integration by dividing the financial market into the short-term debt, long-term debt, and equity markets in order to explain different transmissions of financial shock from one country to another. I find empirical evidence from the 2008 U.S. financial crisis. Short-term debt market integration is associated with a negative spillover effect on output in other countries, whereas long-term debt market integration is associated with a positive spillover effect on foreign output. This result is robust to different market integration measures, U.S. financial shocks, and model specifications. The impact of equity market integration on output is not robust to different U.S. financial shocks.

To explain these empirical findings, I develop a two-country DSGE model which incorporates the short-term debt and long-term debt markets. The credit contract is subject to financial friction which arises due to asymmetric information between the lender and the borrower. The contract in the short-term debt market has to be renewed every period, so the short-term debt market is more subject to financial friction. In the integrated short-term debt market, financial friction in the home country also affects foreign output. This is the financial accelerator effect which leads to negative output spillovers to other countries. On the other hand, long-term bonds are traded based on a perpetuity contract. Financial friction is less pronounced in the integrated long-term debt market, but the efficient allocation effect dominates. Resources move to a country in which the return on capital is higher, and this leads to positive spillover effects on foreign output.

References

Abdul Abiad, Davide Furceri, Sebnem Kalemli-Ozcan, and Andrea Pescatori. Dancing together? spillovers, common shocks, and the role of financial and trade linkages. *World Economic Outlook: Transitions and Tensions*, 2013.

Cristina Arellano and Ananth Ramanarayanan. Default and the maturity structure in sovereign bonds. *Journal of Political Economy*, 120(2):187–232, 2012.

Adam B. Ashcraft. Are banks really special? new evidence from the fdic-induced failure of healthy banks. *The American Economic Review*, 95(5):1712–1730, 2005.

Philippe Bacchetta and Eric Van Wincoop. Sudden spikes in global risk. *Journal of International Economics*, 2012.

D. Backus, P.J. Kehoe, and F.E. Kydland. International business cycles: Theory and evidence. Report, 1995.

B.S. Bernanke, M. Gertler, and S. Gilchrist. The financial accelerator in a quantitative business cycle framework. *Handbook of macroeconomics*, 1:1341–1393, 1999.

Charles W. Calomiris and Joseph R. Mason. Consequences of bank distress during the great depression. *The American Economic Review*, 93(3):937–947, 2003.

Scott J Davis. Financial integration and international business cycle co-movement. *Journal of Monetary Economics*, 2014.

Ester Faia. Finance and international business cycles. *Journal of Monetary Economics*, 54 (4):1018–1034, 2007.

Simon Gilchrist and Egon Zakrajek. Credit spreads and business cycle fluctuations. *American Economic Review*, 102(4):1692–1720, 2012.

J. Heathcote and F. Perri. Why has the us economy become less correlated with the rest of the world? *The American Economic Review*, 93(2):63–69, 2003.

Jonathan Heathcote and Fabrizio Perri. Financial globalization and real regionalization. *Journal of Economic Theory*, (119):207–243, 2004.

Thomas Helbling, Raju Huidrom, M. Ayhan Kose, and Christopher Otrok. Do credit shocks matter? a global perspective. *European Economic Review*, 55(3):340–353, 2011.

N. Hirakata, N. Sudo, and K. Ueda. Chained credit contracts and financial accelerators. *IMES Discussion Paper Series*, 2009.

J. Imbs. Trade, finance, specialization, and synchronization. *Review of Economics and Statistics*, 86(3):723–734, 2004.

J. Imbs. The real effects of financial integration. *Journal of International Economics*, 68(2): 296–324, 2006.

S. Kalemli-Ozcan, E. Papaioannou, and F. Perri. Global banks and crisis transmission. *Journal of International Economics*, 2012.

Nobuhiro Kiyotaki and John Moore. Credit cycles. *Journal of Political Economy*, 105(2): 211–248, 1997.

Robert Kollmann, Zeno Enders, and Gernot J Mller. Global banking and international business cycles. *European Economic Review*, 55(3):407–426, 2011.

M. Ayhan Kose, Christopher Otrok, and Charles H. Whiteman. Understanding the evolution of world business cycles. *Journal of International Economics*, 75(1):110–130, 2008a.

M.A. Kose, E. Prasad, and M. Terrones. *Volatility and comovement in a globalized world economy: an empirical exploration*, volume 3. International Monetary Fund, 2003.

M.A. Kose, C. Otrok, and E.S. Prasad. Global business cycles: convergence or decoupling? Report, National Bureau of Economic Research, 2008b.

Donald P Morgan, Bertrand Rime, and Philip E Strahan. Bank integration and state business cycles. *The Quarterly Journal of Economics*, 119(4):1555–1584, 2004.

Joe Peek and Eric S. Rosengren. The international transmission of financial shocks: The case of japan. *The American Economic Review*, 87(4):495–505, 1997.

Christina D. Romer and David H. Romer. The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks. *American Economic Review*, 100(3): 763–801, 2010.

Frank Smets and Rafael Wouters. Shocks and frictions in us business cycles: A bayesian dsge approach. *American Economic Review*, 97(3):586–606, 2007.

Robert M Townsend. Optimal contracts and competitive markets with costly state verification. *Journal of Economic theory*, 21(2):265–293, 1979.

Kozo Ueda. Banking globalization and international business cycles. Report, Institute for Monetary and Economic Studies, Bank of Japan, 2010.

Kozo Ueda. Banking globalization and international business cycles: Cross-border chained credit contracts and financial accelerators. *Journal of International Economics*, 86(1): 1–16, 2012.

Appendix

A1. Data

Table 4: Data Sources

Variables	Sources
Financial Linkages	
Short-term Debt, long-term Debt, and Equity (assets and liabilities, yearly)	Coordinated Portfolio Investment Survey
Trade Linkages	
Export and Import (quarterly)	Direction of Trade Statistics Database
Macro Variables[a]	
Crude Oil(Europe Brent) Price	U.S. Energy Information Administration
VXO(S&P 100 Volatility Index)	Chicago Board Options Exchange
Shocks	
Excess Bond Premium	Gilchrist and Zakrajek (2012)
GDP Growth Rate Surprises	International Financial Statistics
U.S. Fiscal Policy Shocks	Romer and Romer (2010)
U.S. Monetary Policy Shocks	Smets and Wouters (2007)
Output	
Real GDP(quarterly, percent)	International Financial Statistics
Real GDP Forecast(yearly, percent)	World Economic Outlook

Note: Quarterly data is used in the empirical analysis. However, only yearly data are available in the CPIS. Thus, I use the previous year's assets of short-term debt, long-term debt, and equity for all quarters of the specified year.

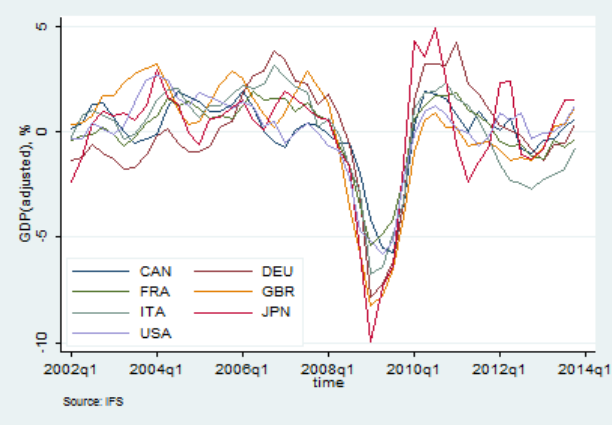
[a] Use the average value to convert from monthly data to quarterly data.

Table 5: Country List

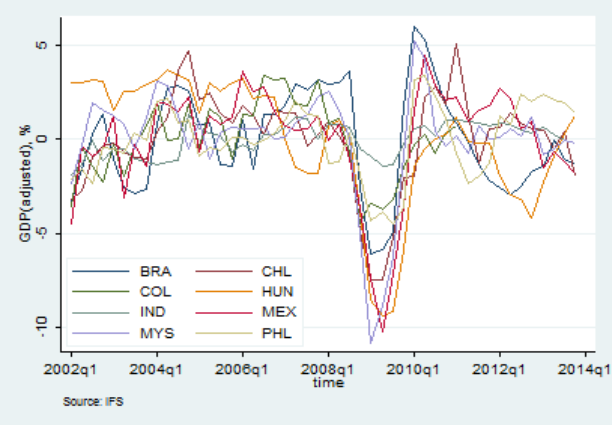
Argentina	(ARG)	Japan	(JPN)
Australia	(AUS)	Korea	(KOR)
Austria	(AUT)	Luxembourg	(LUX)
Belgium	(BEL)	Malaysia	(MYS)
Brazil	(BRA)	Mexico	(MEX)
Canada	(CAN)	Netherlands	(NLD)
Chile	(CHL)	New Zealand	(NZL)
Colombia	(COL)	Norway	(NOR)
Cyprus	(CYP)	Panama	(PAN)
Denmark	(DNK)	Philippines	(PHL)
Egypt	(EGY)	Portugal	(PRT)
Finland	(FIN)	Russia	(RUS)
France	(FRA)	Singapore	(SGP)
Germany	(DEU)	South Africa	(ZAF)
Hong Kong	(HKG)	Spain	(ESP)
Hungary	(HUN)	Sweden	(SWE)
Iceland	(ISL)	Switzerland	(CHE)
Indonesia	(IDN)	Thailand	(THA)
Ireland	(IRL)	Turkey	(TUR)
Italy	(ITA)	United Kingdom	(GBR)
		United States	(USA)

Note: These are all countries whose portfolio assets of short-term debt, long-term debt, and equity in relation to the U.S. are available in the Coordinated Portfolio Investment Survey. The dataset used is unbalanced panel, thus number of observations used in each regression can be different. ISO country codes are in the parentheses.

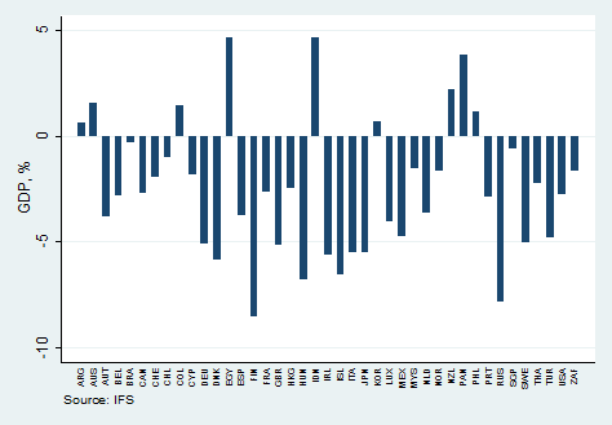
Figure 5: GDP Growth Rates and Financial Market Integration



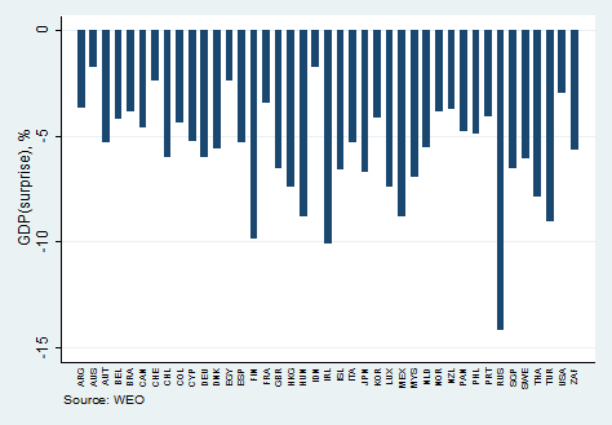
(a) GDP Growth Rates, G7 Countries



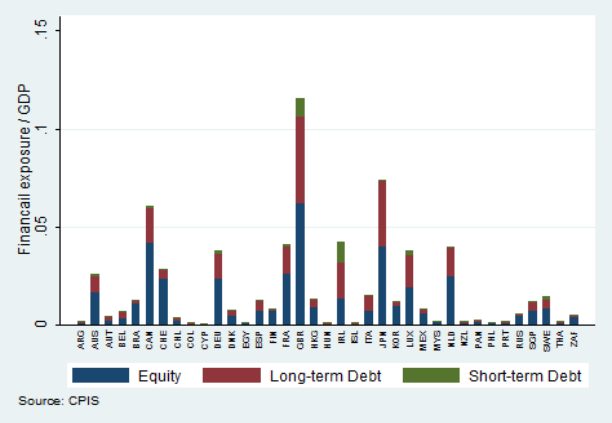
(b) GDP Growth Rates, Developing Countries



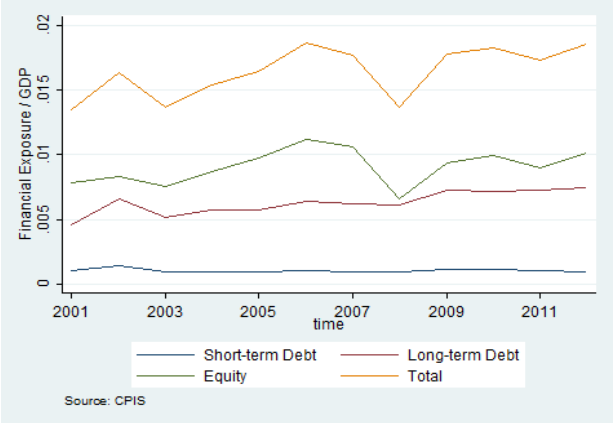
(c) GDP Growth Rates, 2009



(d) GDP Growth Surprises, 2009



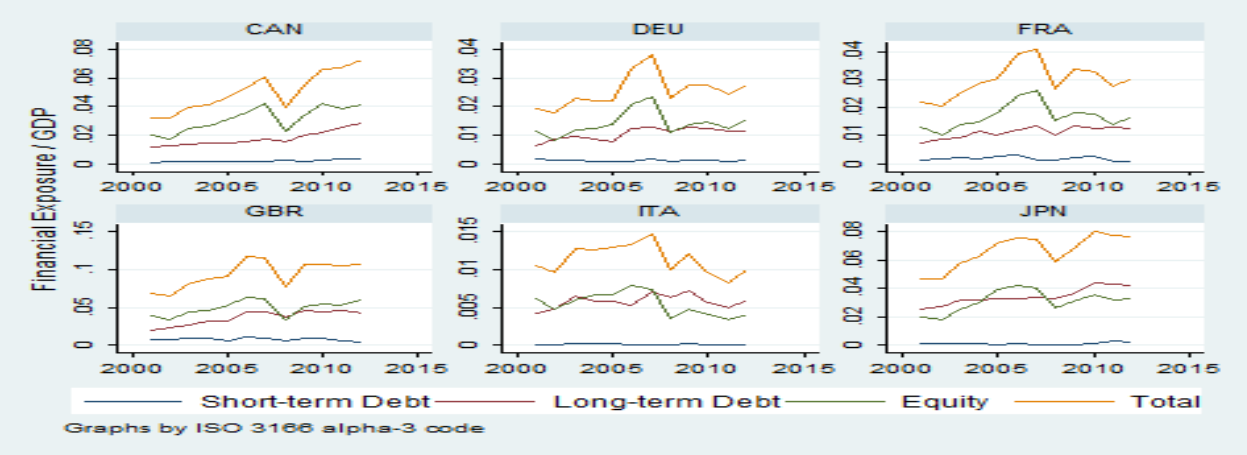
(e) Financial Exposures, 2007



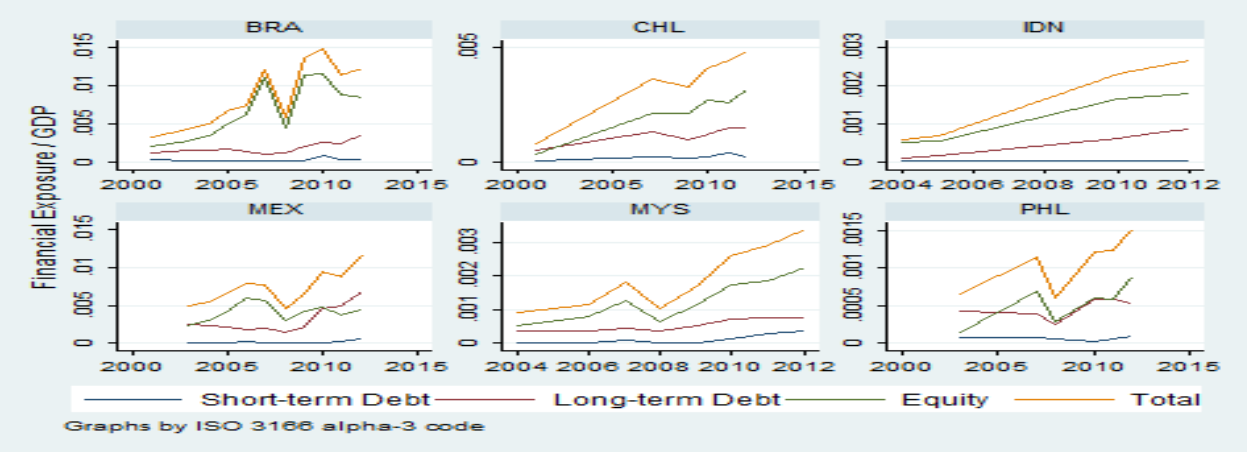
(f) Financial Exposure, 2001 - 2012

Note: $\text{GDP(adjusted)}_t = \text{GDP}_t - \overline{GDP}$, where $\overline{GDP}$ is the average of GDP during 2002 - 2013. GDP surprise $= \text{GDP}_t - \widehat{GDP}$, where $\widehat{GDP}$ is the GDP growth rate forecasts. Financial exposure is sum of the bilateral assets normalized by sum of GDPs.

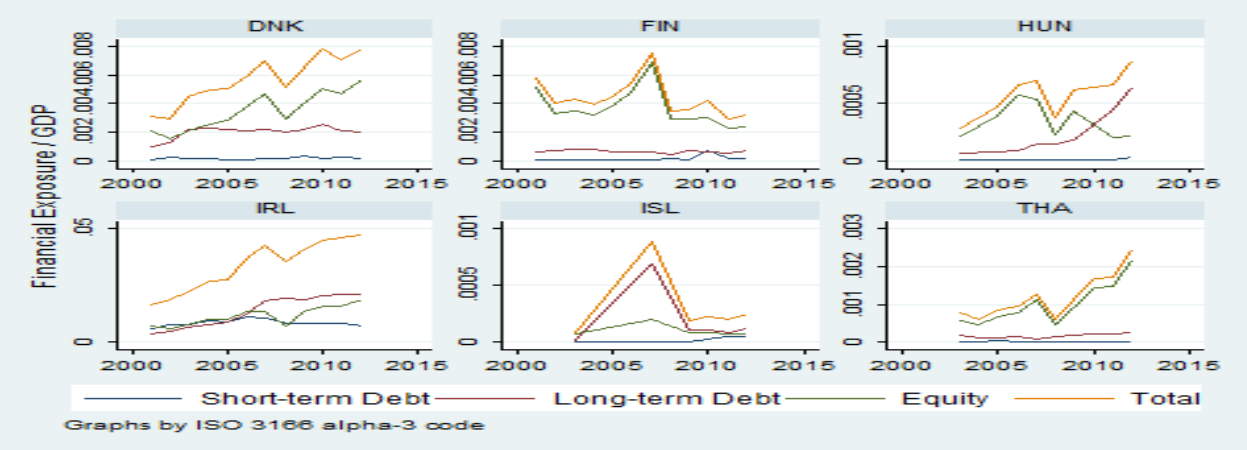
Figure 6: Financial Market Integration by Country



(a) Financial Exposures, G7 Countries



(b) Financial Exposures, Developing Countries



(c) Financial Exposures, Other Countries

Source: CPIS
Note: Financial exposure is sum of the bilateral assets normalized by sum of GDPs.

A2. Impact of the 2008 U.S. Financial Shock with Different Lags

Table 6: Impact of the 2008 U.S. Financial Shock with Different Number of Lags

	(1) L = 6		(2) L = 8	
Financial Link× Shock	-2.91***		-3.36***	
	(5.58)		(5.52)	
Short-term Debt Link × Shock		-2.98***		-4.95*
		(4.06)		(2.07)
Long-term Debt Link × Shock		1.41**		0.16***
		(2.85)		(5.34)
Equity Link × Shock		0.88**		4.65***
		(2.89)		(3.89)
Trade Link× Shock	2.48***	0.73	4.72***	2.04**
	(4.18)	(1.71)	(4.15)	(2.27)
Observation(N)	844	844	758	758
R Squared	0.50	0.51	0.49	0.50

Note: The impact of the shock on output is estimated based on the equation $\Delta y_{it} = \alpha_i + d_t + \beta t + \gamma_1(l)\text{Shock}_t^m + \gamma_2(l)(\text{Shock}_t^m \times \text{Link}_{im,t}) + \gamma_3(l)\text{Link}_{im,t} + \gamma_4(l)\text{Control}_t + \epsilon_{it}$. Shock = Lehman crisis. Links are the integration measures for short-term debt, long-term debt, equity, financial and goods markets. The number of lags is 6 in (1) and 8 in (2). All regressions include country fixed effects, time(year) fixed effects, and control variables. The F statistics based on robust standard errors are in parentheses. *,**,*** denote joint significance at the 10 %, 5%, and 1% levels, respectively.

A3. Robustness Test: Integration Measure

I introduce another integration measures developed by Abiad et al. (2013) for the robustness check of integration measure. Short-term debt market integration measure for country i, Short-term Debt Link$^r_{im,t}$, is the share of bilateral assets and liabilities between country i and the U.S. in time t relative to the sum of two countries' total exposure. The way to construct for long-term debt and equity market integration measures is the same as the short-term debt market integration measure, except the securities used. Different to the integration measure used in the basic model specification, the financial market integration measure developed by Abiad et al. (2013) is not simple summation of short-term debt, long-term debt, and equity market integration measures. Equation (46) shows financial market integration measure used in Abiad et al. (2013). The variable security denotes total exposure of short-term debt, long-term debt, and equity. The trade linkage, Trade Link$^r_{im,t}$, used for the robustness check is also constructed in the same way as above. trade$_{im,t}$(trade$_{mi,t}$) represents country i(U.S.)'s exports and imports in relation to the U.S.(country i) in time t. trade$_{iw,t}$(trade$_{mw,t}$) represents country i(U.S.)'s exports and imports in relation to the world in time t.

$$\text{Short-term Debt Link}^r_{im,t} = \frac{\text{short-term debt}_{im,t} + \text{short-term debt}_{mi,t}}{\text{short-term debt}_{iw,t} + \text{short-term debt}_{mw,t}} \tag{43}$$

$$\text{Long-term Debt Link}^r_{im,t} = \frac{\text{long-term debt}_{im,t} + \text{long-term debt}_{mi,t}}{\text{long-term debt}_{iw,t} + \text{long-term debt}_{mw,t}} \tag{44}$$

$$\text{Equity Link}^r_{im,t} = \frac{\text{equity}_{im,t} + \text{equity}_{mi,t}}{\text{equity}_{iw,t} + \text{equity}_{mw,t}} \tag{45}$$

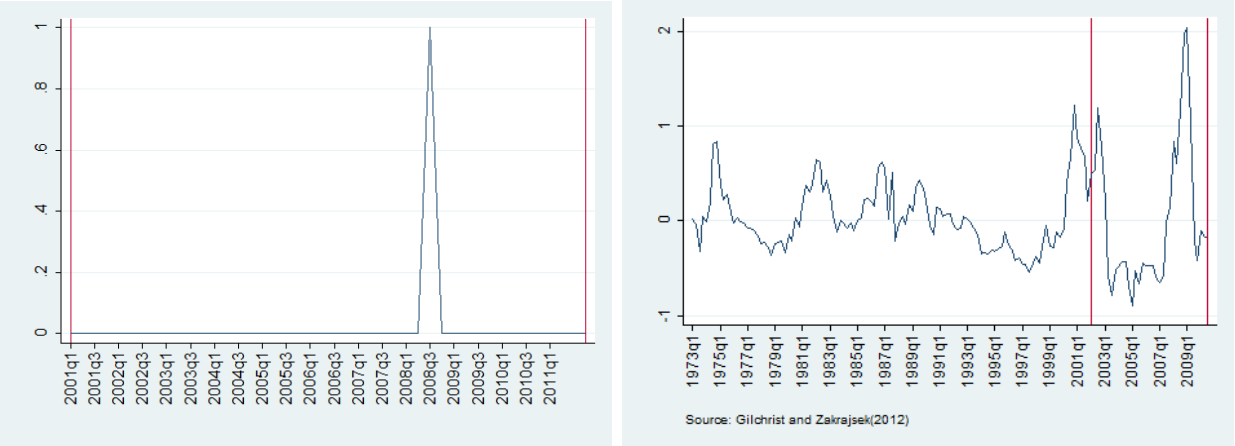
$$\text{Financial Link}^r_{im,t} = \frac{\text{security}_{im,t} + \text{security}_{mi,t}}{\text{security}_{iw,t} + \text{security}_{mw,t}} \tag{46}$$

$$\text{Trade Link}^r_{im,t} = \frac{\text{trade}_{im,t} + \text{trade}_{mi,t}}{\text{trade}_{iw,t} + \text{trade}_{mw,t}} \tag{47}$$

A4. Robustness Test: U.S. Financial Shocks

I introduce another U.S. financial shock which is the excess bond premium taken from Gilchrist and Zakrajek (2012). This implies risk in the financial market. Figure 7 shows Lehman crisis used in the baseline empirical model and excess bond premium used for the robustness check.

Figure 7: U.S. Financial Shocks



(a) Lehman Crisis

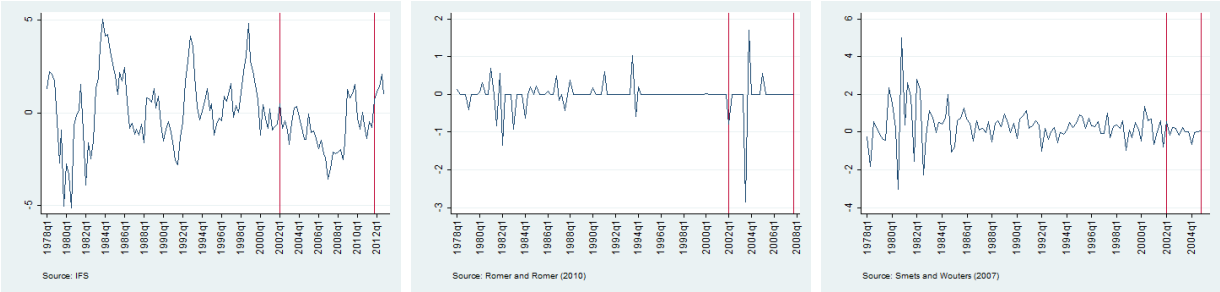
(b) Gilchrist and Zakrajek (2012)

Note: The sample period that the main dataset covers is 2002:Q1 - 2013:Q4. The shocks in-between red lines are taken into consideration.

A5. The Impact of the Other U.S.-Specific Shocks

In order to see the different effects of short-term debt, long-term debt, and equity market integration on the international business cycle in response to the other U.S.-specific shocks, I introduce GDP growth surprise shocks, U.S. fiscal policy shock, and U.S. monetary shock. For the GDP growth surprise shocks, I follow the methodology used in Morgan et al. (2004) and Abiad et al. (2013)[36]. The U.S. fiscal policy shocks are the exogenous tax changes estimated by Romer and Romer (2010). The U.S. monetary shocks are taken from Smets and Wouters (2007). The shocks in-between red lines in Figure 8 are used in this paper.

Figure 8: U.S.-Specific Shocks: GDP Growth Surprises, Fiscal and Monetary Policy Shocks



(a) U.S. Growth Surprises (b) U.S. Fiscal Policy Shocks (c) U.S. Monetary Shocks

Note: The sample period that the main dataset covers is 2002:Q1 - 2013:Q4. The shocks in-between red lines are taken into consideration.

Table 7 shows the effect of market integration in transmitting U.S. GDP growth rate shocks, fiscal policy shocks, and monetary policy shocks to output in other countries. Each market integration has different spillover effects depending on the kind of shocks. The conventional single index(Financial Link $\times$ Shock) masks the different effects or significant effects of short-term debt, long-term debt, and equity market integration.

[36]The GDP growth surprise shocks are the othogonal component of $\Delta y_{it} = \alpha_i + \gamma_t + \varepsilon_{it}$. The number of countries used is 57 and the sample period is from 1978:Q1 - 2012:Q4.

Table 7: Impact of the U.S.-Specific Shocks on the GDP Growth Rate

	(1) GDP Growth Surprises		(2) Fiscal Policy Shock		(3) Monetary Policy Shock	
Financial Link × Shock	-0.003*		7.98***		3.17*	
	(2.06)		(5.03)		(2.28)	
Short-term Debt Link× Shock		0.21*		2.03***		0.11**
		(1.83)		(4.01)		(4.10)
Long-term Debt Link× Shock		0.21***		33.4		5.32
		(3.70)		(1.39)		(2.11)
Equity Link × Shock		-0.47*		-28.1		-1.46
		(2.11)		(1.51)		(0.47)
Trade Link × Shock	0.15**	0.16**	-3.17***	-3.90***	0.14**	-0.32**
	(2.49)	(2.49)	(3.19)	(4.55)	(3.82)	(3.63)
Control Variables	Yes	Yes	No	No	No	No
Observation(N)	801	801	252	252	134	134
R Squared	0.47	0.50	0.001	0.14	0.25	0.16

Note: The impact of the shock on output is estimated based on the equation $\Delta y_{it} = \alpha_i + d_t + \beta t + \gamma_1(l)\text{Shock}_t^m + \gamma_2(l)(\text{Shock}_t^m \times \text{Link}_{im,t}) + \gamma_3(l)\text{Link}_{im,t} + \gamma_4(l)\text{Control}_t + \epsilon_{it}$. The shocks are the U.S. GDP growth surprises in (1), the U.S. fiscal policy shocks in (2) and the U.S. monetary policy shocks in (3). Links are the integration measures for short-term debt, long-term debt, equity, financial and goods markets. The number of lags is 7. All regressions include country fixed effects, time(year) fixed effects, and control variables. The F statistics based on robust standard errors are in parentheses. *,**,*** denote joint significance at the 10 %, 5%, and 1% levels, respectively.

A6. Analytical Expressions for $G(\overline{\omega}_t)$ and $\Gamma(\overline{\omega}_t)$

The analytical expressions for $G(\overline{\omega}_t)$, $\Gamma(\overline{\omega}_t)$, and their first order differentials are taken from Hirakata et al. (2009). ω_t^F and ω_t^E follow log-normal distributions with different means and standard deviations. The mean and standard deviation for the distribution of idiosyncratic shocks to FIs are $\mathbb{F}_t(\omega_t^F) = 1$ and $\sigma_F = 0.107$. The mean and standard deviation for the distribution of idiosyncratic shocks to entrepreneurs are $\mathbb{E}_t(\omega_t^E) = 1$ and $\sigma_E = 0.313$. $F(\omega_t)$ denotes the cdf.

$G(\overline{\omega}_{t+1})$ represents the expected productivity of borrowers who declare default. The analytical expressions for $G(\overline{\omega}_t)$, and its first order differential are given by Equation (48) and (49).

$$G_t(\overline{\omega}_t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}} exp\left(\frac{\upsilon^2}{2}\right) d\upsilon \tag{48}$$

$$G_t'(\overline{\omega}_t) = \left(\frac{1}{\sqrt{2\pi}}\right)\left(\frac{1}{\overline{\omega}_t\sigma_t}\right) exp\left(-0.5\left(\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}\right)^2\right) \tag{49}$$

$\Gamma(\overline{\omega}_{t+1})$ indicates the share of earnings that goes to lenders before monitoring costs are paid. The analytical expressions for $\Gamma(\overline{\omega}_t)$, and its first order differentials are given by Equation (50), and (51).

$$\Gamma_t(\overline{\omega}_t) = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}} exp\left(\frac{\upsilon^2}{2}\right) d\upsilon + \frac{\overline{\omega}_t}{\sqrt{2\pi}} \int_{\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}}^{\infty} exp\left(\frac{\upsilon^2}{2}\right) d\upsilon \tag{50}$$

$$\begin{aligned}\Gamma_t'(\overline{\omega}_t) =& \frac{1}{\sqrt{2\pi}\overline{\omega}_t\sigma_t} exp\left(-0.5\left(\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}\right)^2\right) d\overline{\omega}_t + \frac{1}{\sqrt{2\pi}} \int_{\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}}^{\infty} exp\left(\frac{\upsilon^2}{2}\right) d\upsilon \\ &- \frac{1}{\sqrt{2\pi}\sigma_t} exp\left(-0.5\left(\frac{log\overline{\omega}_t - 0.5\sigma_t^2}{\sigma_t}\right)^2\right) d\overline{\omega}_t\end{aligned} \tag{51}$$

A7. Parameterization

Table 8: Parameter Values

Parameter	Value	Description
Goods market		
β	0.99	Discount factor
δ	0.025	Depreciation rate
α	0.35	Capital share
χ_1	3	Elasticity of labor
χ_2	6.714	Utility weight on leisure
κ	2.5	Adjustment cost of investment
η	1	Elasticity of substitution between home-produced goods and foreign-produced goods
Ω_F, Ω_E	0.01	Share of FIs' and entrepreneurial labor inputs
δ_b	0.936	Risk-free long-term bond depreciation rate
ρ_n	0.3	Autoregressive parameter for net worth shocks
γ_T	0.15	Trade openness
τ	0.1	Short-term debt market openness
Financial market		
σ_F	0.107	S.E of FIs' idiosyncratic productivity at steady state
σ_E	0.313	S.E of entrepreneurial idiosyncratic productivity at steady state
μ^F	0.033	Bankruptcy (monitoring) cost associated with FIs
μ^E	0.013	Bankruptcy (monitoring) cost associated with entrepreneurs
γ^F	0.963	Survival rate of FIs
γ^E	0.984	Survival rate of entrepreneurs
Steady state condition		
R	1.0101	Risk-free rate
R^l	1.0741	Risk-free long-term bond rate
R^E	1.0301	Return on capital
$F(\overline{\omega}^F)$	2%	Default probability in the IF contract
$F(\overline{\omega}^E)$	2%	Default probability in the FE contract
n^F	0.1	FIs' net worth/capital ratio
n^E	0.5	Entrepreneurial net worth/capital ratio

A8. Summary of the Model

A8.1. Welfare

$$U_t = \left\{ \frac{C_t^{1-\sigma}}{1-\sigma} - \chi_2 \frac{H_t^{1+\frac{1}{\chi_1}}}{1+\frac{1}{\chi_1}} \right\} + \left\{ \frac{C_t^{*1-\sigma}}{1-\sigma} - \chi_2 \frac{H_t^{*1+\frac{1}{\chi_1}}}{1+\frac{1}{\chi_1}} \right\} \tag{52}$$

$$W_t = U_t + \beta W_{t+1} \tag{53}$$

A8.2. Financial Market

Participation Constraints of Entrepreneurs

$$\left[1 - \Gamma^E(\overline{\omega}_{H,t}^E)\right] Q_{t-1} K_{H,t-1} \geq N_{t-1}^E \tag{54}$$

$$\left[1 - \Gamma^{E*}(\bar{\omega}_{H,t}^{E*})\right] Q_{t-1}^* K_{H,t-1}^* \geq N_{t-1}^{E*} \tag{55}$$

Participation Constraints of Investors

$$\begin{aligned} &\Phi^F(\bar{\omega}_{H,t}^F) R_t^F \Big[(1-\tau)(Q_{t-1}K_{H,t-1} - N_{t-1}^E) + \tau e_{t-1}(Q_{t-1}^* K_{H,t-1}^* - N_{t-1}^{E*}) \Big] \\ &\geq R_{t-1} \Big[(1-\tau)(Q_{t-1}K_{H,t-1} - N_{t-1}^E) + \tau e_{t-1}(Q_{t-1}^* K_{H,t-1}^* - N_{t-1}^{E*}) - N_{t-1}^F \Big] \end{aligned} \tag{56}$$

FI's Return

$$\begin{aligned} &R_t^F \left[(1-\tau)(Q_{t-1}K_{H,t-1} - N_{t-1}^E) + \tau e_{t-1}(Q_{t-1}^* K_{H,t-1}^* - N_{t-1}^{E*}) \right] \\ &\equiv \Phi^E(\bar{\omega}_{H,t}^E) R_t^E (1-\tau) Q_{t-1} K_{H,t-1} + \Phi^{E*}(\bar{\omega}_{H,t}^{E*}) \frac{e_t}{e_{t-1}} R_t^{E*} \tau Q_{t-1}^* K_{H,t-1}^* \end{aligned} \tag{57}$$

Optimal Financial Contracts

$$
\begin{aligned}
0 = & \left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]\Phi^E(\overline{\omega}^E_{H,t+1})R^E_{t+1} \\
& + \frac{\Gamma^{F\prime}(\overline{\omega}^F_{t+1})}{\Phi^{F\prime}(\overline{\omega}^F_{t+1})}\left\{\Phi^F(\overline{\omega}^F_{t+1})\Phi^E(\overline{\omega}^E_{H,t+1})R^E_{t+1}-R_t\right\} \\
& + \frac{\Phi^{E\prime}(\overline{\omega}^F_{t+1})}{\Gamma^{E\prime}(\overline{\omega}^E_{H,t+1})}\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]R^E_{t+1}\left[1-\Gamma^E(\overline{\omega}^E_{t+1})\right] \\
& + \frac{\Gamma^{F\prime}(\overline{\omega}^F_{t+1})}{\Phi^{F\prime}(\overline{\omega}^F_{t+1})}\cdot\frac{\Phi^{E\prime}(\overline{\omega}^E_{t+1})}{\Gamma^{E\prime}(\overline{\omega}^E_{t+1})}\Phi^F(\overline{\omega}^F_{t+1})R^E_{t+1}\left[1-\Gamma^E(\overline{\omega}^E_{H,t+1})\right]
\end{aligned}
\tag{58}
$$

$$
\begin{aligned}
0 = & \left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]\Phi^{E*}(\overline{\omega}^{E*}_{H,t+1})e_{t+1}R^{E*}_{t+1} \\
& + \frac{\Gamma^{F\prime}(\overline{\omega}^F_{t+1})}{\Phi^{F\prime}(\overline{\omega}^F_{t+1})}\left\{\Phi^F(\overline{\omega}^F_{t+1})\Phi^{E*}(\overline{\omega}^{E*}_{H,t+1})e_{t+1}R^{E*}_{t+1}-R_t\right\} \\
& + \frac{\Phi^{E*\prime}(\overline{\omega}^F_{t+1})}{\Gamma^{E*\prime}(\overline{\omega}^{E*}_{H,t+1})}\left[1-\Gamma^F(\overline{\omega}^F_{t+1})\right]e_{t+1}R^{E*}_{t+1}\left[1-\Gamma^{E*}(\overline{\omega}^{E*}_{H,t+1})\right] \\
& + \frac{\Gamma^{F\prime}(\overline{\omega}^F_{t+1})}{\Phi^{F\prime}(\overline{\omega}^F_{t+1})}\cdot\frac{\Phi^{E*\prime}(\overline{\omega}^{E*}_{H,t+1})}{\Gamma^{E*\prime}(\overline{\omega}^{E*}_{H,t+1})}\Phi^F(\overline{\omega}^F_{t+1})e_{t+1}R^{E*}_{H,t+1}\left[1-\Gamma^{E*}(\overline{\omega}^{E*}_{H,t+1})\right]
\end{aligned}
\tag{59}
$$

Dynamic Behavior of Net Worth

$$N^F_t = \gamma^F V^F_t + (1-\alpha)\Omega^F Y_t \tag{60}$$

$$N^E_t = \gamma^E V^E_t + (1-\alpha)\Omega^E Y_t \tag{61}$$

$$V^F_t \equiv \left[1-\Gamma^F(\bar{\omega}^F_{H,t})\right]R^F_t\left\{(1-\tau)(Q_{t-1}K_{H,t-1}-N^E_{t-1})+\tau e_{t-1}(Q^*_{t-1}K^*_{H,t-1}-N^{E*}_{t-1})\right\} \tag{62}$$

$$V^E_t \equiv \left[1-\Gamma^E(\bar{\omega}^E_{H,t})\right]R^E_t(1-\tau)Q_{t-1}K_{H,t-1}+\left[1-\Gamma^E(\bar{\omega}^E_{F,t})\right]R^E_t\tau Q_{t-1}K_{F,t-1} \tag{63}$$

A8.3. Goods Market

Consumption

$$C_t^{-\sigma} = \beta C_{t+1}^{-\sigma}(R^l_t+\delta_b) \tag{64}$$

$$C_t^{-\sigma}W_t = \chi_2 H_t^{1/\chi_1} \tag{65}$$

$$C_{H,t} = (1-\gamma_T)p_{H,t}^{-\eta}C_t \tag{66}$$

$$C_{F,t} = \gamma_T p_{F,t}^{-\eta} C_t \tag{67}$$

$$C_{H,t}^E = 0.5 p_{H,t}^{-\eta} Y_t^E \tag{68}$$

$$C_{F,t}^E = 0.5 p_{F,t}^{-\eta} Y_t^E \tag{69}$$

$$\begin{aligned} Y_t^E =& \mu^E G^E(\bar{\omega}_{H,t}^E) R_t^E (1-\tau) Q_{t-1} K_{H,t-1} + \mu^E G^E(\bar{\omega}_{H,t}^{E*}) e_{t-1} R_t^{E*} \tau Q_{t-1}^* K_{H,t-1}^* \\ &+ \mu^F G^F(\bar{\omega}_{H,t}^F) R_t^F \left\{ (1-\tau) \left(Q_{t-1} K_{H,t-1} - N_{t-1}^E \right) + \tau e_{t-1} \left(Q_{t-1}^* K_{H,t-1}^* - N_{t-1}^{E*} \right) \right\} \\ &+ (1-\gamma^E) V_t^E + (1-\gamma^F) V_t^F \end{aligned} \tag{70}$$

Capital and Investment

$$R_t^E = \frac{R_t^k + (1-\delta) Q_t}{Q_{t-1}} \tag{71}$$

$$R_t^k = \frac{\alpha}{1-\alpha} \frac{1}{1-\Omega_F - \Omega_E} \frac{H_t W_t}{K_{t-1}} \tag{72}$$

$$\begin{aligned} &Q_t \left\{ 1 - \frac{\kappa}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 - \frac{I_t}{I_{t-1}} \kappa \left(\frac{I_t}{I_{t-1}} - 1 \right) \right\} \\ &\quad = 1 + \beta \left(\frac{C_t}{C_{t+1}} \right)^{\sigma} Q_{t+1} \left(\frac{I_{t+1}}{I_t} \right)^2 \kappa \left(\frac{I_{t+1}}{I_t} - 1 \right) \end{aligned} \tag{73}$$

$$K_t = \left\{ 1 - \frac{\kappa}{2} \left(\frac{I_t}{I_{t-1}} - 1 \right)^2 \right\} I_t + (1-\delta) K_{t-1} \tag{74}$$

$$K_t = (1-\tau) K_{H,t} + \tau K_{F,t} \tag{75}$$

Production

$$Y_t = A \cdot exp(e_t^A) K_{t-1}^{\alpha} H_t^{(1-\Omega_F-\Omega_E)(1-\alpha)} \tag{76}$$

Exchange Rate and Terms of Trade

$$e_t p_{H,t}^* = p_{H,t} \tag{77}$$

$$ToT_t = \frac{e_t p_{F,t}^*}{p_{H,t}} \tag{78}$$

Goods Market Clearing

$$Y_t = C_{H,t} + C^*_{H,t} + I_t + G_t + C^E_{H,t} + C^{E*}_{H,t} \tag{79}$$

$$GDP_{H,t} = C_{H,t} + C^*_{H,t} + I_t + G_t \tag{80}$$

A8.4. Rest of the Economy

Fiscal Policy

$$G_t = T_t \tag{81}$$

Exogenous Variable

$$\varepsilon_t = \rho_n \varepsilon_{t-1} + \xi_t \tag{82}$$