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Financial Integration, Financial Frictions and Business Cycles of Emerging Market Economies

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Abstract

International financial integration has the potential benefit of mitigating the effects of shocks through risk sharing. However, in many instances, emerging market economies experienced increased business cycle volatility following financial integration. Using a small open economy real business cycle model, this paper demonstrates that the response of business cycles to financial integration depends on the extent of domestic financial development. The model is estimated using generalized method of moments (GMM) with data for thirteen emerging market economies. The results are that financial integration reduces business cycle volatility for economies with well developed financial markets, but raises volatility for economies with poorly developed financial markets. The underlying mechanism is shown to be domestic financial friction, which is modeled as a financial accelerator. Because financial integration lowers the cost of borrowing, borrowers take higher leverage. Due to the imperfections in emerging economies' financial markets, the leverage boom increases the vulnerability of the economy to shocks and leads to more volatile business cycles following financial integration.

JEL Codes: E44, F41, F44, F62

Key Words: Financial integration, financial accelerator, business cycles

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1 Introduction

During the past few decades, both developed and emerging markets economies have taken steps to liberalize their capital accounts and become integrated with the international financial market. According to the existing literature, financial integration has the potential benefit of mitigating the effects of shocks through international risk sharing. Because emerging market economies are characterized by more volatile business cycles compared to industrial economies, they are supposed to benefit more from financial integration. However, the data indicates that, in many instances, business cycles in emerging markets become even more volatile after international financial integration.

To obtain a comprehensive picture of business cycle behaviors following international financial integration, I first perform detailed data analysis for both industrial and emerging market economies. I find that as financial openness level increases, the majority of industrial economies experience less volatile business cycles. In contrast, more than half of the emerging market economies experience more volatile business cycles. The heterogeneity in the responses of business cycles to financial integration is not captured by standard macro models, which predict uniform response of decreasing business cycle volatilities. The findings suggest the need for a model to explain the distinctive behaviors of emerging market economies' business cycles.

I build a business cycle model in which the degree of shock amplification and propagation is endogenously determined by the level of international financial integration. This is achieved by embedding a financial accelerator following Bernanke, Gertler, and Gilchrist (1999) (henceforth BGG) into a small open economy real business cycle (RBC) model where terms of trade shock and productivity shock are the driving forces. In this model, the level of financial integration is modeled as a reduced-form international interest rate premium. Changes in the level of financial integration are transmitted into the economy through firms' financial position. The model can very well account for the business cycle behaviors of emerging market economies, and it naturally generates more amplified fluctuations in business cycles after international financial integration. When the barriers in obtaining credit in the international financial market are lowered, firms are encouraged to increase borrowing and become more financially leveraged. To the extent that this economy is higher leveraged, an adverse shock would wipe out larger fraction of firms' net worth, thereby generating more amplified business cycles.

The modeling is motivated by empirical observations. Emerging markets are characterized by poorly developed domestic financial markets. Data has shown that emerging markets on average have much less access to financial intermediaries compared with developed economies. Furthermore, in regions like Latin America and Central Asia, the percentage of firms identifying the access to financial markets as a constraint is much higher than that of the Euro Area. Therefore, the existence of financial frictions in emerging markets motivates the idea that financial frictions play an important role in determining the business cycle behaviors following financial integration.

I then estimate the important model parameters that govern the international borrowing premium and shock processes using data for thirteen emerging market economies. In this sense, this paper offers a general picture for emerging market economies rather than focusing on one single country. The parameters are estimated by matching model moments to key empirical moments of emerging market economies in the post-integration period using generalized method moments (GMM). The model is able to reproduce moments that characterize the empirical counterparts of emerging market economies.

The estimated model is then evaluated with different levels of financial integration. The model successfully produces the observed business cycle behaviors of emerging market economies, *i.e.*, less volatile business cycles in the pre-integration period than in the post-integration period. The underlying mechanism is a leverage channel due to frictions in the domestic financial market. The leverage channel reflects financial frictions in amplifying and propagating shocks. As financial integration reduces the cost of borrowing, borrowers' leverage is boosted. The higher leverage coupled with financial frictions heightens the economy's vulnerability to shocks. As a result, the leverage channel generates more volatile business cycles after financial integration.

The model also sheds light on the fact that financial integration stabilizes business cycles in developed economies. When domestic financial frictions are not present, the model generates less volatile business cycles after financial integration. The result comes from a smoothing channel embedded in the model. The smoothing channel reflects the conventional wisdom of financial integration;

countries that are more financially integrated can better smooth aggregate shocks. Whether the smoothing channel or the leverage channel dominates depends on the degree of financial frictions in the domestic financial market. In developed economies with well-developed financial market, the smoothing channel dominates. In emerging economies with high degree of financial friction, the leverage channel dominates.

The results of this paper are robust to different model specifications. I consider two different ways to model household borrowings and lendings; one features zero aggregate households' borrowings and the other takes into account households' consumption smoothing via borrowing and lending. The analysis shows that the model mechanisms are not sensitive to the inclusion of improved households' consumption smoothing through financial integration.

The predictions of the model are in line with Prasad and Rajan (2008), who point out that there are thresholds for benefiting from financial openness. The quality of domestic financial institutions has to be above a certain threshold in order for it to be beneficial to open up. An empirical study on the growth volatility and financial liberalization by Bekaert, Harvey, and Lundblad (2006) also suggests that the response of business cycles to financial integration depends on the financial development of the opening country.

This paper clarifies the effect of financial integration on business cycles. So far the predictions from proposed theoretical models suggest that the impact of financial integration on business cycles is ambiguous. For example, Baxter and Crucini (1995) use a two-country model to study the linkage between restrictions on asset trade and business cycles. They find that financial integration may not be important when shocks are less persistent or rapidly transmitted. However, financial integration is essential to business cycles when shocks are highly persistent or hard to transmit. Mendoza (1994) studies a small open economy RBC model and finds that consumption and output volatilities are not sensitive to changes in the degree of capital mobility. Heathcote and Perri (2004) predict that the international business cycles correlation is closely related with international asset trade, *i.e.*, increasing international financial integration can account for the less correlated international business cycles. Buch and Pierdzioch (2005) report no significant relationship between business cycle volatility and the linkage of the financial system to international financial market. Evans and Hnatkovska (2007) develop a two-sector RBC model and predict increasing volatility in output and a hump-shaped consumption volatility.

This paper also shows the importance of financial structure in macroeconomics. Canonical RBC models adopt the Modigliani and Miller (1958) theorem, and assume financial structure is both indeterminate and irrelevant to real economic outcomes. Yet, starting from 1980s, a growing number of literature has given a more important role to credit market conditions in the propagation of cyclical fluctuations. For instance, Bernanke and Gertler (1989), Carlstrom and Fuerst (1997), Kiyotaki and Moore (1997), and Bernanke, Gertler, and Gilchrist (1999) use different ways to incorporate credit market imperfections to explain the macroeconomic contractions in Latin American and East Asian countries. Recent works on RBC such as Neumeyer and Perri (2005), García-Cicco, Pancrazi, and Uribe (2010), Chang and Fernández (2013), and Bhattacharya and Patnaik (2013) also point out the importance of financial frictions in explaining the puzzling business cycle behaviors of emerging market economies. The recent 2008 Great Recession has again sparked people's interests in models of financial frictions. Examples include Hall (2010) and Adrian, Colla, and Shin (2012) that show the important roles of financial intermediaries in generating downturns and contractions. However, to the best of my knowledge, this paper is the first to provide a direct linkage between financial integration and financial frictions, and use the interaction between financial integration and domestic financial frictions to interpret the increasing business cycle volatilities after financial integration in emerging market economies.

The rest of the paper is organized as follows. Section two gives a summary of the empirical analysis. Section three presents the model. Section four describes the calibration and estimation. Section five analyzes the estimation results. Section six shows the model mechanism. Section seven provides an extended discussion about domestic financial development and financial integration. Section eight discusses robustness analysis. Section nine concludes.

2 Summary of Empirical Analysis

The basic feature of emerging market economies is that they have more volatile business cycles than developed economies. Table 1 provides the evidence on this feature.

Financial openness in both industrial and emerging market economies increased in the past few decades. Figure 1 plots the financial openness levels before and after the 1970-80s in both economies. As in all of the subsequent figures (except Figure 6), the solid 45 degree line represents the benchmark, *i.e.*, no change in the measured value. Countries are selected according to Kose, Prasad, and Terrones (2003). According to Lane and Milesi-Ferretti (2007), financial openness is measured as the ratio of the sum of external assets and liabilities to GDP. As seen from the figure, both groups of countries lie above the benchmark line, indicating increasing financial openness levels in the 1990s and 2000s.

Meanwhile, trade openness also increased. Figure 2 shows the level of trade openness for both economies before and after the 1970-80s. Evidently, the majority of both groups of countries cluster above the benchmark line, indicating growing trade openness in the 1990s and 2000s.

Financial integration should help smooth business cycles, especially when trade openness is considered. With opened trade accounts, countries are subject to terms of trade shock. Changes in exports and imports would give rise to adjustments in macroeconomic variables such as output, investment and consumption. In this way, terms of trade shock propagates to the economy. With opened capital account, the economy can borrow and lend when terms of trade moves against it, thus mitigating the effect of terms of trade shock.

The experience of industrial economies is consistent with this prediction. Figure 3 shows the consumption volatility for industrial economies before and after the 1970-80s. The majority of them experienced less volatile consumption in the 1990s and 2000s.

In contrast, the experience of emerging market economies contradicts this prediction. As shown in Figure 4, about half of emerging market economies experienced more volatile consumption in the 1990s and 2000s. For example, Korea, Thailand, and Colombia are typical emerging economies with opened trade and capital accounts. They all became fully integrated into international financial market around early 1990s. Figure 5 shows the cyclical patterns of consumption and GDP for these three countries. All of them experienced vastly volatile consumption and GDP in the years following financial integration. Moreover, in Figure 4, around one-third of the countries stay on the benchmark line, indicating no significant change after financial integration. Taken together, the majority of emerging market economies did not benefit from financial integration in terms of business cycle smoothing. This result is also supported by Figure 6, which shows the relationship between financial openness and consumption volatility for emerging market economies. If the conventional wisdom of financial integration applies, we should see a significantly negative correlation. However, Figure 6 shows that the least-square fitted line is rather flat and even slightly positively sloped.

Standard macro models fail to explain business cycle behaviors in emerging market economies. As already pointed out, one important reason is that in such models, financial structure does not affect the real economy. As opposed to industrial economies, emerging market economies are characterized by poorly developed domestic financial markets. Table 2 lists the number of bank branches per 100,000 adults. On average, emerging markets have 15 branches while industrial economies have more than 30. Furthermore, more firms in emerging market economies identify themselves as financially constrained. Table 3 shows that in Euro Area, about 14 percent of firms report financial constraints, while among European and Central Asian developing countries this figure rises to 24 percent. Both tables show that emerging markets on average have less developed financial sectors than industrial economies, indicating an important role of domestic financial frictions.

3 Model

I consider a small open economy real business cycle model. The model features five agents: households, importers, domestic good producers, distributors, and banks. Each agent has a unit mass. Households work, consume, and supply physical capital to good producers. They also buy or sell one-period bond. In aggregate, household savings and borrowings are zero. Importers import raw goods from the rest of the world, and borrow from banks. Banks act as intermediaries, transferring funds from international depositors to domestic importers. Consumption goods are produced by domestic good producers and distributors.

3.1 Production

There are two production sectors in this economy: the domestic goods sector and foreign goods sector. The numeraire is the foreign goods. Firms in the domestic goods sector face perfect competition. They employ labor and capital to produce output according to

$$Y_t^d = z_t^d K_t^{\alpha_d} H_t^{1-\alpha_d}, \quad \alpha_d \in (0,1), \tag{1}$$

where K_t and H_t are capital and labor respectively. The parameter α_d denotes the capital share. The term z_t^d denotes total factor productivity (TFP), which follows the AR(1) process[1]

$$\ln z_t^d = \rho_d \ln z_{t-1}^d + \epsilon_t, \quad \rho_d \in (0,1). \tag{2}$$

Each firm pays capital and labor in accordance with the marginal productivity

$$r_t = \alpha_d Y_t^d / K_t, \tag{3}$$

$$w_t = (1-\alpha_d) Y_t^d / H_t, \tag{4}$$

where r_t and w_t denote the equilibrium factor prices.

Foreign goods are produced by distributors. Distributors buy imported raw goods from importers, repackage and sell them to consumers. Distributors treat imported raw goods as intermediate inputs and produce final outputs (foreign goods) using the technology

$$Y_t^m = z_t^m M_{t-1}^{\alpha_m}, \quad \alpha_m \in (0,1), \tag{5}$$

where M_{t-1} denotes imported raw goods. The decision on how much raw goods to import is made by importers at $t-1$. The share $\alpha_m < 1$ implies decreasing return to scale. The term z_t^m is the

[1]Note that estimation of the model reveals that shock to TFP z^d does not play a significant role in determining the model moments. Therefore, in the estimated model, shock to z^d is removed and z^d takes the value of 1.

TFP of distributors, which follows the AR(1) process

$$\ln z_t^m = \rho_m \ln z_{t-1}^m + \upsilon_t, \quad \rho_m \in (0,1), \tag{6}$$

where ρ_m is the persistence parameter. The innovations to TFP, υ_t, are drawn from a normal distribution with mean 0 and variance σ_υ^2.

Distributors distribute the remaining output to households after paying the importers, as households are the owners of the business. Dividends to households can be written as

$$\Xi_t = Y_t^m - R_t^m q_t M_{t-1}. \tag{7}$$

3.2 Financial Market and Frictions

Financial frictions are introduced in the interactions between importers and banks. Importantly, importers need to borrow from banks to finance their purchases of imported raw goods. As is standard, the asymmetric information between borrowers and lenders, together with, the monitoring cost paid in the case of default, give rise to the financial frictions.

3.2.1 Importers (Borrowers)

The assets of an importer i are the sum of her net worth N_t^i and borrowed funds B_t^i,

$$q_t M_t^i = N_t^i + B_t^i, \tag{8}$$

where $q_t M_t^i$ denotes the total value of imported raw goods and q_t is the terms of trade in unit of the numeriare good. The terms of trade evolves according to the AR(1) process

$$\ln q_t = \rho_q \ln q_{t-1} + \varsigma_t, \quad \rho_q \in (0,1), \tag{9}$$

where ρ_q is the persistence parameter. The innovations to terms of trade, ς_t, are drawn from a normal distribution with mean 0 and variance σ_ς^2.

Additionally, every importer is subject to an idiosyncratic disturbance ω, which is a random variable that follows a lognormal distribution $F(-\frac{\sigma_\omega^2}{2}, \sigma_\omega)$ with standard deviation σ_ω and $\mathrm{E}(\omega) = 1$. The ex-post realized disturbance, ω_{t+1}^i, is a random draw from the distribution. Therefore, the realized value of imported raw goods received by the importer is $\omega_{t+1}^i q_t M_t^i$.

3.2.2 Banks (Lenders)

The realized ω^i is only observable by the importer. In order to learn the specific state of the importer, the bank needs to pay a per unit monitoring cost μ. The optimal contract between a bank and an importer specifies a threshold value of $\bar{\omega}_{t+1}^i$ such that

$$\text{loan repayment at } t+1 = \begin{cases} \bar{\omega}_{t+1}^i R_{t+1}^m q_t M_t^i & \text{if } \omega_{t+1}^i \geq \bar{\omega}_{t+1}^i, \\ \omega_{t+1}^i R_{t+1}^m q_t M_t^i & \text{if } \omega_{t+1}^i < \bar{\omega}_{t+1}^i. \end{cases}$$

This implies that the importer defaults if the realized ω_{t+1}^i is below the threshold $\bar{\omega}_{t+1}^i$. In the case of bankruptcy, the importer is monitored and her asset $\omega_{t+1}^i R_{t+1}^m q_t M_t^i$ will be taken over by the bank. In the case of $\omega_{t+1}^i \geq \bar{\omega}_{t+1}^i$, the importer repays the bank according to the contract $\bar{\omega}_{t+1}^i R_{t+1}^m q_t M_t^i$, and retains the profit $(\omega_{t+1}^i - \bar{\omega}_{t+1}^i) R_{t+1}^m q_t M_t^i$. The contract guarantees that it is optimal not to monitor solvent importers. For a given size M_t of the importer, the auditing threshold $\bar{\omega}_{t+1}$ is set so the bank breaks even:[2]

$$\left[\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})\right] R_{t+1}^m q_t M_t = R_t^* B_t, \tag{10}$$

where

$$G(\bar{\omega}_{t+1}) \equiv \int_0^{\bar{\omega}_{t+1}} \omega_{t+1} dF(\omega_{t+1}), \tag{11}$$

$$\Gamma(\bar{\omega}_{t+1}) \equiv \left[1 - F(\bar{\omega}_{t+1})\right] \bar{\omega}_{t+1} + G(\bar{\omega}_{t+1}), \tag{12}$$

[2]Note that banks provide homogeneous and standard contracts to all importers. Therefore, the superscript i is removed. See Bernanke, Gertler, and Gilchrist (1999).

and

$$R^m_{t+1} = \alpha_m \frac{Y^m_{t+1}}{M_t}. \tag{13}$$

The left-hand side of the break even condition Eq. (10) expresses the returns on risky loans to the bank net of monitoring cost μ. It includes the repayment from the solvent importers, *i.e.*, the first component of $\Gamma(\bar{\omega}_{t+1})$, and the repayment by defaulting importers, *i.e.*, the second component of $\Gamma(\bar{\omega}_{t+1})$ net of $\mu G(\bar{\omega}_{t+1})$. The term R^m denotes the return on imported raw goods. The right-hand side of the break even condition Eq. (10) expresses the cost of raising funds B_t from the international depositors, and R^*_t is the inter-period interest rate that this economy faces in the international financial market.

Note that the frictions in financial market create a wedge between R^m and R^*. Define

$$\tau \equiv \mathrm{E_t}\left(R^m_{t+1}\right) - R^*_t, \tag{14}$$

as the external financing premium of borrowers, which represents the degree of financial frictions in the economy.[3] The higher the external financing premium is, the higher the measured degree of financial frictions is. In the extreme case of a perfect financial market, $\tau = 0$.

3.2.3 Borrowers and Lenders

The timing of events is as follows. At the beginning of time t, the shock to z^m_t is realized and importers learn the return to imported raw goods R^m_t. Also, the value of ω_t is revealed, and a pooled importers with net worth N_t remain solvent. Those importers decide upon the demand level of M_t, and hence, the level of debt B_t. The optimal threshold value of $\bar{\omega}_{t+1}$ is found by maximizing the importer's expected profits subject to the break even condition:

$$\max_{\bar{\omega}_{t+1}, L_t} \quad \frac{\int_{\bar{\omega}_{t+1}}^{\infty} (\omega_{t+1} - \bar{\omega}_{t+1}) dF(\omega_{t+1}) R^m_{t+1}}{R_t} L_t, \tag{15}$$

where $L_t \equiv q_t M_t / N_t$ is the financial leverage of importers. The importers treat the break even condition as a menu of contracts, which lists all combinations of L and $\bar{\omega}$. The solution of the

[3] According to Hall (2012), a comprehensive measure of financial friction is the difference between the return that businesses earn from capital and the market cost of capital, *i.e.*, the interest rate.

importer's problem yields the contract $(L_t, \bar{\omega}_{t+1})$ that maximizes the expected profit.

Following Bernanke, Gertler, and Gilchrist (1999), I assume that, at the end of each period, a fraction $1-\gamma$ of importers will die and be replaced by a new cohort so as to keep the number of importers constant.[4] In order to endow those new born importers initial wealth, households transfer W^e as a lump sum to each importer. Therefore, the aggregate net worth evolves according to

$$N_{t+1} = \gamma\big[1-\Gamma(\bar{\omega}_{t+1})\big] R^m_{t+1} q_t M_t + W^e. \tag{16}$$

The importers as a whole then take this net worth to period $t+1$, get loans, and purchase imported raw goods. The net worth of dead importers $(1-\gamma)\big[1-\Gamma(\bar{\omega}_{t+1})\big] R^m_{t+1} q_t M_t$ is transferred to households. Therefore, the net transfer from importers to households is

$$\Omega_t = (1-\gamma)\big[1-\Gamma(\bar{\omega}_{t+1})\big] R^m_{t+1} q_t M_t - W^e. \tag{17}$$

3.3 Households and Occupational Choice

There is a continuum of infinitely-lived risk-averse households. Each household is endowed with one unit of labor and supplies labor and capital to domestic good producers. The utility maximization problem of a representative household is

$$\max_{C^d_t, C^m_t, H_t} \quad \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\kappa} \left(C^h_t - \psi \frac{H_t^{1+\theta}}{1+\theta} \right)^{1-\kappa}, \tag{18}$$

where

$$C^h_t = [\pi (C^d_t)^\rho + (1-\pi)(C^m_t)^\rho]^{1/\rho}. \tag{19}$$

The household's utility depends on hours worked H and an aggregate C^h of foreign goods C^m and domestic goods C^d. I adopt the preferences of Greenwood, Hercowitz, and Huffman (1988).

Households can smooth consumption by issuing one-period bond among each other. Households are assumed to never default. The net supply of bond is zero in equilibrium. The budget constraint

[4]This dying process ensures that importers do not accumulate enough wealth so as to make the financing problem irrelevant.

of the represented household is given by

$$C_t^m + p_t(C_t^d + X_t) + R_{t-1}B_{t-1}^d = p_t(w_t L_t + r_t K_t) + B_t^d + \Xi_t + \Omega_t, \tag{20}$$

where p_t denotes the relative price of domestic goods. Alongside income from supplying labor and capital, households also receive dividends Ξ_t and transfer payment Ω_t. Therefore, the household's income and consumption are sensitive to unexpected shifts in the distributor's profit or importer's net worth.

Households own physical capital and make investment X_t. Capital accumulates as

$$K_{t+1} = \Phi\left(\frac{X_t}{K_t}\right) K_t + (1-\delta)K_t, \tag{21}$$

where

$$\Phi\left(\frac{X_t}{K_t}\right) = \frac{w_1}{1-\frac{1}{\xi}}\left(\frac{X_t}{K_t}\right)^{1-\frac{1}{\xi}} + w_2. \tag{22}$$

The term $\Phi\left(\frac{X_t}{K_t}\right)$ represents the investment adjustment cost. The parameter ξ measures the elasticity of investment to Tobin's q. As $\xi \to +\infty$, the above accumulation process collapses down to $K_{t+1} = X_t + (1-\delta)K_t$. Parameters w_1 and w_2 are set so that in the steady state $\Phi(\cdot) = \delta$ and $\Phi(\cdot)' = 1$.

3.4 International Financial Market

In this economy, the aggregate household lending is zero. Thus, the debt position of the economy in the international financial market is determined by the importers' borrowing B_t. The interest rate R_t^* is augmented by a small risk premium term ϕ such that

$$R_t^* = \bar{R} + \phi\big[\exp(B_t) - 1\big], \tag{23}$$

where $\bar{R}$ is the international risk-free interest rate and $\phi > 0$ denotes the sensitivity of the interest rate to the debt level. The higher ϕ is, the higher obstacle the economy needs to overcome to obtain credit. Therefore, an increase in the financial integration level is modeled as a reduction in ϕ. For simplicity, the following discussion uses ϕ to denote the international borrowing premium.

It is important to realize that the degree of financial frictions in this economy is closely related to the value of ϕ. To see this, note that the bank's break even condition can be written as the supply curve for investment finance:

$$\mathrm{E}_t\left\{\frac{R^m_{t+1}}{R^*_t(\phi)}\right\} = \Upsilon(L_t), \quad \Upsilon'(\cdot) > 0. \tag{24}$$

This implies a positive correlation between the leverage and the external financing premium. In particular, a reduction in ϕ raises the importer's demand for imported raw goods, leading to a higher leverage. At the new level of demand, the external financing premium increases as well, because the rise in leverage raises the expected default probability. Therefore, a reduction in ϕ raises both the leverage and the degree of financial frictions.

3.5 Market Clearing Conditions

Because of the importers' debt position, the economy must export to balance its national accounts. I assume that domestic goods are non-tradable. The economy reexports part of its foreign goods Y^m. The market clearing conditions for both domestic and foreign goods are as follows[5]

$$C^d_t + X_t = Y^d_t, \tag{25}$$

$$C^m_t + EX_t + d_t = Y^m_t, \tag{26}$$

where

$$\begin{aligned} EX_t &= N_t + R^*_{t-1}B_{t-1} \\ &= q_t M_t + R^*_{t-1}B_{t-1} - B_t, \end{aligned} \tag{27}$$

and

$$d_t = \mu \int_0^{\bar{\omega}_t} \omega_t dF(\omega_t) R^m_t q_{t-1} M_{t-1}. \tag{28}$$

[5]Appendix C provides details for this derivation.

In the resource constraint Eq. (26), EX_t denotes total amount of exports. It equals the sum of imports $q_t M_t$ and next exports $R^*_{t-1}B_{t-1} - B_t$, as shown in Eq. (27). The term d_t denotes the monitoring cost. Therefore, the produced goods Y^m_t is consumed, used to cover the monitoring costs, and exported.

In particular, from the household's budget constraint, I derive

$$C^m_t = \Xi_t + \Omega_t. \tag{29}$$

That is households' consumption of foreign goods is the sum of dividends Ξ_t and transfer payments Ω_t. Recall that, besides the TFP shock, both Ξ_t and Ω_t are subject to terms of trade shock. Therefore, household consumption is subject to both TFP shock and terms of trade shock. Due to the independence of shock processes, volatility of consumption is higher than that of output, which only subjects to TFP shock.[6]

4 Calibration and Estimation

As is standard, the model does not possess an analytical solution. I approximate the dynamics of the economy in the neighborhood of the non-stochastic steady state.[7] To do so, the system equations are log-linearized around the steady state, and the resulting linear difference equations are solved as in Blanchard and Kahn (1980).

The parameter values of the model are either estimated or calibrated. The important parameters that are estimated are the persistence parameter of TFP shock ρ_m, the persistence parameter of terms of trade shock ρ_q, the standard deviation of innovations to TFP σ_υ, the standard deviation of innovations to terms of trade σ_ς, international financial market borrowing premium ϕ, and the investment adjustment cost parameter ξ. All the other parameters are calibrated.

Due to the availability of data, the model is estimated and calibrated on the post financial integration period, *i.e.*, 1993 and after. I then evaluate the model to see its implications on the

[6]The idea of generating volatile consumption shares the view of Boileau and Normandin (2014) who show that countries depend heavily on imports of equipment are at the mercy of terms of trade shock, and that variations in the price of imported goods can generate more response in consumption than output.

[7] This is a standard method in the RBC literature.

pre-integration period. Table 4 lists the timing of financial integration for key emerging market economies. Most of them became fully integrated in the late 1980s and early 1990s. The most recent one is Argentina in 1993.

The time unit of the model is a quarter. Table 5 presents the calibrated parameter values. The coefficient of relative risk aversion κ is set to 2. The parameter θ is set to 0.65 so that Frisch elasticity of labor supply is 1.7. The parameter ψ is set to 1.6 such that in the steady state households spend around 33% percent of time on working. The elasticity of substitution between domestic good and foreign good is $1/(1-\rho) = 2$. The weight of domestic good in the CES aggregate π is 0.5. The capital depreciation rate is set to 0.02. The discount factor β is set to 0.98 so that the annual interest rate is around 8%. The share of capital goods α_d in the gross output Y^d is set to 0.33. The production technology parameter α_m is set to 0.33.

The parameter γ denotes the fraction of importers that survives to the next period. I follow Bernanke, Gertler, and Gilchrist (1999) and set this parameter to 0.97. In a quarterly-based model, this value implies that the lifetime of firms $1/(1-\gamma)$ is around 33 quarters or 8 years. Given that empirical finance literature, for instance Morris (2009), estimates firms' average life to be 7-11 years, this is a reasonable choice for the value of γ.

Two parameters govern the level of domestic financial frictions, the monitoring cost μ and the standard deviation σ_ω of the distribution of idiosyncratic disturbance. Earlier work by Carlstrom and Fuerst (1997) considers the calibration of μ with 0.2, 0.25 and 0.36, while BGG calibrates it as 0.12. Fernández and Gulan (2015) estimate this parameter using data from twelve emerging market economies and get 0.32, a value close to the upper bond of Carlstrom and Fuerst (1997). I set μ to 0.32. The parameter σ_ω is then calibrated by matching the average leverage of non-financial firms in emerging market economies. Its value is set to 0.3 so that the steady state leverage is around 1.6. As will be shown later, the two parameters affect the level of financial development in the domestic economy.

I estimate the six remaining parameters, ρ_m, ρ_q, σ_v, σ_ς, ϕ, and ξ, using Generalized Method of Moments (GMM). I use the estimator discussed in Driscoll and Kraay (1998) on panel data. This estimator yields standard errors that are robust to general forms of spatial dependence.

I choose the following nine second moments:

$$m(\Theta) = \left[\sigma^2(Y) \;\; \frac{\sigma^2(C)}{\sigma^2(Y)} \;\; \frac{\sigma^2(X)}{\sigma^2(Y)} \;\; \frac{\sigma^2(TB)}{\sigma^2(Y)} \;\; \frac{\sigma^2(R^*)}{\sigma^2(Y)} \;\; \rho(C,Y) \;\; \rho(X,Y) \;\; \rho(TB,Y) \;\; \rho(R^*,Y) \right]', \quad (30)$$

where $\Theta = \left[\phi \;\; \xi \;\; \rho_m \;\; \rho_q \;\; \sigma_\upsilon \;\; \sigma_\varsigma\right]'$ is the vector of parameters. The trade balance TB is defined as the ratio of net export to output, *i.e.*, $TB = NX/Y$. Country's risky interest rate is represented by R^*. I use R^* rather than R, because the former takes into account the country specific risk spread on top of the non-risky benchmark interest rate. Plus, R^* reacts to changes in the degree of financial integration.

The empirical counterparts of the model moments are based on five time series: output, private consumption, investment, trade balance and interest rate. The data of these five series is collected from IFS and JP Morgan EMBI database for thirteen emerging market economies, including Argentina, Brazil, Chile, Colombia, Ecuador, Korea, Malaysia, Mexico, Peru, Philippines, South Africa, Thailand, and Turkey. The data used to estimate the model is an unbalanced panel from 1993:IV to 2011:IV. All series is in per capita form and is logged and filtered following Hodrick and Prescott (1997). The exception is trade balance which is directly filtered.

The vector of parameters Θ is identified as follows. The parameters defining the shock processes, ρ_m, ρ_q, σ_υ, σ_ς, are identified by using the information on output, consumption, and the trade balance. The investment adjustment cost parameter ξ is identified from the investment series. The international borrowing premium ϕ is identified through the information on interest rates.

5 Estimation Results

Table 6 presents the estimated moments along with the empirical moments. Panel A shows the targeted moments in the GMM estimation, and Panel B shows the other model moments. The model does a good job matching the key moments of emerging market economies. It is able to generate a high standard deviation for output, and a more volatile consumption than output. Moreover, the model generates countercyclical interest rate and trade balance.

The model underestimates the standard deviations of the interest rate and of the trade balance.

The reason is the low estimated value of the borrowing premium ϕ. ϕ affects the sensitivity of R^* to changes in the debt position. For the estimated value of $\phi = 0.08$, debt changes barely affect the interest rate. Therefore, it is not surprising to see a low volatility for the interest rate. Note that Fernández and Gulan (2015) use the return to capital as a proxy for the country's interest rate, while in this paper I use country specific spreads plus benchmark interest rate. Although the model does not match well with the data, the interest rate defined in this model is more consistent with the empirical counterpart.[8]

The model also does a good job matching moments that are not included in the estimation. As shown in Panel B of Table 6, the model matches the magnitude and sign of the correlations for several moments except for the correlation between R^* and TB.

Table 7 presents the estimated parameter values. In relating the model to financial integration, the most relevant parameter is ϕ, which is estimated to be 0.08. It is lower than previous estimates. Early works on small open economy such as Schmitt-Grohé and Uribe (2003) and Aguiar and Gopinath (2007) assume ϕ to be negligible (as small as 0.001). A recent related work by Miyamoto and Nguyen (2015) estimates this parameter for seventeen small open economies (including both developed and developing countries) using data from 1900 to 2013. They find that ϕ falls into the range of 0.2-1.4 for emerging economies. Given the fact that I use the data for post integration period from 1993 to 2011, the estimated ϕ is appropriately small.

The estimate of the investment adjustment cost parameter ξ is 2.873. The value of ξ largely determines the relative standard deviation of investment to output. There is no consensus on the value of ξ, because it depends on the model specification and the actual functional form of investment adjustment process. Nevertheless, the presented estimate is close to the values used in Aguiar and Gopinath (2007) and García-Cicco, Pancrazi, and Uribe (2010).

The standard deviation σ_v of innovations to TFP is estimated to be 0.02, similar to the values reported in previous studies.[9] The persistence of the TFP shock ρ_m is estimated to be 0.994.[10]

[8]One way to generate consistent second moments of interest rate is to introduce interest rate shocks. That is modeling the international benchmark interest rate as a stochastic process.

[9]Neumeyer and Perri (2005) estimates its range to be 1.47-1.98%.

[10]Although ρ_m is rather close to unity, the model does not rely on the trend shock assumption as in Aguiar and Gopinath (2007) to produce more volatile consumption than output.

The persistence ρ_q and standard deviation σ_ς of terms of trade shock is estimated to be 0.89 and 0.102, respectively. The value of σ_ς implies that terms of trade shock plays a non-negligible role in generating the model moments. Table 8 reports the variance decomposition of the two shocks. The innovations to TFP and terms of trade contribute roughly equally to the fluctuations in output. However, innovations to terms of trade contributes substantially more to the volatility of consumption, which explains the high volatility of consumption in emerging economies. Moreover, the fluctuations in the interest rate, trade balance and investment all rely heavily on terms of trade shock.

6 Financial Integration and Model Mechanism

In this section, I examine the estimated model with different levels of financial integration. The key question to answer is what happens to the volatilities of output and consumption once the level of financial integration changes.

The level of international financial integration is represented by the international borrowing premium ϕ. Because one important aspect of financial integration is removing obstacles for countries to participate in the international financial market, it is reasonable to assume that a decrease in ϕ represents a more integrated financial market. Miyamoto and Nguyen (2015) model the frictions in a similar way and finds that ϕ differs significantly for developed and developing countries.

Figure 7 and 8 plot the standard deviations of output and consumption for different values of ϕ, with the other parameters calibrated and estimated as in Section 5. Both figures are V-shaped with a minimum when ϕ is around 0.15. To facilitate the discussion, I divide both figures into two regions, Region I and II.

In Region I, the model produces a considerable drop in both the standard deviations of output and consumption when ϕ goes up. Specifically, as ϕ increases from 0.08 to 0.15, the standard deviation of output drops from 3.78% to around 3.71%, and the standard deviation of consumption drops from 5.29% to 5.22%. Compared to the existing literature, for instance Bhattacharya and Patnaik (2013), the magnitude of change in the model is large.

Note that the estimated value of ϕ in the post-integration period is 0.08, thus is in Region I. In this region, the volatilities of output and consumption increases as ϕ goes down, which is consistent with the empirical fact that emerging market economies experience more volatile business cycles after financial integration.

The agreement of the model prediction with the experience of emerging economies follows from the counter co-movement of both leverage and external financing premium with ϕ. Figures 9 and 10 plot the steady state values of leverage and external financing premium as a function of ϕ. The figures show that a reduction in ϕ raises both the leverage and external financing premium. Evidently, borrowers increase their leverages once borrowing cost goes down. Yet, an increasing leverage comes at the cost of a higher financing premium. The is because higher efficiency loss must be incurred as increasing value of credits are intermediated through a frictional financial market.

It is the increasing leverage coupled with financial frictions that explain higher volatilities when ϕ goes down, as observed in Region I. Consider the net worth accumulation process

$$\begin{aligned} N_t =& \gamma\Big\{R_t^m q_{t-1}M_{t-1} - R_{t-1}^*(q_{t-1}M_{t-1} - N_{t-1}) - \mu\int_0^{\bar{\omega}_t}\omega_t dF(\omega_t)R_t^m q_{t-1}M_{t-1}\Big\} + W^e \\ =& \gamma V_t + W^e, \end{aligned} \tag{31}$$

where V_t is the equity held by importers at t. Let $U_t^{rm} \equiv R_t^m - \mathrm{E}_{t-1}\{R_t^m\}$ denotes the unexpected shift in the gross return to M. Differentiating V_t with respect to U_t^{rm} yields

$$\frac{\partial V_t/\mathrm{E}_{t-1}\{V_t\}}{\partial U_t^{rm}/\mathrm{E}_{t-1}\{R_t^m\}} = \frac{\mathrm{E}_{t-1}\{R_t^m\}q_{t-1}M_{t-1}}{\mathrm{E}_{t-1}\{V_t\}}, \tag{32}$$

which represents the ratio of the percentage change in the importer's equity to the percentage change in the return to M. This ratio depends on the leverage of the importer. To the extent that the importer is more leveraged, this ratio is higher. In this case, an unexpected change in the asset price leads to a more than proportional change in net worth, and hence a more than proportional change in output, consumption and so forth. This summarizes the mechanism that gives rise to higher fluctuations. The mechanism is dubbed "leverage channel" in the spirit of the financial accelerator from Bernanke, Gertler, and Gilchrist (1999).

In Region II, the model predicts decreasing standard deviations of output and consumption when ϕ goes down. At first glance, this might be somewhat surprising, because this is the characteristic of industrial economies. Note that in Region II, the value of ϕ is large. In this case, borrowers' leverage and the measured financial friction stay at very low level.[11] Therefore, the leverage channel plays a negligible role in this region. Intuitively, this is because when the borrowing premium is too large, firms are discouraged from borrowing or taking leverage. As a result, the domestic financial market is not functioning.

In this region, conventional smoothing effect of financial integration plays the predominant role. Consider the terms of trade shock. According to Bhattacharya, Patnaik, and Pundit (2013), financial integration affects the extent to which the economy can absorb external shocks. This can be seen from the resource constraint

$$C_t^m + q_t M_t + R_{t-1}^* B_{t-1} + d_t = Y_t^m + B_t. \tag{33}$$

With low level of financial integration (big ϕ), the economy cannot borrow or lend freely to help smooth fluctuations in q_t. As a result, consumption and output must absorb the shock to keep trade balanced. When ϕ decreases, the economy is less constrained and can borrow and lend more freely to smooth shocks. Therefore, external terms of trade shocks are not transmitted to output and consumption. As a consequence, volatilities of output and consumption go down. This mechanism is dubbed the "smoothing channel". Note that the smoothing channel always exists along the financial integration path. However, it is dominated by the leverage channel in Region I.

To provide more insights to the mechanism, I perform detailed analysis of impulse responses of the model. Figure 11 plots the impulse response of net worth to a one standard deviation increase in the innovations to q for different values of ϕ. A visual inspection suggests that ϕ affects the magnitude and persistence of the impulse responses in a non-monotonous way. Table 9 reports the standard deviations of output, consumption, and investment with the terms of trade shock only. The table shows that all of the second moments display V-shaped pattern across values of ϕ. The results imply that the impact of terms of trade shock on the economy is subject to both the leverage

[11] See Figure 9 and 10.

and smoothing channel.

Figure 12 plots the impulse response of net worth to a one standard deviation increase in the innovation to z^m for different values of ϕ. Generally, with an one standard deviation increase in the TFP, net worth rises. When the value of ϕ is lower, net worth rises more and is more persistent, suggesting higher volatilities. Table 10 reports the standard deviations of output, consumption, and investment with the TFP shock only. All of them increase with decreasing values of ϕ. The results imply that the leverage channel is much more important for an internal shock such as the TFP shock.

To sum up, the effects of financial integration on business cycles depend on the interactions between the leverage and smoothing channel. When the leverage channel dominates, a reduction in ϕ results in an increase in volatilities (Region I). When the smoothing channel prevails, a reduction in ϕ smooths fluctuations (Region II). The predictions of the model match the experiences of both emerging and industrial economies. For emerging market economies, the leverage channel dominates, and we observe rising volatilities in the post integration period. For industrial economies, the smoothing channel outweighs the leverage channel, and financial integration reduces the volatility of business cycles.

7 Extended Discussion: Financial Development and Financial Integration

So far the discussion assumes that financial integration does not directly affect the financial development in emerging market economies. However, exposure to international capital flows can spur a country's financial sector development. As a result, domestic financial market develops even without the direct inflows of foreign capital. This type of benefit is called the "collateral benefit".[12]

As in Arellano, Bai, and Zhang (2012), financial development can be modeled as a reduction in the monitoring cost μ of the banking sector. The monitoring cost arises because of poor financial supervision or low efficiency of financial intermediates. The monitoring cost generates frictions in

[12] See Prasad and Rajan (2008) for a detailed discussion about capital account liberalization and its collateral benefit.

the financial market. The external financing premium that measures the degree of financial frictions can be written as

$$R_t^m - R_t^* = \frac{\mu \int_0^{\bar{\omega}_{t+1}} \omega_{t+1} dF(\omega_{t+1}) R_{t+1}^m q_t M_t}{q_t M_t - N_t}, \tag{34}$$

which depends on the value of μ. A decrease in the monitoring cost μ reduces this premium and hence the frictions in the financial market.

The standard deviation σ_ω of the lognormal distribution of the idiosyncratic disturbance also affects financial development. The value of σ_ω measures the difficulty for lenders to monitor the state of borrowers. When σ_ω approaches zero, the asymmetric information between borrowers and lenders disappears. Therefore, lower value of σ_ω implies a more efficient domestic financial market.

Figures 13 and 14 plot the steady state leverage and external financing premium as a function of μ and σ_ω. In Figure 13, as μ and σ_ω get lower, optimal leverage rises. Meanwhile, as shown in Figure 14, external financial premium decreases. The figures show that financial development reduces financial frictions and encourages firms to raise leverage. Recall that in Figure 9 and 10, financial integration increases firms' leverage, but with the cost of raising financial frictions.

Therefore, it is expected that changes in the level of financial development affect business cycles differently from changes in the level of financial integration. Figures 15 and 16 plot the standard deviations of output and consumption as a function of μ and σ_ω. In both figures, as μ and σ_ω get lower, volatilities go down. This is because an improvement of financial development reduces the degree of financial frictions in the domestic economy. The latter leads to less volatile business cycles.

8 Robustness Analysis

The model in previous sections assumes that the household aggregate borrowing and saving are zero so that the only channel that financial integration affects the economy is through the importer-bank connection. In light of this, it is important to explore to which extent this assumption affects the model mechanism.

To this end, I build an extended model, in which the population is splitted into two types: patient households and impatient importers. Patient households supply labor and capital to the good producers, and become net savers in this economy. Impatient importers borrow and import raw goods from the rest of the world. The population share of patient households is π_s, and that of the impatient importers is $1 - \pi_s$. Banks collect deposits from both international and domestic savers and make loans to impatient importers. As before, distributors and domestic good producers produce final goods that are readily consumable.

8.1 Model Features

The patient household, denoted by a subscript s, solves the the following problem:

$$\max \quad E_0 \sum_{t=0}^{\infty} \beta_s^t U(C_{st}^d, C_{st}^m, H_{st}), \tag{35}$$

subject to

$$C_{st}^m + p_t(C_{st}^d + X_{st}) + S_t = p_t(w_t H_{st} + r_t K_{st}) + R_{t-1}^h S_{t-1} + \Theta_{st}^{tran}, \tag{36}$$

$$K_{st+1} = \Phi\left(\frac{X_{st}}{K_{st}}\right) K_{st} + (1-\delta) K_{st}, \tag{37}$$

where Eqs. (36) and (37) denote the budget constraint and capital accumulation process, respectively. The term S_t denotes household savings at period t and R_t^h is the interest rate faced by domestic savers. Alongside the income from wages and capital returns, patient households also receive net transfers from good producers Θ_{st}^{tran}.

The impatient household, denoted by a subscript i, solves the the following problem:

$$\max \quad E_0 \sum_{t=0}^{\infty} \beta_i^t U(C_{it}^d, C_{it}^m), \tag{38}$$

subject to the budget constraint and bank's break-even condition

$$C_{it}^m + p_t C_{it}^d + q_t M_{it} + \Gamma(\bar{\omega}_t) R_t^m q_{t-1} M_{it-1} = R_t^m q_{t-1} M_{it-1} + D_t, \tag{39}$$

$$[\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})] R_{t+1}^m q_t M_{it} = R_t^*(D_t - S_t) + R_t^h S_t, \tag{40}$$

where $G(\bar{\omega}_{t+1}) \equiv \int_0^{\bar{\omega}_{t+1}} \omega_{t+1} dF(\omega_{t+1})$ and $\Gamma(\bar{\omega}_{t+1}) \equiv \big[1 - F(\bar{\omega}_{t+1})\big]\bar{\omega}_{t+1} + G(\bar{\omega}_{t+1})$.

Formally, the impatient importer discounts the future more than the patient household. For this, the discount factors satisfy $\beta_i < \beta_s$. This implies that importers consume earlier than households, preventing importers from becoming self-financed. In the budget constraint, the term $\Gamma(\bar{\omega}_t) R_t^m q_{t-1} M_{it-1}$ represents expected repayment to the bank which depends on the realized value of ω. The term D_t denotes the amount of loans that the importer takes from the bank. In the bank's break-even condition, the right hand side represents the cost of raising funds from domestic and international savers. Here, it is assumed that the bank first collects deposits from domestic savers and then fills the credit gap from international funds. The interest rate charged by the international financial market is R_t^*.

I model the two interest rates following Schmitt-Grohé and Uribe (2003):

$$R_t^* = \bar{R} + \phi\big[\exp(B_t) - 1\big], \tag{41}$$

and

$$R_t^h = \bar{R} + \tilde{\phi}\big[\exp(S_t) - 1\big], \tag{42}$$

where $\phi > 0$ represents the international borrowing premium, and the constant parameter $\tilde{\phi} < 0$ induces stationarity. Specifying different interest rates is justified in the sense that the economy is only partially opened depending on the value of ϕ. An international financial integration process can be viewed as a reduction in ϕ, or an increase in $\tilde{\phi}$, or both at the same time. Given that the financial integration process is best presented as removing obstacles in obtaining credit, the key parameter determining the degree of international financial integration is still ϕ.

The production technology of domestic good producers and distributors are the same as before. Finally, I close the model by specifying the market clearing conditions for both types of goods

$$C_t^d + X_t = Y_t^d, \tag{43}$$

$$C_t^m + q_t M_t + d_t + R_{t-1}^* B_{t-1} - B_t = Y_t^m. \tag{44}$$

8.2 Model Performances

The model is estimated with the inclusion of $\tilde{\phi}$. The two additional parameters π_s and β_i are calibrated as 0.5 and 0.97 respectively.[13] All other parameters are calibrated in line with the original model.

Table 11 reports the estimated parameter values. The estimated ϕ is 0.099, which is near the value obtained in the original model. The estimated $\tilde{\phi}$ is large at -10.854. However, its standard error implies that $\tilde{\phi}$ does not have significant impact on the model moments.

Table 12 shows the model moments. It targets well the second moments of output, as well as the relative volatility between investment and output. All other moments remain consistent with those obtained in the estimation of original model in terms of signs and magnitudes.

Table 13 reports the standard deviations of output, consumption, and investment across different values of ϕ. The moments are computed with parameters calibrated and estimated as above. As shown from the table, the patterns of second moments still exhibit the V-shape pattern as before. Therefore, the leverage and smoothing channel of the original model are robust to the inclusion of household savings and borrowings.

9 Concluding Remarks

To summarize, this paper develops a small open economy real business cycle model with financial frictions to study the distinctive features of business cycles in emerging markets economies. The model incorporates domestic financial imperfections as a variant of financial accelerator. The model introduces two channels that characterize the effects of international financial integration, the leverage channel and the smoothing channel. The leverage channel reflects financial frictions in amplifying and propagating shocks. As international financial integration lowers the cost to obtain credit, borrowers are encouraged to borrow. As a consequence, the economy becomes more financially leveraged. More importantly, as borrowers in emerging markets increase their leverage,

[13] See other similar treatments of population share as in Iacoviello (2015). The value of β_i is calibrated to satisfy $\beta_i < \beta_s$.

financial frictions also increase. The latter leads to more volatile business cycles. The smoothing channel reflects the conventional wisdom of financial integration; countries that are more financially integrated can better smooth fluctuations. Whether the leverage channel or the smoothing channel dominates depends on the degree of financial frictions in the domestic financial market. Consistent with empirical data, the model predicts that financial integration stabilizes business cycles when the country has a well developed financial market, but increases the economic volatility when the domestic financial market is imperfect.

In the future, it would be interesting to explore some extensions to the present model. In its current form, the international financial market is modeled as a reduced form. It may be worthwhile to model the international financial market in more details. This may provide more accurate predictions about the effects of financial integration.

References

Adrian, T., P. Colla, and H. S. Shin (2012): "Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-09," Federal Reserve Bank of New York Staff Reports No. 528.

Aguiar, M. and G. Gopinath (2007): "Emerging Market Business Cycles: The Cycle is the Trend," *Journal of Political Economy*, 115, 69–102.

Arellano, C., Y. Bai, and J. Zhang (2012): "Firm Dynamics and Financial Development," *Journal of Monetary Economics*, 59, 533–549.

Baxter, M. and M. J. Crucini (1995): "Business Cycles and the Asset Structure of Foreign Trade," *International Economic Review*, 36, 821–854.

Bekaert, G., C. R. Harvey, and C. Lundblad (2005): "A Chronology of Important Financial, Economic and Political Events in Emerging Markets," http://people.duke.edu/~charvey/Country_risk/chronology/chronology_index.htm.

——— (2006): "Growth Volatility and Financial Liberalization," *Journal of International Money and Finance*, 25, 370–403.

Bernanke, B. and M. Gertler (1989): "Agency Costs, Net Worth, and Business Fluctuations," *American Economic Review*, 79, 14–31.

Bernanke, B., M. Gertler, and S. Gilchrist (1999): "The Financial Accelerator in a Quantitative Business Cycle Framework," in *Handbook of Macroeconomics*, ed. by J. B. Taylor and M. Woodford, North Holland, vol. 1, 1341–1393.

Bhattacharya, R. and I. Patnaik (2013): "Credit constraints, Productivity Shocks and Consumption Volatility in Emerging Economies," IMF Working Paper No. 13/120.

Bhattacharya, R., I. Patnaik, and M. Pundit (2013): "Emerging Economy Business Cycles: Financial Integration and Terms of Trade Shocks," IMF Working paper No. 13/119.

Blanchard, O. J. and C. M. Kahn (1980): "The Solution of Linear Difference Models Under Rational Expectations," *Econometrica*, 48, 1305–1311.

Boileau, M. and M. Normandin (2014): "The Price of Imported Capital and Consumption Fluctuations in Emerging Economies," Working paper.

Buch, C. M. and C. Pierdzioch (2005): "The Integration of Imperfect Financial Markets: Implications for Business Cycle Volatility," *Journal of Policy Modeling*, 27, 789–804.

Carlstrom, C. T. and T. S. Fuerst (1997): "Agency Costs, Net Worth, and Business Fluctuations: A Computable General Equilibrium Analysis," *American Economic Review*, 87, 893–910.

Chang, R. and A. Fernández (2013): "On the Sources of Aggregate Fluctuations in Emerging Economies," *International Economic Review*, 54, 1265–1293.

Driscoll, J. C. and A. C. Kraay (1998): "Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data," *Review of Economics and Statistics*, 80, 549–560.

Evans, M. D. and V. V. Hnatkovska (2007): "International Financial Integration and the Real Economy," *IMF Staff papers*, 54, 220–269.

Fernández, A. and A. Gulan (2015): "Interest Rates, Leverage, and Business Cycles in Emerging Economies: The Role of Financial Frictions," *American Economic Journal: Macroeconomics*, 7, 153–188.

García-Cicco, J., R. Pancrazi, and M. Uribe (2010): "Real Business Cycles in Emerging Countries?" *American Economic Review*, 100, 2510–2531.

Greenwood, J., Z. Hercowitz, and G. W. Huffman (1988): "Investment, Capacity Utilization, and the Real Business Cycle," *American Economic Review*, 78, 402–417.

Hall, R. E. (2010): "Why Does the Economy Fall to Pieces after a Financial Crisis?" *Journal of Economic Perspectives*, 24, 3–20.

——— (2012): "Financial Frictions," Prepared for the conference "New Frameworks for Monetary Policy Analysis in an Era of Crises", the Fourth annual IJCB fall conference.

Heathcote, J. and F. Perri (2004): "Financial Globalization and Real Regionalization," *Journal of Economic Theory*, 119, 207–243.

Hodrick, R. J. and E. C. Prescott (1997): "Postwar U.S. Business Cycles: An Empirical Investigation," *Journal of Money, Credit, and Banking*, 29, 1–16.

Iacoviello, M. (2015): "Financial business cycles," *Review of Economics Dynamics*, 18, 140–163.

Kiyotaki, N. and J. Moore (1997): "Credit Cycles," *Journal of Political Economy*, 105, 211–248.

Kose, M. A., E. S. Prasad, and M. E. Terrones (2003): "Financial Integration and Macroeconomic Volatility," *IMF Staff Papers*, 50, 119–142.

Lane, P. R. and G. M. Milesi-Ferretti (2007): "The External Wealth of Nations Mark II: Revised and Extended Estimates of Foreign Assets and Liabilities, 1970-2004," *Journal of International Economics*, 73, 223–250.

Mendoza, E. G. (1994): "The Robustness of Macroeconomic Indicators of Capital Mobility," in *Capital Mobility: The Impact on Consumption, Investment and Growth*, ed. by L. Leiderman and A. Razin, Cambridge University Press, 83–111.

Miyamoto, W. and T. L. Nguyen (2015): "Business Cycles in Small Open Economies: Evidence from Panel Data between 1900 and 2013," Working paper.

Modigliani, F. and M. H. Miller (1958): "The Cost of Capital, Corporation Finance and the Theory of Investment," *American Economic Review*, 48, 261–297.

Morris, J. R. (2009): "Life and Death of Businesses: A Review of Research on Firm Mortality," *Journal of Business Valuation and Economic Loss Analysis*, 4, 1–41.

Neumeyer, P. A. and F. Perri (2005): "Business Cycles in Emerging Economies: The Role of Interest Rates," *Journal of Monetary Economics*, 52, 345–380.

Prasad, E. S. and R. G. Rajan (2008): "A Pragmatic Approach to Capital Account Liberalization," *Journal of Economic Perspectives*, 22, 149–172.

Schmitt-Grohé, S. and M. Uribe (2003): "Closing Small Open Economy Models," *Journal of International Economics*, 61, 163–185.

Table 1. Business Cycles of Selected Countries

	$\sigma(C)/\sigma(Y)$		$\sigma(C)/\sigma(Y)$
EME		**Industrial E.**	
Brazil	1.32	Australia	0.96
Chile	1.87	Canada	0.73
Colombia	1.27	Finland	0.81
India	0.84	France	0.73
Indonesia	2.17	Germany	0.66
Korea	1.14	Italy	0.86
Malaysia	1.42	Japan	0.76
Mexico	1.27	Netherlands	0.93
Morocco	1.11	Portugal	0.95
Peru	1.07	Spain	1.08
Philippines	0.46	Sweden	0.87
South Africa	1.20	UK	1.00
Thailand	0.99	USA	0.83
Average	1.24	***Average***	0.86

Note: Annual data from World Bank database. $\sigma(C)$ denotes the standard deviation of private consumption and $\sigma(Y)$ denotes the standard deviation of GDP. EME stands for emerging market economy. Industrial E. stands for industrial economy. All series have been logged and detrended using HP filter.

Table 2. Number of Bank Branches per 100,000 Adults

EME		Industrial E.	
Argentina	13.31	Australia	30.89
Brazil	43.62	Austria	12.98
Chile	15.17	Brazil	50.26
Colombia	13.86	Canada	24.35
Egypt	4.22	Denmark	48.35
Hong Kong	23.43	Finland	15.28
India	9.45	France	38.02
Indonesia	6.52	Germany	17.46
Israel	19.70	Greece	38.41
Korea	18.17	Ireland	32.91
Malaysia	11.07	Italy	66.31
Mexico	12.81	Japan	34.12
Morocco	15.18	Netherlands	26.95
Pakistan	8.02	New Zealand	34.93
Peru	25.94	Norway	11.73
Philippines	7.90	Portugal	65.62
Singapore	10.8	Spain	99.80
South Africa	7.94	Sweden	23.42
Thailand	9.71	Switzerland	54.34
Turkey	15.78	UK	26.72
Venezuela	16.97	USA	34.45
Average	14.75	***Average***	37.49

Note: Data from Global Financial Development database. The number of bank branches per 100,000 adults measures the access to financial institutions. EME stands for emerging market economy. Industrial E. stands for industrial economy.

Table 3. Percentage of Firms Identifying Access to Finance as a Constraint

Region	Percentage
Euro Area	14.28
Europe & Central Asia (developing only)	24.37
Latin America	37.56
Middle Income	27.24
Low & Middle Income	35.43

Note: Data from Global Financial Development database.

Table 4. Timing of Financial Integration

Country	Year	Country	Year
Argentina	1993	Brazil	1991
Chile	1992	Colombia	1991
Korea	1992	Malaysia	1988
Mexico	1989	Peru	1991
Philippines	1991	South Africa	1984
Thailand	1987	Turkey	1989
Ecuador	1986		

Note: Data from Bekaert, Harvey, and Lundblad (2005).

Table 5. Calibration of Basic Parameters

Parameters	Description	Value	Target
β	Discount factor	0.98	Average annual interest of 8%
θ	inverse of Frisch elasticity of labor supply	0.65	Labor supply elasticity of 1.7%
κ	Value of risk averse	2	Common in SOE literature
ψ	Relative importance of leisure	1.6	Agent spends 1/3 time on working
ρ	Elasticity of substitution $1/(1-\rho)$	0.5	Common in macro literature
α_d	Capital income share	0.33	Standard capital share of 0.3
α_m	Distributor production function	0.33	Benchmark production tech.
δ	Capital depreciation rate	0.02	Ave. investment ratio is 17%
μ	Monitoring cost	0.32	Fernández and Gulan (2015)
π	Share of foreign good in consumption	0.5	Benchmark consumption share
γ	Survival rate of importers	0.97	BGG
σ_ω	Standard deviation of $F(\mu_\omega, \sigma_\omega)$	0.3	Leverage is around 1.6

Table 6. Model Moments

Moment	EME		Model	
Panel A. targeted moments				
$\sigma(Y)$	3.13	(0.003)	3.78	(0.220)
$\sigma(C)/\sigma(Y)$	1.31	(0.004)	1.40	(0.032)
$\sigma(X)/\sigma(Y)$	3.95	(0.014)	3.07	(0.306)
$\rho(C, Y)$	0.78	(0.054)	0.95	(0.010)
$\rho(X, Y)$	0.64	(0.063)	0.82	(0.050)
$\rho(TB, Y)$	-0.34	(0.086)	-0.34	(0.029)
$\rho(R^*, Y)$	-0.39	(0.052)	-0.34	(0.048)
$\sigma(TB)$	2.86	(0.003)	1.48	(0.327)
$\sigma(R^*)$	0.87	(0.000)	0.19	(0.032)
Panel B. other moments				
$\rho(R^*, C)$	-0.39	(0.088)	-0.51	(0.108)
$\rho(R^*, X)$	-0.35	(0.057)	-0.50	(0.060)
$\rho(R^*, TB)$	0.29	(0.096)	-0.37	(0.082)
$\rho(TB, C)$	-0.68	(0.057)	-0.40	(0.072)
$\rho(TB, X)$	-0.71	(0.053)	-0.55	(0.101)

Note: $\sigma(\cdot)$ is the standard deviation of the variable in the bracket and $\rho(\cdot, \cdot)$ is the correlation of variables in the bracket. Standard errors of estimation are reported in the brackets. See Appendix A for data sources.

Table 7. Estimated Parameters

Parameter	ϕ	ξ	ρ_m	ρ_q	σ_υ	σ_ς
Estimated value	0.080	2.873	0.994	0.890	0.020	0.102
	(0.012)	(1.264)	(0.010)	(0.218)	(0.002)	(0.015)

Note: Standard errors of estimation are reported in the brackets.

Table 8. Variance Decomposition

Shock	Y	C	X	TB	R
z^m	55.11	25.05	6.50	0.90	1.02
q	44.89	74.95	93.50	99.10	98.98

Note: Entries are contributions of innovations to TFP and the terms of trade to the variance of selected macroeconomic variables. The selected variables are logged and detrended output, consumption, investment, interest rate and detrended trade balance. The variance decomposition is performed on the estimated model.

Table 9. Business Cycles with Financial Integration: Terms of Trade Shock

	$\phi = 0.5$	$\phi = 0.3$	$\phi = 0.1$	$\phi = 0.05$	$\phi = 0.0$
Std. Deviation					
$\sigma(Y)$	2.69	2.55	2.50	2.55	2.58
$\sigma(C)$	4.69	4.58	4.55	4.59	4.61
$\sigma(X)$	11.57	11.26	11.17	11.27	11.35
Correlation with Y					
$\rho(C, Y)$	0.99	0.99	0.99	0.99	0.99
$\rho(X, Y)$	0.99	0.99	0.99	0.99	0.99
$\rho(R^*, Y)$	-0.59	-0.61	-0.62	-0.61	-
$\rho(\text{TB}, Y)$	-0.53	-0.51	-0.50	-0.50	-0.50

Note: $\sigma(\cdot)$ is the standard deviation of the variable in the bracket and $\rho(\cdot, \cdot)$ is the correlation of variables in the bracket. Entries are computed based on the estimated model by shutting down the TFP shock.

Table 10. Business Cycles with Financial Integration: TFP Shock

	$\phi = 0.5$	$\phi = 0.3$	$\phi = 0.1$	$\phi = 0.05$	$\phi = 0.0$
Std. Deviation					
$\sigma(Y)$	2.76	2.77	2.79	2.80	2.81
$\sigma(C)$	2.60	2.62	2.64	2.64	2.65
$\sigma(X)$	2.87	2.90	2.95	2.97	2.99
Correlation with Y					
$\rho(C, Y)$	0.99	0.99	0.99	0.99	0.99
$\rho(X, Y)$	0.95	0.95	0.95	0.95	0.95
$\rho(R^*, Y)$	0.89	0.93	0.96	0.94	-
$\rho(\text{TB}, Y)$	0.01	-0.03	-0.09	-0.11	-0.13

Note: $\sigma(\cdot)$ is the standard deviation of the variable in the bracket and $\rho(\cdot, \cdot)$ is the correlation of variables in the bracket. Entries are computed based on the estimated model by shutting down the terms of trade shock.

Table 11. Extended Model: Estimated Parameters

Parameter	ϕ	$\tilde{\phi}$	ξ	ρ_m	ρ_q	σ_υ	σ_ς
Estimated value	0.099	-10.854	17.293	0.993	0.986	0.019	0.123
	(0.0185)	(12.623)	(14.424)	(0.024)	(0.023)	(0.002)	(0.009)

Note: Standard errors of estimation are reported in the brackets.

Table 12. Extended Model: Model Moments

Targeted Moments			Non-targeted Moments		
$\sigma(Y)$	3.78	(0.265)	$\rho(R^*, C)$	-0.67	(0.094)
$\sigma(C)/\sigma(Y)$	1.68	(0.067)	$\rho(R^*, X)$	-0.35	(0.244)
$\sigma(X)/\sigma(Y)$	3.58	(0.384)	$\rho(R^*, TB)$	-0.30	(0.038)
$\rho(C, Y)$	0.90	(0.025)	$\rho(TB, C)$	-0.28	(0.112)
$\rho(X, Y)$	0.78	(0.063)	$\rho(TB, X)$	-0.72	(0.137)
$\rho(TB, Y)$	-0.30	(0.059)			
$\rho(R^*, Y)$	-0.35	(0.077)			
$\sigma(TB)$	1.79	(0.227)			
$\sigma(R^*)$	0.27	(0.044)			

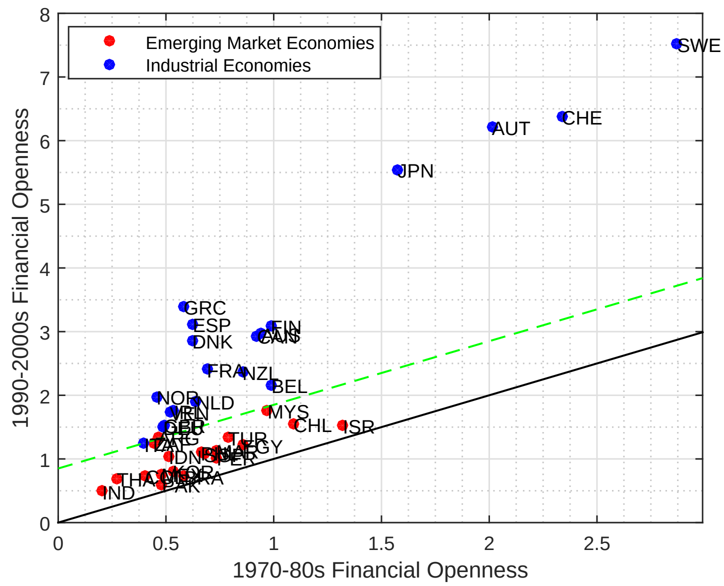
Note: $\sigma(\cdot)$ is the standard deviation of the variable in the bracket and $\rho(\cdot,\cdot)$ is the correlation of variables in the bracket. Standard errors of estimation are reported in the brackets. See Appendix A for data sources.

Table 13. Extended Model: Business Cycles with Financial Integration

	$\phi = 0.5$	$\phi = 0.3$	$\phi = 0.2$	$\phi = 0.1$	$\phi = 0.05$	$\phi = 0.0$
Std. Deviation						
$\sigma(Y)$	3.87	3.77	3.72	3.78	3.81	3.83
$\sigma(C)$	6.44	6.34	6.30	6.36	6.40	6.41
$\sigma(X)$	13.88	13.52	13.36	13.54	13.65	13.71

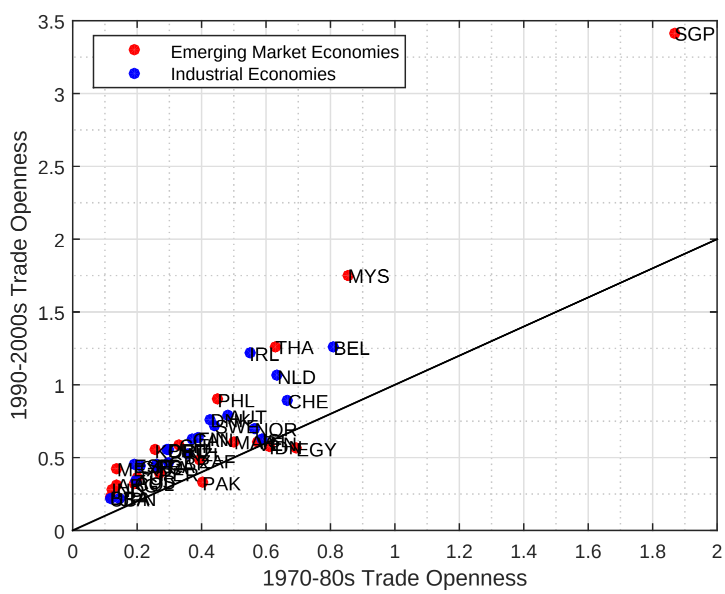
Note: $\sigma(\cdot)$ is the standard deviation of the variable in the bracket and $\rho(\cdot,\cdot)$ is the correlation of variables in the bracket. Entries are computed based on the estimated model in the robustness analysis.

Figure 1. Change in Financial Openness



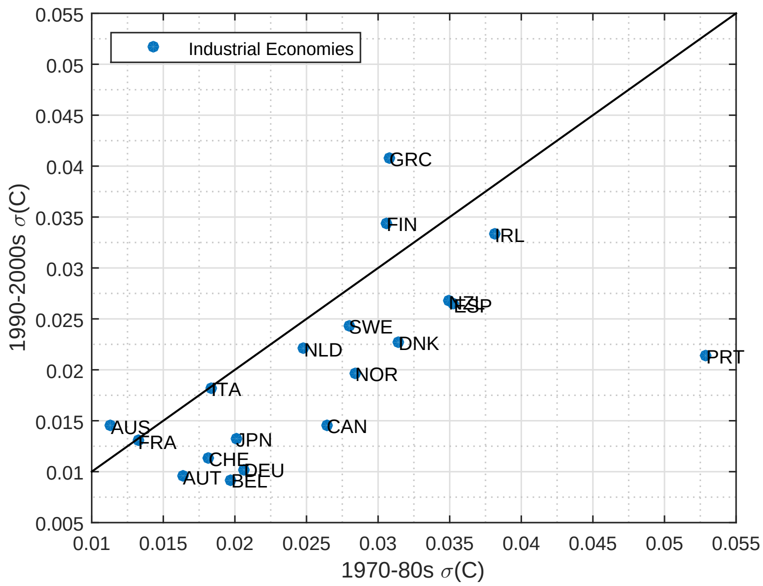
Note: Data from Lane and Milesi-Ferretti (2007). Financial openness is measured as the ratio of the sum of external assets and liabilities to GDP. Simple averages are taken across years. The annual data is from 1971 to 2010. The 45 degree straight line represents the benchmark, *i.e.*, no change before and after.

Figure 2. Change in Trade Openness



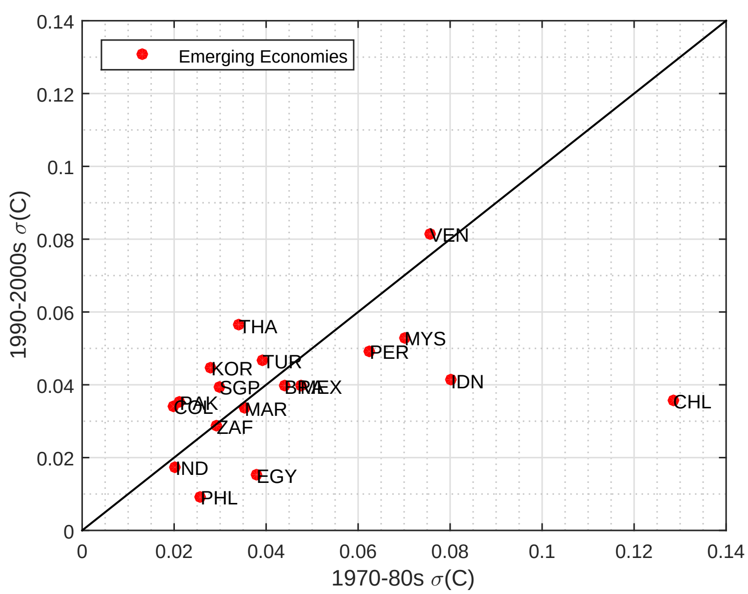
Note: Data from World Bank database. Trade openness is computed as the sum of exports and imports as a percentage of GDP. Simple averages are taken across years. The annual data is from 1971 to 2010. The 45 degree straight line represents the benchmark, *i.e.*, no change before and after.

Figure 3. Change in Consumption Volatility: Industrial Economies



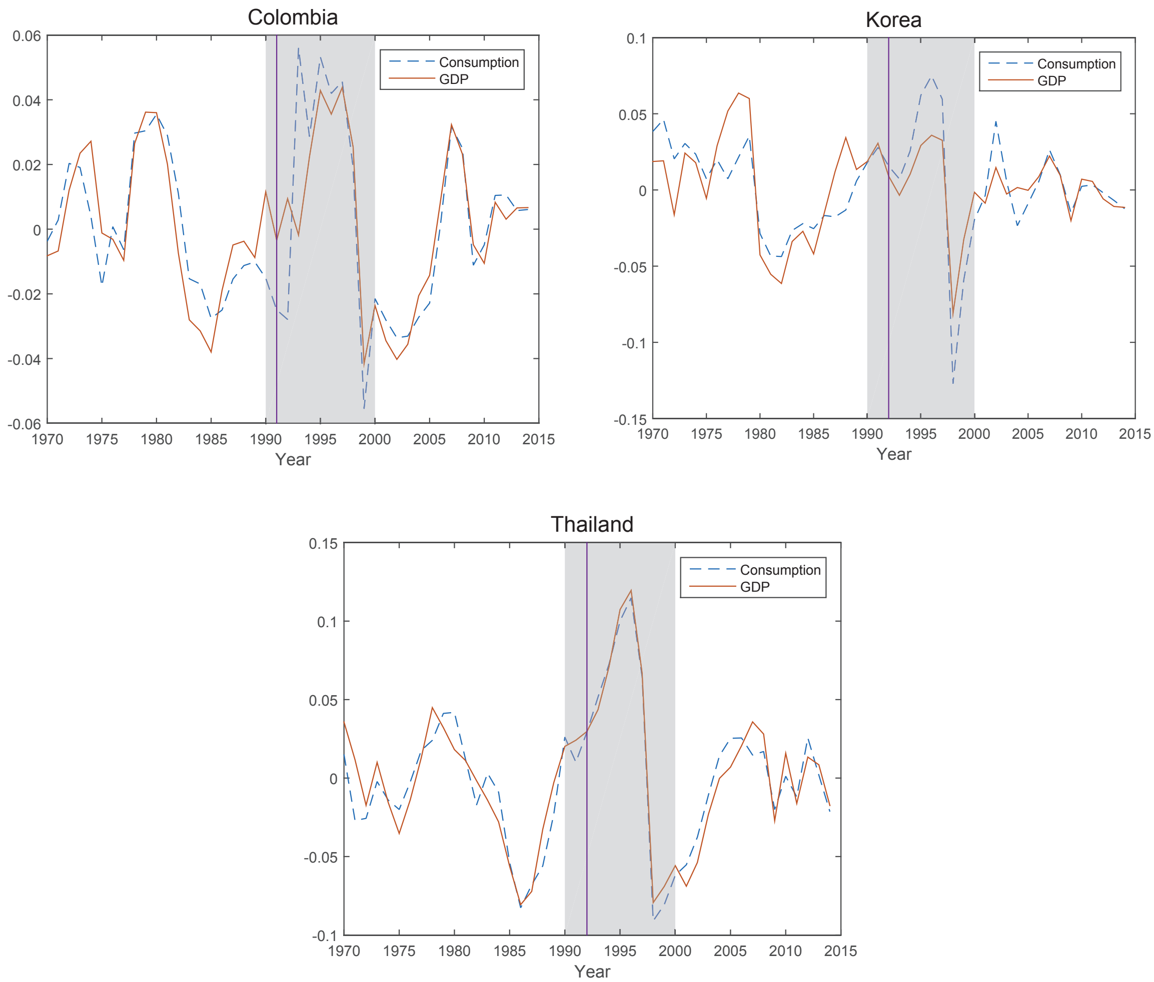
Note: Data from World Bank database. $\sigma(C)$ is the standard deviation of private consumption. All series have been logged and detrended using HP filter. Annual data from 1971 to 2010. The 45 degree straight line represents benchmark, *i.e.*, no change before and after.

Figure 4. Change in Consumption Volatility: Emerging Market Economies



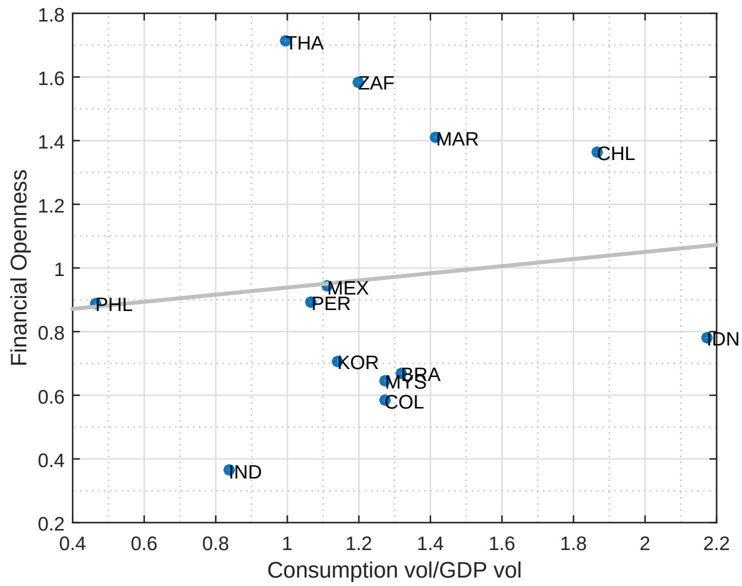
Note: Data from World Bank database. $\sigma(C)$ is the standard deviation of private consumption. All series have been logged and detrended using HP filter. The annual data is from 1971 to 2010. The 45 degree straight line represents the benchmark, *i.e.*, no change before and after.

Figure 5. Cyclical Patterns



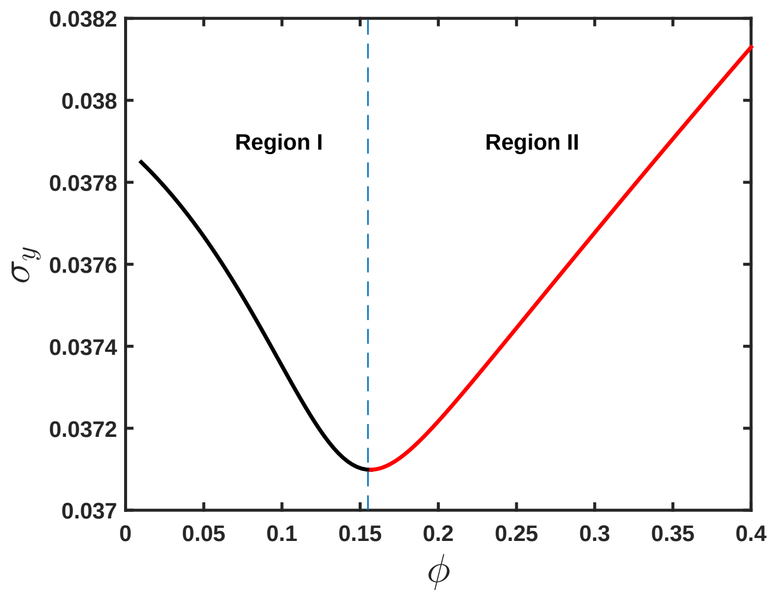
Note: Data from World Bank database. Figures show the cyclical components of private consumption and GDP. All series have been logged and detrended using HP filter. The annual data is from 1971 to 2013. Shaded area denotes the decade of 1990. The straight line represents the year in which the country became fully integrated according to Bekaert, Harvey, and Lundblad (2005).

Figure 6. Financial Openness and Consumption Volatility



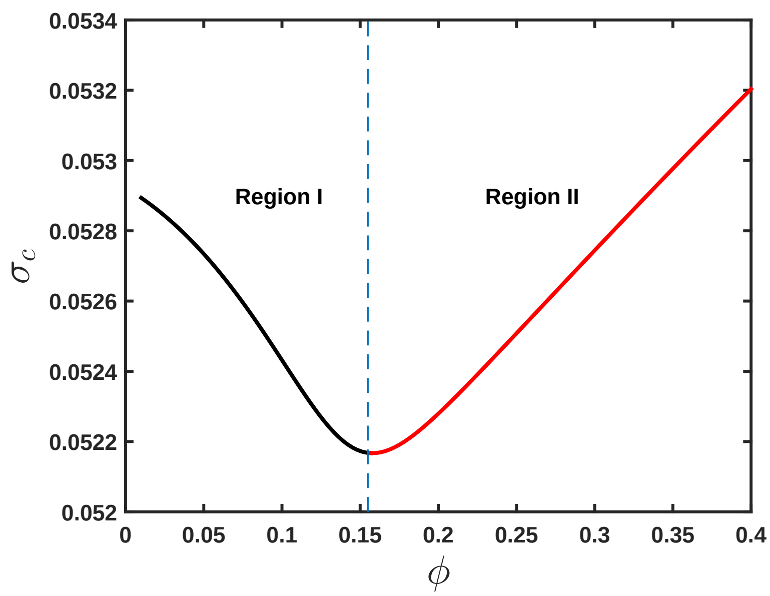
Note: Data from World Bank database and Lane and Milesi-Ferretti (2007). Financial openness is computed as the ratio of the sum of external assets and liabilities to GDP. The straight line is the least square fitted line.

Figure 7. Financial Integration and Output Volatility



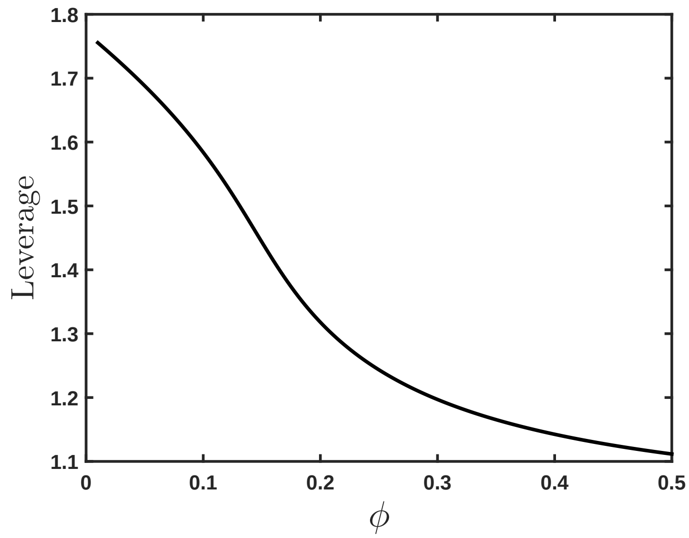
Note: Axises denote the estimated value of ϕ and the standard deviation of output.

Figure 8. Financial Integraiton and Consumption Volatility



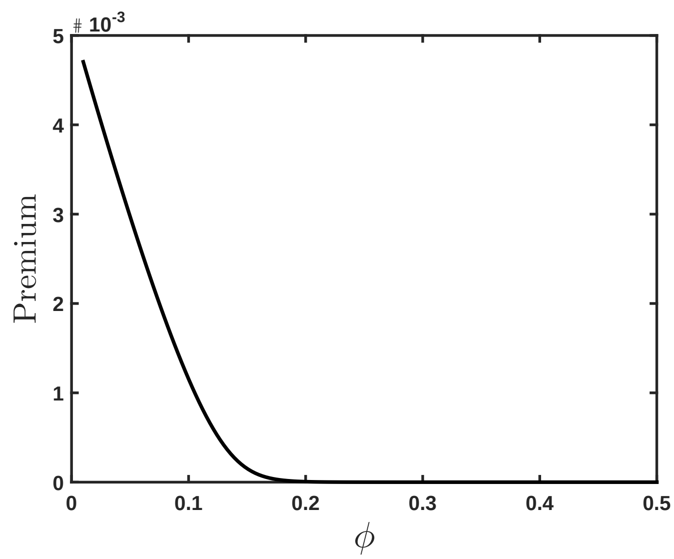
Note: Axises denote the estimated value of ϕ and the standard deviation of consumption.

Figure 9. Financial Integration and Steady State Leverage



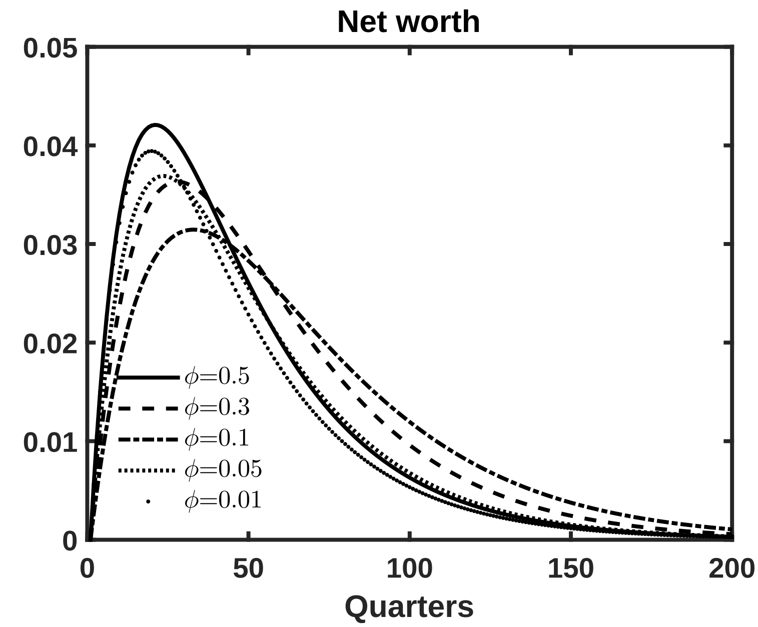
Note: Axises denote the estimated value of ϕ and the steady state value of leverage.

Figure 10. Financial Integration and Steady State Premium



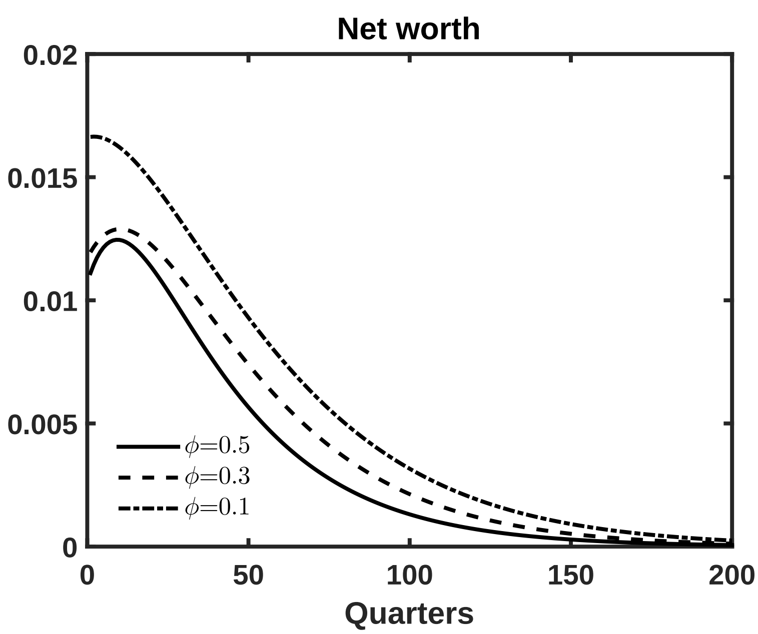
Note: Axises denote the estimated value of ϕ and the steady state value of external financing premium.

Figure 11. Impulse Response of Terms of Trade Shock



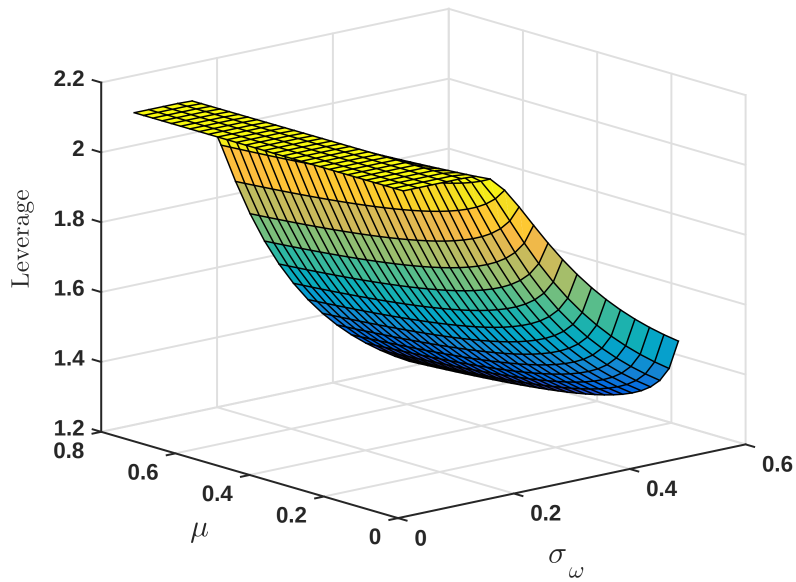
Note: Responses of net worth following a one standard deviation increase in innovations to terms of trade for different values of ϕ.

Figure 12. Impulse Response of TFP Shock



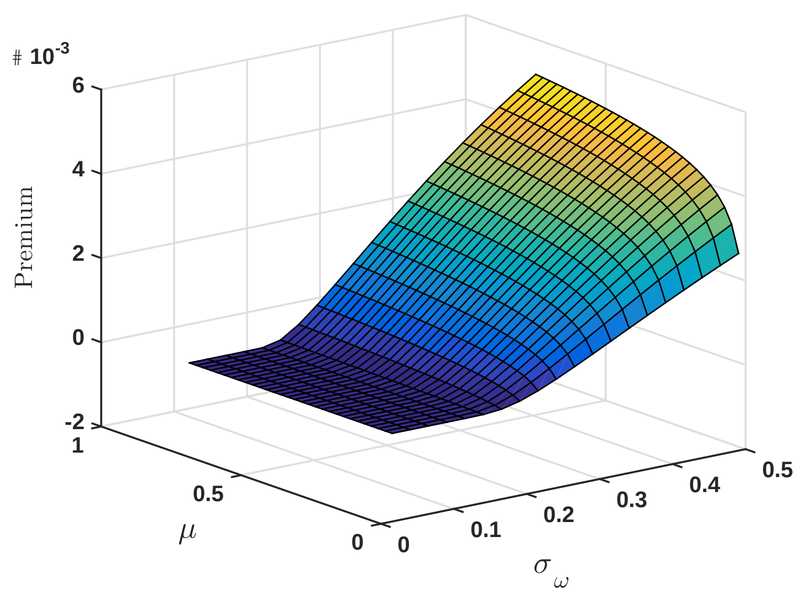
Note: Responses of net worth following a one standard deviation increase in innovations to TFP for different values of ϕ.

Figure 13. Financial Integration and Steady State Leverage



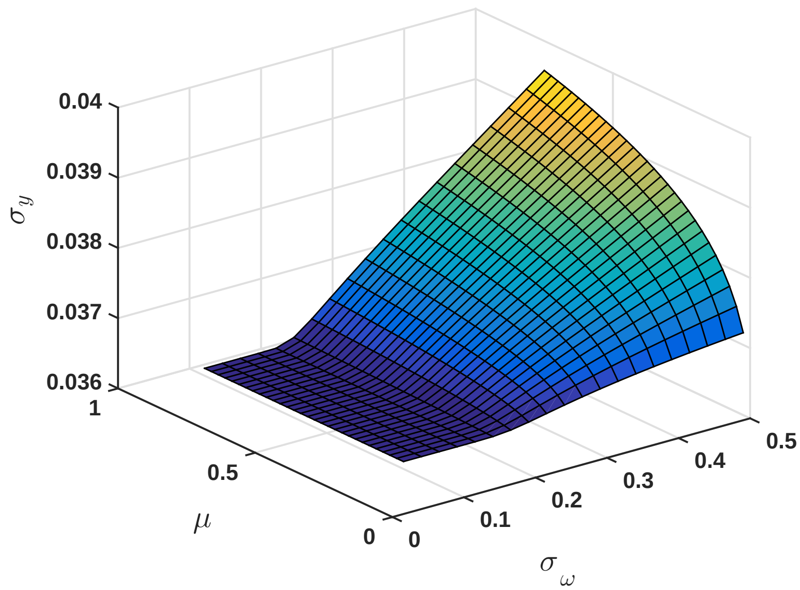
Note: Three-dimensional plot of steady state leverage as a function of μ and σ_ω.

Figure 14. Financial Integration and Steady State Premium



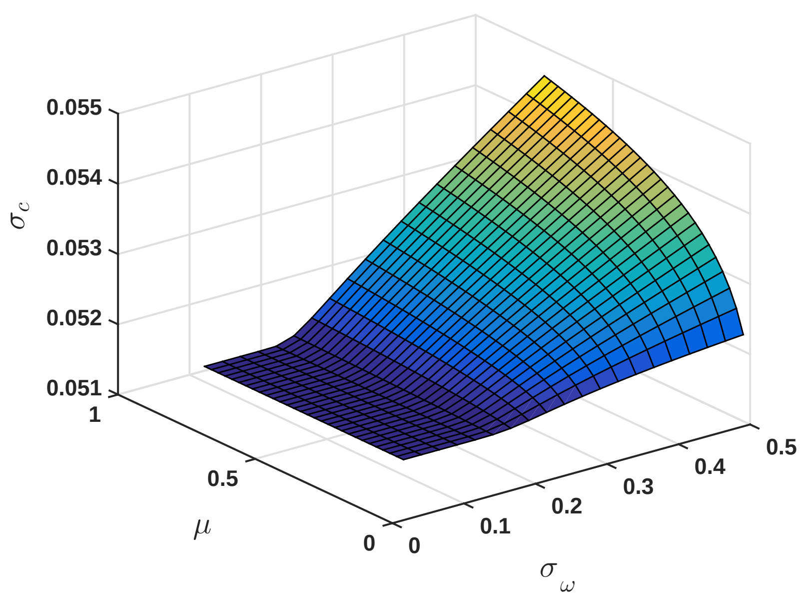
Note: Three-dimensional plot of steady state external financing premium as a function of μ and σ_ω.

Figure 15. Financial Development and Output Volatility



Note: Three-dimensional plot of standard deviation of output across values of μ and σ_ω.

Figure 16. Financial Development and Consumption Volatility



Note: Three-dimensional plot of standard deviation of consumption across values of μ and σ_ω.

Appendix A Data

A.1 Data in Summary of Empirical Analysis

The emerging market economies in Section 2 are: Argentina (ARG), Brazil (BRA), Chile (CHL), Colombia (COL), Egypt (EGY), India (IND), Indonesia (IDN), Israel (ISR), Korea (KOR), Malaysia (MYS), Mexico (MEX), Morocco (MAR), Pakistan (PAK), Peru (PER), Philippines (PHL), Singapore (SGP), South Africa (ZAF), Thailand (THA), Turkey (TUR), and Venezuela (VEN). These countries are developing countries but are relatively more financially opened according to Kose, Prasad, and Terrones (2003).

The industrial economies in Section 2 are: Australia (AUS), Austria (AUT), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Ireland (IRL), Italy (ITA), Japan (JPN), Netherlands (NLD), New Zealand (NZL), Norway (NOR), Portugal (PRT), Spain (ESP), Sweden (SWE), Switzerland (CHE), United Kingdom (GBR), and United States (USA). The source of National Account data, including output, investment and consumption, is World Bank. The annual data covers the 1971 to 2010 period.

The source of trade openness data is World Bank. Trade openness is measured as (exports+imports)/GDP. The source of financial openness data is Lane and Milesi-Ferretti (2007). Financial openness is measured as the ratio of the sum of external assets and liabilities to the GDP.

A.2 Data in Estimation

Due to data limitation, the estimation is performed on a subset of countries. The subset of countries include Argentina, Brazil, Chile, Colombia, Ecuador, Korea, Malaysia, Mexico, Peru, Philippines, South Africa, Thailand, and Turkey. The quarterly data is from 1993 Q4 to 2011 Q4. The dataset contains data from the International Monetary Fund's International Financial Statistics, and from EMBI (Emerging Market Bond Index), whose original source is Bloomberg. In this paper, the data on EMBI is from Fernández and Gulan (2015).

Following Fernández and Gulan (2015), the country's real interest rates are constructed as a product between country specific EMBI spreads and the 3-Month real US T-Bill rate. Because EMBI data is reported at a higher frequency, the quarterly frequency is constructed as a simple average.

Appendix B Timing

The timing of importers is:

At time t,

- importers get paid R_t^m from selling imported goods M_{t-1} to distributors.
- importers learn the disturbance ω_t.
- importers pay back the bank either $\bar{\omega}_t R_t^m q_{t-1} M_{t-1}$ or $\omega_t R_t^m q_{t-1} M_{t-1}$.
- importers learn its net worth at time t $N_t = \max\{0, (\omega_t - \bar{\omega}_t) R_t^m q_{t-1} M_{t-1}\}$.
- importers decide how much M_t to buy with its net worth N_t and loans B_t.

The timing of banks is:

At time t,

- banks pay back $R_{t-1}^* B_{t-1}$ to its depositors.
- banks write the contract (zero-profit condition).
- banks lend B_t to importers and collect this much from depositors.

Appendix C Market Clearing Conditions

From the household's budget constraint

$$c_t^m + p_t(c_t^d + x_t) + R_{t-1} B_{t-1}^d = p_t(w_t l_t + r_t k_t) + B_t^d + \Xi_t + \Omega_t, \quad \text{(C.1)}$$

where the aggregate borrowing and lending among households is zero, we can get

$$
\begin{aligned}
& C_t^m + p_t(C_t^d + X_t) \\
&= p_t Y_t^d + \Xi_t + \Omega_t \\
&= p_t Y_t^d + \underbrace{Y_t^m - R_t^m q_{t-1} M_{t-1}}_{\text{profit}} + \underbrace{(1-\gamma)\big[1-\Gamma(\bar{\omega}_t)\big] R_t^m q_{t-1} M_{t-1} - W^e}_{\text{transfers}} \\
&= p_t Y_t^d + Y_t^m - \underbrace{\{\gamma\big[1-\Gamma(\bar{\omega}_t)\big] R_t^m q_{t-1} M_{t-1} + W^e\}}_{\text{net worth } N_t} - R_t^m q_{t-1} M_{t-1} + \big[1-\Gamma(\bar{\omega}_t)\big] R_t^m q_{t-1} M_{t-1} \\
&= p_t Y_t^d + Y_t^m - N_t - \{R_t^m q_{t-1} M_{t-1} - \big[1-\Gamma(\bar{\omega}_t)\big] R_t^m q_{t-1} M_{t-1}\} \\
&= p_t Y_t^d + Y_t^m - N_t - \Gamma(\bar{\omega}_t) R_t^m q_{t-1} M_{t-1} \\
&= p_t Y_t^d + Y_t^m - N_t - \Big\{\big[1-F(\bar{\omega}_{t+1})\big]\bar{\omega}_{t+1} + G(\bar{\omega}_{t+1})\Big\} R_t^m q_{t-1} M_{t-1} \\
&= p_t Y_t^d + Y_t^m - N_t - \Big\{\big[1-F(\bar{\omega}_t)\big]\bar{\omega}_t R_t^m q_{t-1} M_{t-1} + (1-\mu)\int_0^{\bar{\omega}_t} \omega_t dF(\omega_t) R_t^m q_{t-1} M_{t-1} + d_t\Big\} \\
&= p_t Y_t^d + Y_t^m - N_t - \Big\{R_{t-1}^* B_{t-1} + d_t\Big\} \\
&= p_t Y_t^d + Y_t^m \underbrace{- N_t - R_{t-1}^* B_{t-1}}_{\text{export } EX_t} - d_t.
\end{aligned}
\tag{C.2}
$$

Therefore (assuming domestic good is non-tradable),

$$C_t^d + X_t = Y_t^d, \tag{C.3}$$

$$C_t^m = Y_t^m - N_t - R_{t-1}^* B_{t-1} - d_t. \tag{C.4}$$

Each period this economy borrows B_t and pays back $R^*_{t_1} B_{t-1}$. Then net exports are

$$
\begin{aligned}
NX_t &= R^*_{t-1} B_{t-1} - B_t \\
&= EX_t - IM_t \\
&= \underbrace{N_t + R^*_{t-1} B_{t-1}}_{\text{export}} - \underbrace{q_t M_t}_{\text{import}} \\
&= \underbrace{N_t + R^*_{t-1} B_{t-1}}_{\text{export}} - \underbrace{(N_t + B_t)}_{\text{import}} \\
&= R^*_{t-1} B_{t-1} - B_t.
\end{aligned} \tag{C.5}
$$

Net worth N_t is

$$
\begin{aligned}
N_t &= \gamma \big[1 - \Gamma(\bar{\omega}_t)\big] R^m_t q_{t-1} M_{t-1} + W^e \\
&= \gamma \Big\{ 1 - \big[1 - F(\bar{\omega}_t)\big] \bar{\omega}_t - G(\bar{\omega}_t) \Big\} R^m_t q_{t-1} M_{t-1} + W^e \\
&= \gamma \Big\{ 1 - \big[1 - F(\bar{\omega}_t)\big] \bar{\omega}_t - (1-\mu) G(\bar{\omega}_t) - \mu G(\bar{\omega}_t) \Big\} R^m_t q_{t-1} M_{t-1} + W^e \\
&= \gamma \Big\{ \big[1 - \mu G(\bar{\omega}_t)\big] R^m_t q_{t-1} M_{t-1} \underbrace{- \left[1 - F(\bar{\omega}_t)\right] \bar{\omega}_t R^m_t q_{t-1} M_{t-1} - (1-\mu) G(\bar{\omega}_t) R^m_t q_{t-1} M_{t-1}}_{R^*_{t-1} B_{t-1}} \Big\} + W^e \\
&= \gamma \Big\{ \big[1 - \mu G(\bar{\omega}_t)\big] R^m_t q_{t-1} M_{t-1} - R^*_{t-1} B_{t-1} \Big\} + W^e.
\end{aligned} \tag{C.6}
$$

Appendix D GMM Estimation

Because the dataset is an unbalanced panel, the estimator has to adjust for both autocorrelation and cross-correlation among countries. Therefore, I use Driscoll and Kraay (1998) estimator, which is a modification of the HAC estimator. The key input in the estimation is the set of p moment conditions

$$
\boldsymbol{M}(\Theta) = \left((1/T) \sum_{t=1}^{T} \frac{1}{N(t)} \sum_{i=1}^{N(t)} \boldsymbol{m}(\boldsymbol{x}_{i,t}) - E\left[\frac{1}{N(t)} \sum_{i=1}^{N(t)} \boldsymbol{m}_{i,t}(\boldsymbol{\Theta}) \right] \right), \tag{D.1}
$$

where $\{\boldsymbol{x}_{i,t}\}$ is a sample of T observations of data for country i, and $\boldsymbol{\Theta}$ denotes the unknown parameters. The estimator is the value of $\boldsymbol{\Theta}$ that minimize the distance between empirical moments and the theoretical moments predicted by the model.

The GMM estimator is

$$\hat{\Theta} = \text{argmin} \quad \boldsymbol{M}(\Theta)'\boldsymbol{W}\boldsymbol{M}(\Theta). \tag{D.2}$$

I use a usual two step to estimate. The first step is to use a identity weighting matrix and the second step uses a optimal weighting matrix to reestimate the model.

Appendix E Impulse Responses

Figure 17. Impulse Responses (Original Model): Shock to z^m

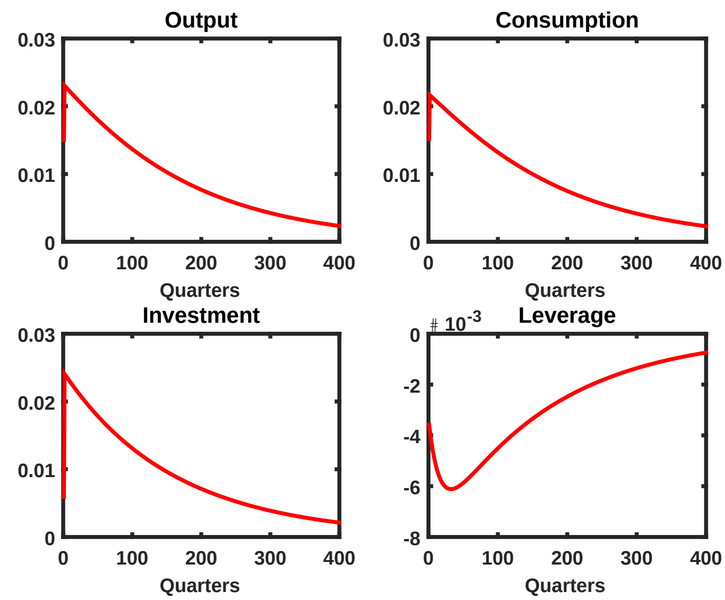


Figure 18. Impulse Responses (Original Model): Shock to q

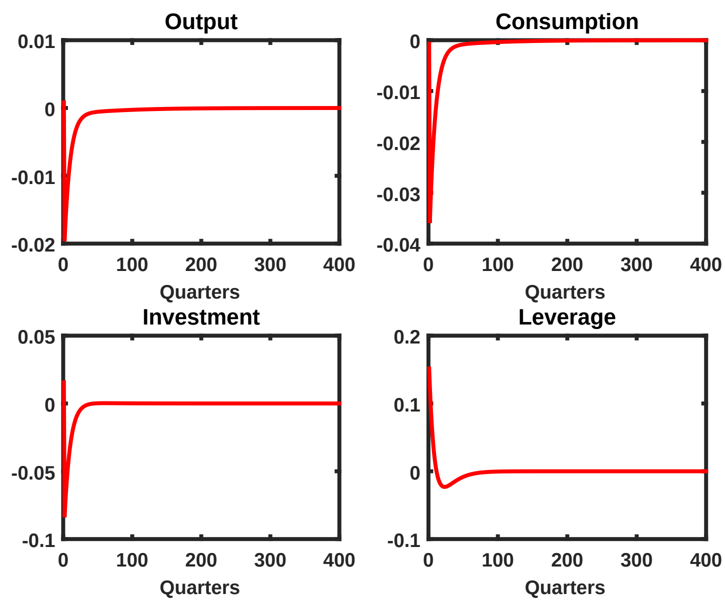


Figure 19. Impulse Responses (Extended Model): Shock to z^m

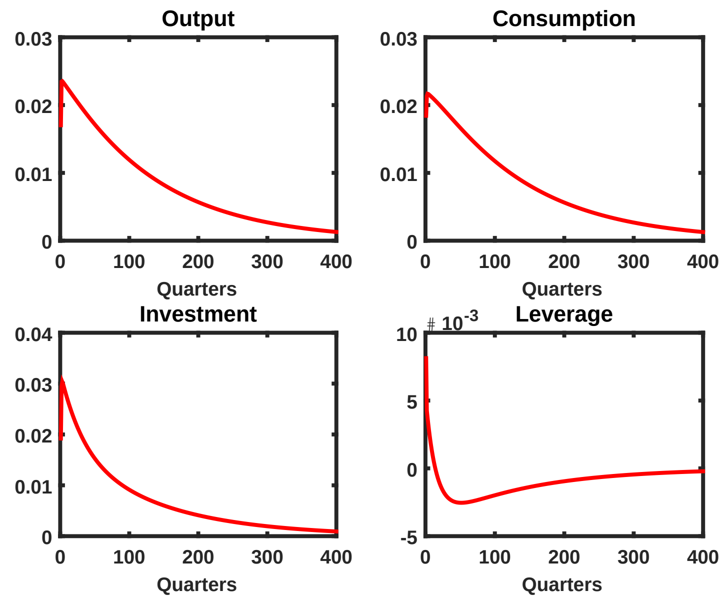


Figure 20. Impulse Responses (Extended Model): Shock to q