UNIVERSITY of York

This is a repository copy of *It is not your fault but it is your problem: : Global financial crisis and emerging markets*.

White Rose Research Online URL for this paper:
https://eprints.whiterose.ac.uk/113613/

Version: Accepted Version

Article:
Ozkan, Fatma Gulcin orcid.org/0000-0001-7652-1361 and Unsal, D. Filiz (2017) It is not your fault but it is your problem: : Global financial crisis and emerging markets. Oxford Economic Papers. pp. 1-21. ISSN 0030-7653

https://doi.org/10.1093/oep/gpw069

Reuse
Items deposited in White Rose Research Online are protected by copyright, with all rights reserved unless indicated otherwise. They may be downloaded and/or printed for private study, or other acts as permitted by national copyright laws. The publisher or other rights holders may allow further reproduction and re-use of the full text version. This is indicated by the licence information on the White Rose Research Online record for the item.

Takedown
If you consider content in White Rose Research Online to be in breach of UK law, please notify us by emailing eprints@whiterose.ac.uk including the URL of the record and the reason for the withdrawal request.

White Rose university consortium
Universities of Leeds, Sheffield & York

eprints@whiterose.ac.uk
https://eprints.whiterose.ac.uk/

It is not your fault, but it is your problem: global financial crisis and emerging markets

By F. Gulcin Ozkan*and D. Filiz Unsal†

This version: 17 October 2016

Abstract

The financial and economic conditions in emerging markets (EM) responded sharply to the 2008-09 global financial crisis (GFC). Motivated by the lack of appropriate frameworks to explore interlinkages between emerging and advanced economies, we propose a two-country model with explicit trade and financial channels. This enables us to identify the differences in the implications of domestic versus global financial crises and explore the role of real and financial cross-border spillovers. We find that (i) the interaction between the degree of trade integration and the scale of financial contagion; and (ii) the relative importance of the export versus balance sheet channels play a key role in determining the overall impact of the global financial shock. Indeed, in the wake of the GFC, while some of the very open EMs suffered substantial output losses initially, those that were able to attract the capital flowing out of the crisis-struck advanced economies recovered swiftly.

JEL Classification: E32, F41, F44

*Department of Economics and Related Studies (DERS), University of York, Heslington, York, YO10 5DD; e-mail:gulcin.ozkan@york.ac.uk.

† International Monetary Fund, 700 19th Street, N.W. Washington, D.C. 20431, USA; e-mail:dunsal@imf.org.

1 Introduction

A key feature of the 2008-09 global financial crisis (henceforth GFC) has been the strength of the transmission from the advanced to the emerging economies (EMs), especially during the early phases of the crisis (see, for example, Dooley and Hutchison, 2009). Given the scale of the financial turmoil, a lively debate on the comparison between the GFC and the EMs' past crises ensued (see, for example, Calvo and Loo-Kung, 2010). During the previous large-scale financial crises in EMs—notably at the end of the 1990s and beginning of the 2000s—private capital inflows dried up for a substantial period of time, and output recovered only slowly despite sizable devaluations improving export performance in many cases. In contrast, during the GFC, (i) the sharp reduction in financial flows to the EMs that followed from the standstill in the credit markets of developed economies in 2008 reversed quickly; (ii) EMs witnessed a substantial fall in their exports as the financial turbulence hit consumer spending in the developed world. Hence, given the strong downturn in the global economy, countries were unable to export their way out of the crisis in spite of the substantial loss of value in their currencies. Yet, after the initial collapse, capital flows to many EMs surged, fuelling credit expansion and hence leading to the GFC to be short-lived for many of these economies.

The above evaluation suggests that both financial and trade channels play a crucial role in the propagation and transmission of domestic and global financial shocks within and across countries. Motivated by this observation, in this paper we develop a two-country dynamic stochastic general equilibrium (DSGE) model with an explicit treatment of both trade and financial linkages between the countries. This enables us (i) to identify, from a small open EM economy point of view, differences in the impact and policy implications of domestic and global financial crisis scenarios; and (ii) to explore the role of real and financial cross-border spillovers.

There are three features of our model economy that are representative of EM economies. First, the domestic economy exhibits financial frictions that translate into risk premium on its external borrowing. This has important implications for macroeconomic outcomes of a shock when a large share of investment is financed with external resources, as is the case for many EMs. Second, a significant proportion of the borrowing is taken to be in foreign currency terms, also common in these economies.[1] In the presence of such foreign currency denominated debt — widely referred to as partial liability dollarization—the balance sheets of the financial system become unduly sensitive to the changes not only in global investment patterns, but also in exchange rates. Third, and relatedly, the costly nature of exchange rate fluctuations in EMs are explicitly taken into account by utilizing a modified Taylor rule that responds to changes in the nominal exchange rate, as widely adopted in these economies especially during crises periods (Ghosh *et al.*, 2016).

We take a domestic and a foreign financial shock to represent the case of a domestic and a

[1] Although foreign currency denominated debt in the corporate sector has declined since the financial turbulance in EMs during 2000s, it does remain sizeable. For example, the share of foreign currency denominated corporate debt as a share of total debt varies from 10% in China to 65% in Hungary, averaging around 40% for the EMs as a whole (GFSR Database, IMF, October 2015).

global financial crisis, respectively. Following the shock, lending to entrepreneurs becomes risky, leading to a rise in the risk premium in the economy. Entrepreneurs reduce borrowing and thus supply of capital, lowering investment and output. For the domestic economy, a global financial shock triggers immediate movements in trade and financial channels: (i) the export demand of the foreign economy shrinks (export channel), and (ii) capital inflows increase as global investors look for alternative investment opportunities (financial substitution). However, there exists another mechanism, which we refer to as 'financial contagion'—in the presence of close financial linkages between the countries, the global shock prompts a more cautious view toward the domestic EM economy on impact, above and beyond what could be expected based on economic fundamentals in the model.[2] Hence, under financial contagion, foreign lenders re-price credit risk upward, and the cost of external financing increases, causing a sharp decline in output and domestic inflation, and a depreciation of the domestic currency.

We calibrate our two-country model to the (South) Korean and the US data and derive the stochastic structure of our quantitative model accordingly. Korea's substantial integration with the global economy and its major crisis experience in 1997 make it a particularly interesting example to study domestic versus global crises in our two-country framework with explicit trade and financial channels. Utilizing our quantitative model, we first show that an economy's response to a global financial crisis is inherently different from that to a domestic one. When the economy is hit by a domestic financial shock, the depreciation of the currency boosts net exports, partly offsetting the initial decline in output. In contrast, when the financial shock is of global origin, the reduction in the aggregate demand in the global economy reduces demand for the home produced goods, preventing the domestic economy to export its way out of the crisis. Second, we find that the interaction between the intensity of financial contagion and the degree of trade openness plays a key role in the transmission of the global financial shock. In the absence of financial contagion, the global financial shock triggers capital inflows into the domestic economy via financial substitution, raising the price of domestic currency and hence reducing exports. As a result, the greater the openness, the greater the drop in exports and thus in output. In contrast, in the presence of financial contagion from the global shock onto the domestic economy, the domestic economy experiences a sharp fall in capital inflows, depreciating the domestic currency, boosting exports. However, the depreciation of the currency also worsens the balance sheet of the financial system, given the scale of foreign currency denominated debt. Overall, the relative importance of the export channel versus the balance sheet channel determines the output response in the aftermath of a global financial shock. With greater the initial financial leverage, the greater the endogenous rise in the risk premium and the depreciation in the domestic economy following the global financial shocks and hence the greater the fall in output.

[2]In this paper, we use the term 'financial contagion' in a rather narrow sense to refer to exogenous changes in the perception of investors about the domestic EM economy following the global shock. This reflects increased (rational or irrational) herding behavior of international investors during times of global financial distress. Note that even in the absence of such financial contagion, there are endogenous financial transmission channels at work, affecting the financing conditions of the domestic EM economy in the model.

Our work in this paper is related to several strands in the literature, in particular to the growing body of work on the international transmission of shocks in the presence of financial frictions. A key focus of this literature has been the financial contagion arising from an external shock being transmitted onto the domestic economy. Among the transmission mechanisms studied are leveraged financial institutions (van Wincoop, 2013); leverage constrained investors (Devereux and Yetman, 2010); binding enforcement constraints on credit supply (Devereux and Sutherland, 2011); and global banking (Enders *et al.*, 2011). In addition to several differences regarding the modelling choice between our paper and these studies both financial and trade linkages are explicitly modelled and play a key role in our work, in contrast to the studies listed above where financial interactions are treated as the main source of interdependence between countries.

A second strand of the related literature explored the fluctuations in EMs and how financial frictions affect the transmission of shocks onto these economies. It has been shown that financial frictions, through impacting the transmission of shocks, play a major role as a source of business cycle fluctuations in EMs (Chang and Fernandez, 2013). Moreover, financial frictions have also been shown to determine the form of optimal policy via impacting the transmission mechanism of monetary policy (Batini *et al.*, 2010). Our paper differs from the former set of studies in their choice of small open economy real business cycle models and their focus on business cycles fluctuations; and the latter in their focus on optimal policy. Unlike in these studies, we also explore different channels of transmissions by examining the interactions between the trade openness, financial leverage and financial contagion.

Finally, there exists a number of other studies explicitly taking up the issue of international transmission of financial shocks using stochastic general equilibrium frameworks. Among these Gilchrist (2004) explores the role of leverage in the transmission of shocks from developed to developing countries; Dedola and Lombardo (2012) study the synchronization of borrowing costs and credit spreads across countries and Kamber and Thoenissen (2013) investigate the international transmission of banking sector shocks. Although the former two share our two-country modelling choice, Gilchrist (2004) examine the transmission of a positive productivity shock in the centre country to the periphery while Dedola and Lombardo (2012) incorporate endogenous portfolio choice and examine its effects as shock propagation. The third differs from our analysis in their choice of shocks as global banking as well as the adoption of a small open economy framework.

The remainder of the paper is organized as follows. Section 2 sets out the analytical model structure. Section 3 extends the benchmark model to a two-country framework incorporating some important emerging market features and describes calibration and the solution strategy. By utilizing the quantitative model, Section 3 also considers a number of domestic versus global financial crisis scenarios. Finally, Section 4 provides the concluding remarks.

2 The analytical framework

Based on the financial accelerator mechanism developed by Bernanke *et al.* (1999), our sticky price DSGE model shares its basic features with the theoretical studies incorporating the financial accelerator in combination with liability dollarization such as Cespedes *et al.* (2004). To simplify the analysis, we assume in this part that the domestic economy is small so that foreign economy is exogenously modelled following the small open economy (SOE) literature such as Gertler *et al.* (2007).

The SOE is inhabited by infinitely lived households who derive utility from consumption and disutility from hours worked. There are three types of firms in the model. Production firms produce a differentiated final consumption good using both capital and labor as inputs and face price adjustment costs. Importers and exporters are perfectly competitive, with complete exchange rate pass-through of nominal exchange rate changes to prices of imported and exported goods.[3] Finally, there are competitive firms that combine investment with rented capital to produce unfinished capital goods that are then sold to entrepreneurs.

Entrepreneurs play a major role in the model. They produce capital, which is rented to firms, and finance their investment in capital through internal funds as well as external borrowing; however, financial frictions make the latter more expensive than the former. Specifically, monitoring the business activity of borrowers is a costly activity, and hence lenders must be compensated by an external finance premium. The magnitude of this premium varies with the leverage of the entrepreneurs, linking the terms of credit to balance sheet conditions.

In what follows, variables with a star indicate the foreign economy variables, unless indicated otherwise.

2.1 Households

A representative household is infinitely-lived and seeks to maximize:

$$\boldsymbol{E}_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}(C_t - \frac{H_t^{1+\varphi}}{1+\varphi})^{1-\sigma}, \tag{1}$$

where C_t is a composite consumption index, H_t is hours of work, E_t is the mathematical expectation conditional upon information available at t, β is the representative consumer's subjective discount factor where $0 < \beta < 1$, $\sigma > 0$ is the inverse of the intertemporal elasticity of substitution and $\varphi > 0$ is the inverse elasticity of labour supply. We adopt Greenwood *et al.* (1988) preferences, which eliminate wealth effects from labor supply.

[3] Note that some of the implications of less than complete pass-through associated with local currency pricing by exporters and importers have already been analysed by several authors (see, for example, Monacelli, 2005). We have also examined the role of incomplete exchange rate pass-through and find that our results are robust to this assumption.

The composite consumption index, C_t, is given by:

$$C_t = \left[(1-\alpha)^{\frac{1}{\gamma}} C_{H,t}^{(\gamma-1)/\gamma} + (\alpha)^{\frac{1}{\gamma}} C_{M,t}^{(\gamma-1)/\gamma}\right]^{\gamma/(\gamma-1)}, \tag{2}$$

where $\gamma > 0$ is the elasticity of substitution between domestic and imported goods, $0 < \alpha < 1$ denotes the weight of imported goods in domestic consumption basket, and $C_{H,t}$ and $C_{M,t}$ are consumption of domestic and foreign goods.

The real exchange rate REX_t is defined as $REX_t = \frac{S_t P_t^*}{P_t}$, where S_t is the nominal exchange rate, domestic currency price of foreign currency, and P_t^* is the foreign price level and is normalized to 1.

Households own all home production firms and thus are recipients of profits, Π_t. Other sources of income for the representative household are wages W_t and new borrowing net of repayments on outstanding debt, B_t, secured at rate i_{t-1}. Hence, the representative household's budget constraint in period t can be written as follows:

$$P_t C_t + (1 + i_{t-1}) B_t = W_t H_t + B_{t+1} + \Pi_t. \tag{3}$$

where H_t denotes the hours worked. The representative household chooses the paths for $\{C_t, H_t, B_{t+1}\}_{t=0}^{\infty}$ in order to maximize its expected lifetime utility in (1) subject to the budget constraint in (3).[4]

2.2 Firms

2.2.1 Production Firms

Each firm produces a differentiated good using the production function:

$$Y_t = A_t {N_t}^{1-\eta} {K_t}^{\eta}, \tag{4}$$

where A_t denotes labor productivity, common to all the production firms and N_t is the labor input which is a composite of household, H_t, and entrepreneurial labor, H_t^E; defined as $N_t = {H_t}^{1-\Omega} {H_t^E}^{\Omega}$.[5] K_t denotes capital provided by the entrepreneur, as is explored in the following subsection.

Firms face quadratic menu costs in changing prices of domestic goods, expressed in the units of consumption basket given by $\frac{\Psi}{2}(\frac{P_t}{P_{t-1}} - 1)^2$.[6]

[4] We have also explored the case of household borrowing in foreign currency. We find that this has no qualitative impact on our results (not reported).

[5] In line with much of the literature on financial frictions we maintain the assumption of flexible wages. There is also empirical evidence pointing to wages being more flexible in emerging economies than in advanced ones (see, for example, Li, 2011). Given the dynamics of our model, relaxing this assumption would have negligible effects on our results.

[6] As often stated in the literature, it is possible to draw a mapping between the Rotemberg adjustment cost and the Calvo probability of fixing prices every quarter. In particular, the value of price adjustment cost could be set such

2.2.2 Importing Firms

There is a set of perfectly competitive importing firms, owned by domestic households, who buy foreign goods at prices $P^*_{X,t}$ and then sell to the domestic market in domestic currency.

2.2.3 Unfinished Capital Producing Firms

Let I_t denote aggregate investment in period t, which is composed of domestic and imported goods:

$$I_t = \left[(1-\alpha)^{\frac{1}{\gamma}} I_{H,t}^{(\gamma-1)/\gamma} + (\alpha)^{\frac{1}{\gamma}} I_{M,t}^{(\gamma-1)/\gamma}\right]^{\gamma/(\gamma-1)}, \tag{5}$$

where the domestic ($I_{H,t}$) and imported investment goods' ($I_{M,t}$) prices are assumed to be the same as the domestic and imported consumer goods prices, $P_{H,t}$ and $P_{M,t}$. The new capital stock requires the same combination of domestic and foreign goods so that the nominal price of a unit of investment equals the price level, P_t.

Competitive firms use investment as an input, I_t and combine it with rented capital K_t to produce unfinished capital goods. The stock of capital evolves according to:

$$K_{t+1} = [\frac{I_t}{K_t} - \frac{\Psi_I}{2}(\frac{I_t}{K_t} - \delta)^2]K_t + (1-\delta)K_t. \tag{6}$$

where Ψ_I denotes investment adjustment costs and δ is the rate of depreciation. The optimality condition with respect to the choice of I_t yields the following nominal price capital $Q_t = P_t[1 - \Psi_I(\frac{I_t}{K_t} - \delta)]^{-1}$.

2.3 Entrepreneurs

Entrepreneurs transform unfinished capital goods and sell them to the production firms. They finance their investment by using their own net worth and by borrowing from foreign lenders where all borrowing is taken to be in foreign currency terms — an assumption which is relaxed in Section 3.

Each entrepreneur has access to a stochastic technology in transforming K_{t+1} units of unfinished capital into $\omega_{t+1}K_{t+1}$ units of finished capital goods.[7]

Denoting the net worth of entrepreneurs as NW_t, one can write the budget constraint of the entrepreneur as follows:

$$P_t NW_t = Q_t K_{t+1} - S_t D^E_{t+1}, \tag{7}$$

where D^E_{t+1} denotes foreign currency denominated debt. Equation (7) simply states that capital financing is divided between net worth and foreign debt. It is clear that the entrepreneurs are

that linear quadratic approximation for both cases are equivalent. See Rotemberg (1982) or Lombardo and Vestin (2009) for details.

[7] There is a continuum of entrepreneurs indexed by k in the interval [0,1]. Following Bernanke *et al.* (1999), the idiosyncratic productivity $\omega_t(k)$ is assumed to be *i.i.d.* (across time and across firms) with $\log(\omega_t(k)) \sim N(\frac{-1}{2}\sigma^2_\omega, \sigma^2_\omega)$. We ignore entrepreneurs' index k for notational simplicity.

exposed to exchange rate risk, that is, fluctuations in the nominal exchange rate create balance sheet effects in the model.

Entrepreneurs observe ω_{t+1} *ex post*, but the lenders can only observe it at a monitoring cost which is assumed to be a certain fraction (μ) of the return. The contracting problem identifies the capital demand of entrepreneurs K_{t+1} and a cut off value, $\overline{\omega}_{t+1}$, such that the entrepreneur maximizes their expected return subject to the participation constraints of the lender. The resulting first-order conditions are:

$$E_t[R^K_{t+1}] = E_t[(1+i^*_t)(1+\Phi_{t+1})], \tag{8}$$

where R^K_{t+1} is the return the capital and $(1+\Phi_{t+1})$ is the external risk premium, which is a function of entreprenur's leverage.

Net worth, NW_t, evolves in the model with entrepreneurs' capital net of borrowing costs carried over from the previous period and the entrepreneurial wage:

$$P_t NW_t = \vartheta[R^K_t Q_{t-1} K_t z(\overline{\omega}_t)] + W^E_t, \tag{9}$$

where the fraction of entrepreneurs who survive each period is denoted by ϑ. Given that the borrower's and the lender's share of total return should add up to $1-\nu_t$ where ν_t is the cost of monitoring, we can rewrite NW_t as:

$$P_t NW_t = \vartheta[R^K_t Q_{t-1} K_t (1-\nu_t) - (1+i^*_{t-1}) S_t D^E_t] + W^E_t. \tag{10}$$

Note that unanticipated changes in the nominal exchange rate increase the debt burden of the entrepreneur, and therefore decrease its net worth. This, in turn, increases the leverage of the entrepreneur and raises the external risk premium, implying a higher cost of financing. This additional mechanism magnifies the role of the financial accelerator in the economy through transmitting fluctuations in the nominal exchange rate to the balance sheets of entrepreneurs.[8]

Because of investment adjustment costs and incomplete capital depreciation, entrepreneurs' return on capital, R^K_t which is the sum of the rental rate on new and used capital, and the value of the non-depreciated capital stock, after the adjustment for the fluctuations in the asset prices $\binom{Q_{t+1}}{Q_t}$, is not identical to the rental rate of capital, R_t.

2.4 Monetary policy

In our benchmark case, we adopt a standard formulation for the monetary policy framework where the policy interest rate responds to inflation and output deviations from the steady state.

$$1 + i_t = (1+i)\ \ (\pi_t)^{\epsilon_\pi} (Y_t/Y)^{\epsilon_Y}, \tag{11}$$

[8] The entrepreneurs leaving the scene at time t consume their return on capital. The consumption of the exiting entrepreneurs, C^E_t, is $P_t C^E_t = (1-\vartheta)[R^K_t Q_{t-1} K_t (1-\nu_t) - (1+i^*_{t-1}) S_t D^E_t]$.

where i, and Y denote the steady-state level of nominal interest rate and output; and π_t is the CPI inflation.

2.5 Benchmark model simulations

To organize the discussion, we first present simulations from this simple framework to show the main working of the model as well as how the impact of the shock is amplified through financial frictions. In this section, we examine the impact of a standard, 1% exogenous change in the risk premium in the domestic economy. This prepares the ground for our two-country framework in the next section that enables us to trace the transmission of a financial shock originating in the foreign economy onto the domestic economy. Calibrated values of the parameters are listed in Table 1 and are discussed in detail in Section 3.

The response of the domestic SOE to the risk premium shock is presented in Fig.1. The rise in the risk premium leads to a reversal of capital flows out of the domestic country by about 1.2% of GDP on impact. As the cost of borrowing rises, entrepreneurs reduce their use of external financing by undertaking fewer projects. This decline in leverage causes a downward adjustment in the risk premium, mitigating the initial impact of the risk premium shock. Lower borrowing, however, decreases the future supply of capital and hence brings about a decrease in investment, in labor demand and real wages in the economy.

The fall in capital inflows also lowers the demand for the domestic currency, leading to its depreciation. Since the entrepreneurs' borrowing is denominated in foreign currency, this change in the exchange rate also creates balance sheet effects through a rise in the real debt burden, further lowering investment and thus output in the economy. While the depreciation of the domestic currency improves exports, it is not sufficient to reverse the drop in output arising from the fall in investment. Although the rise in the nominal exchange rate puts an upward pressure on the CPI based inflation, the decrease in the domestic price level more than offsets this effect, bringing about a fall in inflation.

Overall, the model highlights two effects. On the one hand, the financial shock drags down capital flows and hence credit growth. As a result, the currency depreciates, which further increases the risk premium through its impact on leverage given the foreign currency denomination of the debt. On the other hand, exports go up, which mitigates the impact of the shock, although the post-shock output is still lower than its previous level for a prolonged period.

3 The two-country model

Given that our main interest is in the international transmission of financial shocks onto EMs, we now extend the above framework by incorporating some important features of these economies. To that end we adopt (i) a two-country framework, (ii) a well-defined representation of a financial shock, (iii) borrowing in both domestic and foreign currency, (iv) monetary policy response to exchange rate changes.

First, we utilize a two-country model to (i) explicitly consider trade and financial linkages which are typically ignored in SOE models where the rest of the world is presented with exogenous processes; and (ii) provide greater realism, as it allows for feedback effects, which are general equilibrium in nature. We assume that the total measure of the world economy is normalized to unity, with domestic and foreign economies having measures n and $(1-n)$, respectively. In this case, α, the share of imported goods in the consumption basket, becomes $\alpha \equiv (1-n)\upsilon$, where $(1-n)$ is the relative size of the foreign economy, and υ represents a degree of trade openness. Although asymmetric in size, the domestic and foreign countries share the same preferences, technology, and market structure for consumption and capital goods, but they differ in the scale of financial frictions and the formulation of monetary policy

Second, in our framework, the origin of a financial shock is modelled as an unfavorable change in the perception of investors which creates a self-fulfilling pessimism about the economy through the enforcement of tighter credit conditions, similar to Curdia (2008). We argue that this better represents the 2008-09 episode relative to the much of the existing work on the GFC and sudden stops which typically defines the initial shock as an aggregate structural shock such as a rise in foreign interest rates, facing individual countries. Building towards that aim, we maintain that productivity is observed by the entrepreneur, but not by the lenders who have imperfect knowledge of the distribution of ω_{t+1}. Following Curdia (2008) we specify the lenders perception of $\omega_{t+1}(k)$ as given by $\omega^*_{t+1}(k) = \omega_{t+1}(k)\varrho_t$ where ϱ_t is the misperception factor over a given interval [0,1].[9] Further, the misperception factor, ϱ_t, is assumed to follow $\ln(\varrho_t) = \rho_\varrho \ln(\varrho_{t-1}) + \xi \ln(\varrho^*_t) + \varepsilon_\varrho$ where ρ_ϱ denotes the persistence parameter, and ξ measures the degree of financial contagion from the foreign to the domestic economy (only relevant in the case of a global shock).

In our analysis of the financial perception shock, we take the origin of the shock as a change in lenders' perception regarding idiosyncratic productivity (ε_ϱ). We assume that when there is uncertainty about the underlying distribution, lenders take the worst case scenario as the mean of the distribution of ω_{t+1}. Similarly, we assume that ϱ^*_t, the perception of lenders regarding the foreign entrepreneurs' productivity, follows an AR(1) process with persistence parameter ρ_{ϱ^*} and ε_{ϱ^*}.

Third, we now move away from the limiting case of all borrowing being in foreign currency term, as adopted in the previous section. Motivated by the relatively developed domestic debt markets in many EMs at present, the extended model features borrowing in both domestic and foreign currency.[10]

[9] As in Curdia (2008), our specification of the debt contract between investors and entrepreneurs explicitly takes into account the misperception factor, which makes risk premium sensitive to the perception of investors. Curdia (2008) adopts a max-min criteria for the misperception factor so that during the sudden stop episode, the misperception factor is set to a constant value lower than 1. This implies that, in his calibration, the investors' perception is constant for 2.5 years at a pre-set, lower value. In our case, however, we let the misperception factor to be an AR(1) process during the sudden stop episode such that the abrupt change in the perception of investors gradually goes back to the pre-shock level, rather than staying constant for a prolonged period.

[10] Korea, which we use in our calibration, also has an advanced domestic financial system where the share of corporate borrowing in foreign currency remains around 20% of the total corporate debt (GFRS Database, IMF).

Finally, we modify the Taylor rule to reflect the significance of exchange rate movements in policy making in the EMs:

$$1 + i_t = (1 + i) \ (\pi_t)^{\epsilon_\pi} (Y_t/Y)^{\epsilon_Y} (S_t/S_{t-1})^{\epsilon_s}. \tag{12}$$

where ϵ_s is the weight attached to exchange rate changes in setting the policy interest rate.[11]

3.1 Calibration of the extended model

In this section we calibrate the extended model to the Korean and the US economies as representatives of the EM and the global economy, respectively, based on the data over the period (2000-2014). The reasons underlying our choice of Korea to represent EMs are three-fold. First, Korea is a largely open economy, subject to global shocks due to its close financial and trade links with the rest of the world, which makes it a particularly interesting country to study in our setting. Second, Korea was one of the EMs that was severely hit by the GFC, although its recovery was relatively fast. And third, Korea had a major financial crisis experience in 1997 alongside a number of other Asian economies, comparable to the GFC. By analyzing Korea's adjustment to different types of financial crises, we seek to gain a better understanding of the transmission of global financial shocks onto EMs; of how they differ from domestic financial crises episodes; and the key determinants of the severity of global financial shocks on individual countries.

The quantitative model is set at quarterly frequency.[12] We maintain that the structure of consumption and production is identical in the two economies and thus use the same parametrization with the exception of the size parameter, n, which is set to 0.1 for Korea (Table 1).[13] We set the discount factor, β at 0.99, implying a riskless annual return of approximately 4 per cent in the steady state. The inverse of the elasticity of intertemporal substitution is taken as $\sigma = 1$, which corresponds to log utility. The inverse of the elasticity of labour supply φ is set to 2, which implies that 1/2 of time is spent working. The share of capital in production, η, is taken to be 0.35. The elasticity of substitution between differentiated goods of the same origin, λ, is taken to be 11, implying a flexible price equilibrium mark-up of 1.1, and price adjustment cost is assumed to be 120.[14] The quarterly depreciation rate δ is taken to be 0.025. We set the share of entrepreneurs' labour, Ω, at 0.01, implying that 1 per cent of the total wage bill goes to the entrepreneurs. The

[11] A number of EMs made an explicit commitment to allow the exchange rate to float more freely when they adopted inflation targeting. However, in countries with significant currency mismatches in domestic balance sheets, high exchange rate pass-through to inflation, and limited inter-sectoral factor mobility, ignoring exchange rate volatility can prove costly (Ostry *et al.*, 2012).

[12] In solving the model, we first transform it to reach a stationary representation where the steady state exists. We then solve it numerically up to a second-order approximation around the non-stochastic steady state using Sims (2005). The non-stochastic steady state of the model is solved numerically in MATLAB, and the second-order approximation of the model and the stochastic simulations are computed using Dynare. Details of the computation of the non-stochastic steady state and the stationary model equations are available upon request.

[13] The average nominal GDP (in U.S. dollars) of Korea over the last 15 years is about 10% of that of the US (WEO database, IMF).

[14] Denoting Calvo parameter with Υ, one can express the Rotemberg adjustment cost as $\Psi = (\lambda-1)\Upsilon/((1-\Upsilon)(1-\beta\Upsilon))$. Given our calibrated value for Ψ, this relationship implies $\Upsilon = 0.75$, a widely used value in the literature (see, for example, Smets and Wouters, 2003 among many others).

monitoring cost parameter, μ, is taken as 0.12. Regarding monetary policy, we use the original Taylor estimates and set $\epsilon_\pi = 1.5$ and $\epsilon_Y = 0.5$, and we use $\epsilon_s = 0.1$ for Korea, following Alp *et al.* (2012).

In the baseline case, we set α, the share of imported goods in the consumption basket, to 0.45 to match imports/GDP ratio in Korea. The parameter values for the entrepreneurial sector in Korea and in the US are set to reflect their defining characteristics. For Korea, we set the steady state leverage ratio, χ, the ratio of debt to net worth, and the value of quarterly external risk premium in the domestic economy, Φ, respectively at 0.25 and 340 basis points. For the U.S., the leverage ratio and the risk premium are set to 0.5 and 800 basis points.[15]

Calibrating our model to the Korean and the US data allowed us to establish the stochastic structure of the model accordingly. We set the size of the perception shock to reflect changes in the corporate spreads during the 1997 and the global financial crisis (1% for Korea and 0.3% for the U.S.). We set the persistency of the perception shock to be 0.5, so that it takes 9 quarters for the shock to die away, as in the data.

Magnitude and persistency of the domestic and foreign productivity shocks are set to match the volatility and the persistency of domestic and foreign output (0.7% for Korea and 1.2% for the U.S.) and those of the terms of trade shock to match the relevant moments of the exchange rate (0.4%).

Regarding financial contagion, we follow Park and Song (2012) and calculate financial contagion as the increase in the correlation of corporate spreads during the relevant crisis episodes. Our basis for focusing on the corporate bond spreads are two-fold. First, even though the US sub-prime market was an important source of the shock, there is a tight connection between the housing and corporate bond markets and hence the shock is closely reflected on the corporate spreads. This can be seen from Fig.2 displaying the time series plots of the US and Korean corporate spreads over the period, 1999-2015. Fig.2 establishes corporate spreads as a key spill-over mechanism, as maintained in our analysis. Second, in the literature utilizing the financial accelerator framework, which we borrow from, corporate bond spreads are seen as the closest approximation to the external risk premium and are widely viewed as the relevant empirical counterparts (see, for example, Gertler *et al.,* 2007 and Alp *et al.*, 2012).

To generate confidence in the model's ability to capture dynamics and in the proposed calibration of the parameters values, we also compare movements and comovements of a set of key variables in the data and in the model. In this analysis, in addition to the domestic and foreign financial shock, we incorporate domestic and foreign productivity shock, and a terms of trade shock to represent business cycles changes.

Table 2 presents business cycle statistics in the data as well as from the simulation results from our quantitative model. In the top panel of Table 2, standard deviations of output, investment,

[15] Leverage is calculated as debt as a percentage of assets from Worldscope data (data item WS 08236). We use corporate spreads as a proxy for external risk premia, calculated as the difference between 1-year AA-rated corporate bond and Treasury yields of the same maturity from Asian Development Bank for Korea and the BofA Merrill Lynch for the US.

current account, inflation, interest rate and exchange rate are listed, while the second panel reports standard deviations of the same set of variables relative to the standard deviation of output. Correlations with output and autocorrelations are displayed in the third panel, while the cross-country correlations are reported in the bottom panel. In all four panels, the simulation results are based on a contagion parameter of 0.3, calculated from the Korean data as explained above. As can be seen from Table 2, in most cases moments from the data are well-matched by moments from the model. The only major discrepancy is in the case of cross-country investment correlations where the simulated correlation is much greater than that in the data. This is in line with the well-known inability of general equilibrium models to match cross-country investment correlations (see, for example Ambler *et al.* 2002 and Comin *et al.* 2014).

3.2 Financial shocks to domestic and global economy

We now turn to exploring the implications of financial shocks in our two-country framework with both trade and financial linkages and present two alternative crisis scenarios, utilizing calibrated values from the US and the Korean data. As opposed to the risk premium shock in our benchmark scenario, we now consider the case of an unfavourable shift in the perception of lenders regarding the productivity of domestic and foreign entrepreneurs, respectively, hence representing endogenous rises in risk premia. These represent, respectively, a domestic and a global financial crisis, arising from a domestic financial shock versus a global one.

Fig.3 exhibits the response of the domestic economy to the domestic and the global financial perception shocks, denoted by the red (thin) and the blue (thick) lines, respectively. In the former, following the negative change in investors' perception about the distribution of the entrepreneurs' productivity, lending to domestic entrepreneurs becomes more risky, leading to a rise in the external risk premium on impact. This case represents a more conventional, domestic-born financial crisis scenario in line with the Korean experience during 1997 as well as those of several EM countries during the 1990s. Similar to the mechanism in Fig.1, the rise in the risk premium reduces the entrepreneurs' demand for capital, reducing capital inflows, and hence investment and output. The reduction in capital inflows reduces the demand for domestic currency, leading to its depreciation. The resulting boost to competitiveness raises the foreign demand for domestic goods, while imports decline on account of both income and exchange rate effects. Hence, the trade balance improves, but this effect is not strong enough to offset the decline in domestic demand in our simulations, and hence output contracts initially.[16]

In Fig.3, the blue (thick) line traces the transmission of a global financial shock to the domestic economy, with the aim of reflecting the GFC experience for the EM economies. The impact of the unfavourable financial perception shock regarding the productivity of foreign entrepreneurs on the foreign economy is similar to what domestic financial shock does to the domestic economy; a rise

[16] In practice, the export channel is generally highly effective for countries that are hit by financial crises and experience a sizable loss of value of their currencies. For instance, most East Asian countries enjoyed significant improvements in their exports following the 1997 Asian crisis (see, for example, Bleaney, 2005).

in the risk premium lowers borrowing and thus supply of capital, and hence investment and output in the foreign economy.

How is the global financial shock propagated to the domestic economy? The first channel is the export channel; the financial crisis in the foreign economy reduces output and thereby import demand in the foreign economy and thus net exports of the domestic economy. One main difference between this case of a foreign financial shock and the domestically originated one is in the way the export channel works. As can be seen in Fig.3, when the economy is hit by a financial shock of domestic origin, the depreciation of the currency brings about an improvement in net exports, which partly offsets the initial decline in output. In contrast, when the financial shock is originated in the foreign economy, the export channel is no longer effective. This is because the global financial crisis reduces net worth, capital, investment and output in the foreign economy, and hence its demand for imported goods. As a result, the global financial shock prevents the domestic economy from exporting its way out of the crisis.

The second channel of propagation of the global financial shock operates via a financial substitution effect. The unfavourable change in investors' perception of the foreign entrepreneurs' productivity induces investors to look for alternative investment opportunities —widely referred to as flight to quality. Investors now view the domestic entrepreneurs more favourably relative to those in the foreign economy. This leads to an increase in capital inflows into the domestic economy, partly offsetting the impact of the first channel, leading to the fall in capital inflows to be smaller than that under the domestic financial shock. Overall, in our simulations the output loss under the GFC is visibly smaller, in line with the Korean experience; Korea's GDP contracted much more sharply in 1997 as compared with 2008.

3.2.1 Financial contagion

In addition to the export and the financial substitution channels explored above, the global financial crisis is transmitted onto the domestic economy also through 'financial contagion'. We postulate that investors' perception regarding the true distribution of entrepreneurs' productivity in the foreign economy and the domestic economy could be inherently related. This is based on the notion that investors choose the scale and the terms of credit they extend to borrowers in a forward looking manner. For instance, when faced with credit tightening in the global economy, investors can anticipate *ex-ante* that this will be transmitted to the domestic emerging economy through real and financial cross-country linkages, implying an unfavorable change in their perceptions of the domestic entrepreneurs today. Also, some asset market linkages such as herding behavior only or mainly exist during times of crisis (see, for example, Kaminsky and Reinhart, 2000). We thus maintain that an unfavourable (exogenous) shift in investors' perception of the domestic entrepreneurs is another channel through which the global financial shock could spill over onto the domestic economy. In what follows, we refer to this mechanism as the 'financial contagion' channel. We now turn to exploring these channels separately.

In order to isolate the impact of financial contagion, Fig.4 and Fig.5 present two limiting cases;

with zero and full financial contagion, respectively, both at different values of trade openness. There are now two opposing effects of the GFC on the domestic economy. The first is through the reduced exports due to the global contraction following the global financial shock. The second, in contrast, is a favourable impact working through increased capital inflows, resulting from investors' flight to quality, leading to increased lending to domestic entrepreneurs at the expense of foreign entrepreneurs. As is seen from Fig.4 and Fig.5 in the absence of financial contagion, the increase in risk premium is considerably lower and thus the contraction in output in the domestic economy is much smaller than the one with financial contagion. This is because when there is financial contagion from the global to the domestic economy, the sharp depreciation of the exchange rate delivers an increase in exports, as is seen in Fig.5. Yet, the worsening of the risk premium and of entrepreneurs' balance sheets is much greater and thus the decline in output is much larger than under no contagion.

3.2.2 The role of trade openness

Having established that a global financial shock is transmitted to the domestic economy through both the trade and financial channels, we now turn to exploring the role of trade openness in the propagation of the foreign financial shock and its interaction with financial contagion.

In our simulations the degree of trade integration is measured by v, which, together with the size of the economy, n, determines the share of imported goods in the domestic consumption basket. The profile of the domestic economy in both Fig.4 and Fig.5 exhibit the important role played by the degree of trade openness in the amplification of the global financial shock. In the case with financial contagion, a greater trade integration between the two countries helps alleviate the adverse effects of the global financial crisis, similar to the case with a domestic financial crisis (Fig.3). Under this scenario, exports still help recover from the crisis to a certain extent because (i) the demand for goods in the domestic economy falls even more than that in the foreign economy, and (ii) exchange rate depreciates as capital outflows surge. However, when financial contagion is absent (Fig.4), the global financial shock triggers capital inflows onto the domestic economy via financial substitution, raising the price of domestic currency and hence reducing exports; and the greater the openness, the greater the drop in exports and thus in output. As a result, the impact of the global financial crisis on the domestic economy is amplified with a rise in trade openness in this case.[17]

The relationship between a country's openness to trade and its vulnerability to crises attracted a great deal of interest in the existing literature (see, for example, Calvo *et al.*, 2006 and Claessen *et al.*, 2012 among many others). In the line of work exploring crises in pre-GFC period, which typically considers domestic-born crisis scenarios, a number of studies point to openness as a feature reducing vulnerability to crises, although others present evidence to the contrary (see, for example, Calderon *et al.*, 2005; Calvo *et al.*, 2006; and Cavallo and Frankel, 2008 for the former and Glick and Rose, 1999 and Forbes, 2004 for the latter).

In contrast, we find that when the crisis is a global one, the more open an economy, the

[17] This also holds in the case of partial contagion ($\xi = 0.5$).

greater the unfavorable consequences of the financial crisis for the domestic economy pointing to the importance of the trade channel in the transmission of international shocks. Indeed, the global nature of the 2008-09 episode and the potentially detrimental impact of trade openness in its transmission to individual countries has been a major focus of the empirical studies on the GFC. There is now a large body of work, using data from the 2008-09 episode and variety of empirical methods, that examines the role of trade openness on both the incidence and the severity of financial crises. Cross-country evidence suggests that countries that were more open to trade experienced greater contractions in output, as compared with pre-crisis forecasts (Blanchard *et al.*, 2010 and Berkmen *et al.*, 2012); and greater cumulative drop in output, consumption and aggregate demand over 2008-2009 (Lane and Milesi-Ferretti, 2011). Similarly, firm level evidence also indicates that the crisis had a greater negative impact on firms' sales, profits and investment in countries that are more open to trade (Claessen *et al.*, 2012). [18]

3.2.3 The role of financial leverage

Finally, we examine the implications of the domestic economy's initial borrowing for the severity of a global financial shock. We use the ratio of debt to net worth as our measure of indebtedness the steady state value of which is taken to be 0.25 based on the Korean data.

Fig.6 displays the response of the economy to the same global financial shock as before for three separate values of the leverage ratio, all under no financial contagion assumption. As can be clearly seen from Fig.6, the greater the initial level of financial leverage the more costly a given global financial shock for the domestic economy. This is because an economy with lower initial indebtedness faces a smaller increase in the risk premium, and a greater rise in capital inflows—given the absence of financial contagion. This leads to a rise/ a smaller fall in output in the post-crisis period as the positive balance sheet effect outweighs the negative trade effect brought by a more appreciated currency. The pattern of the domestic economy's response in Fig.6 is also in line with the Korean experience of 1997 versus 2008; the more substantial output losses suffered by Korea in 1997 compared to that in 2008 coincided with more unfavourable external borrowing position in the former period relative to the latter. For example, the short term external debt as a proportion of GDP was down from 58% in 1996-97 to 40% in 2007-08.

4 Conclusions

This paper has developed a two-country DSGE model to investigate the transmission of a global financial shock onto a small open emerging economy. Our framework fully specifies both trade and financial linkages between countries, enabling us to explore a number of key aspects of the recent

[18] Among the countries that have experienced largest falls in economic activity during the initial stage of the recent financial crisis have been Singapore, Taiwan and Turkey, all of which are highly open economies. The fall in output in the first quarter of 2009 as compared with a year earlier was 10.1, 10.2 and 13.8% for Singapore, Taiwan and Turkey, respectively. Similarly, Germany and Japan, that are among the most open of mature economies, contracted by 6.9 and 8.8%, respectively over the same period (The Economist, July 4th, 2009).

GFC experience that differed from previous and mostly domestic-born crisis experiences in key respects.

We find that the response of a small open economy to a domestic financial shock is inherently different from its response to a financial shock of global origin. We identify three separate transmission channels through which the global financial shock impacts on the domestic economy. The first is the financial substitution channel reflecting the sudden inflow of capital arising from capital flowing out of the foreign economy hit by the financial shock. The second is the financial contagion channel arising from the comovement in the domestic and the global financial markets, adversely affecting the risk premium and hence capital inflows. And, the third is the export channel the size of which is determined by the relative strength of favourable financial substitution versus unfavourable financial contagion effects. The greater the importance of the financial contagion relative to financial substitution, the greater the fall in capital inflows leading to a greater depreciation and thus greater improvement in exports. Yet, such an improvement in exports is not sufficient to overturn the drop in output under high financial contagion given the negative impact of higher risk premia and the resulting depreciation of the domestic currency on the balance sheet of the financial system.

Our results reveal that the degree of financial contagion, the degree of trade openness and the degree of financial leverage are the key determinants of how an economy is impacted by a global crisis. We find that it is the interaction between the degree of trade integration and the scale of financial contagion on the one hand, and the relative importance of the export versus balance sheet channels on the other that determine the overall impact of the global financial shock on domestic macroeconomic outcomes. Indeed, the GFC provided ample examples; while some of the very open EMs suffered substantial output losses initially, those that were able to attract the capital flowing out of the crisis-struck advanced economies recovered swiftly.

Acknowledgement

We are grateful to the editor and two anonymous referees for helpful suggestions. We also benefitted from comments of Christopher Adam, Lynne Evans, Hugh Metcalf, Marcus Miller, Joe Pearlman, Peter Sinclair, Mike Wickens and seminar participants at the International Monetary Fund, Heriot-Watt University, Newcastle University and the Cass Business School, the University of London. The usual disclaimer applies.

References

[1] Alp, H., S. Elekdag, and S. Lall (2012). Did Korean monetary policy help to soften the impact of the global financial crisis of 2008-09? IMF Working Paper, No. 12/5. IMF, Washington, DC.

[2] Ambler, S., E. Cardia, and C. Zimmermann (2002). International transmission of the business cycle in a multi-sector model', *European Economic Review*, 46, 273-30.

[3] Batini, N., P. Levine, and J. Pearlman (2010). Monetary rules in emerging economies with financial market imperfections, in J. Galí and M. J. Gertler (eds), *International Dimensions of Monetary Policy*, 251 - 311.

[4] Berkmen, S. P., G. Gelos, R. Rennhack, and J. P. Walsh (2012). The global financial crisis: explaining cross-country differences in the output impact. *Journal of International Money and Finance* 31(1), 42-59.

[5] Bernanke, B. S., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework, in J. B. Taylor and M. Woodford (eds.), *Handbook of Macroeconomics*, Volume 1C, Chapter 21, 1341–93. Amsterdam: North-Holland.

[6] Blanchard, O., M. Das, and H. Faruqee (2010). The initial impact of the crisis on emerging market countries. *Brookings Papers on Economic Activity*, Spring 2010, 263-323.

[7] Bleaney, M. (2005). The aftermath of a currency collapse: how different are emerging markets? *World Economy*, 28(1), 79-89.

[8] Calderon, C., N. Loayza and K. Schmidt-Hebbel (2005). Does openness imply greater exposure? World Bank Policy Research Working Paper, No. 3733. World Bank, Washington, DC.

[9] Calvo, G., A. Izquierdo, and R. Loo-Kung (2006). Relative price volatility under sudden stops: the relevance of balance sheet effects. *Journal of International Economics*, 69(1), 231-254.

[10] Calvo, G. and R. Loo-Kung (2010). US recovery: A new "Phoenix Miracle"? Vox, 2010. http://voxeu.org/article/us-recovery-new-phoenix-miracle (date last accessed 17.10. 2016).

[11] Cavallo, E. A. and J. A. Frankel (2008). Does openness to trade make countries more vulnerable to sudden stops or less? Using gravity to establish causality. *Journal of International Money and Finance*, 27 (8), 1430–1452.

[12] Cespedes, L. F., R. Chang, and A. Velasco (2004). Balance sheets and exchange rate policy. *American Economic Review*, 94, 1183–1193.

[13] Chang, R. and A. Fernandez (2013). On the sources of aggregate fluctuations in emerging economies. *International Economic Review*, 54(4), 1265-1293.

[14] Claessens, S., H. Tong, and S. Wei (2012). From the financial crisis to the real economy: using firm-level data to identify transmission channels. *Journal of International Economics*, 88, 375-387.

[15] Comin, D., N. Loayza, F. Pasha and L. Serven (2014). Medium term business cycles in developing countries. *American Economic Journal*: *Macroeconomics*, 6(4), 209-45.

[16] Curdia, V. (2008). Optimal monetary policy under sudden stops. Staff Report No. 323, Federal Reserve Bank of New York, New York.

[17] Dedola, L. and G. Lombardo (2012). Financial frictions, financial integration and the international propagation of shocks. *Economic Policy*, 27(70), 319-359.

[18] Devereux, M. B. and A. Sutherland (2011). Evaluating international financial integration under leverage constraints. *European Economic Review,* 55(3), 427-442.

[19] Devereux, M. B. and J. Yetman (2010). Leverage constraints and the international transmission of shocks. *Journal of Money, Credit and Banking*, 42, 71-105.

[20] Dooley, M. and M. Hutchison (2009). Transmission of the U.S. subprime crisis to emerging markets: Evidence on the decoupling-recoupling hypothesis. *Journal of International Money and Finance,* 28(8), 1331-1349.

[21] Enders, Z., R. Kollmann and G. Muller (2011). Global banking and international business cycles. *European Economic Review*, 55, 407-426.

[22] Forbes, K.J (2004). The Asian flu and Russian virus: the international transmission of crises in firm-level data. *Journal of International Economics,* 63, 59-92.

[23] Gertler, M., S. Gilchrist, and F. Natalucci (2007). External constraints on monetary policy and the financial accelerator. *Journal of Money, Credit and Banking*, 39, 295–330.

[24] Ghosh, A.R., J. D. Ostry and M. Chamon (2016). Two targets, two instruments: Monetary and exchange rate policies in emerging market economies. *Journal of International Money and Finance*, 60, 172–196

[25] Gilchrist, S. (2004). Financial markets and financial leverage in a two-country world economy. In *Banking Market Structure and Monetary Policy*. Central Bank of Chile, Santiago.

[26] Glick, R. and A. Rose (1999). Contagion and trade: Why are currency crises regional? *Journal of International Money and Finance*, 18(4), 603–617.

[27] Greenwood, J., Z. Hercowitz, and G. Huffman (1988). Investment, capacity utilization, and the real business cycles. *American Economic Review*, 78 402-417.

[28] Kamber, G. and C. Thoenissen (2013). Financial exposure and the international transmission of financial shocks. *Journal of Money, Credit and Banking*, 45(2), 127-158.

[29] Kaminsky, G.L. and C.M. Reinhart (2000). On crisis, contagion and confusion. *Journal of International Economics*, 51, 145-168.

[30] Lane, P.R and G. M. Milesi-Ferretti (2011). The cross-country incidence of the global crisis. *IMF Economic Review*, 59, 77–110.

[31] Li, N. (2011). Cyclical wage movements in emerging markets compared to developed economies: the role of interest rates. *Review of Economic Dynamics*, 14(4), 686-704.

[32] Lombardo, G. and D. Vestin (2007). Welfare implications of Calvo vs. Rotemberg pricing assumptions. ECB Working Paper, No.770. ECB, Frankfurt.

[33] Monacelli, T. (2005). Monetary policy in a low pass-through environment. *Journal of Money, Credit, and Banking*, 37(6), 1047-1066.

[34] Ostry, J, A. Ghosh, and A. Korinek (2012). Multilateral aspects of managing the capital account. IMF Discussion Note, 7. IMF, Washington, DC.

[35] Park, Y.C. and Song, C (2012). Financial contagion in the East Asian crisis: with reference to the Republic of Korea, in S. Claessen and K. Forbes (eds) *International Financial Contagion*, Springer Press.

[36] Rotemberg, J. (1982). Sticky prices in the United States. *Journal of Political Economy,* 90, 1187–1211.

[37] Sims, C. (2005). Second-order accurate solution of discrete time dynamic equilibrium models. Mimeo, Princeton University, Princeton.

[38] Smets, F. and R. Wouters (2003). An estimated dynamic stochastic general equilibrium model of the euro area. *Journal of European Economic Association*, 1(5), 1123-1175.

[39] van Wincoop, E. (2013). International contagion through leveraged financial institutions. *American Economic Journal: Macroeconomics*, 5(3), 152-189.

Table 1: Parameter Values for Consumption, Production and Monetary Policy

$n = 0.1$	Size of the domestic economy
$\beta = 0.99$	Discount factor
$\sigma = 1$	Inverse of the intertemporal elasticity of substitution
$\gamma = 1$	Elasticity of substitution between domestic and foreign goods
$\varphi = 2$	Frisch elasticity of labour supply
$v = 0.35$	Degree of openness
$\eta = 0.35$	Share of capital in production
$\lambda = 11$	Elasticity of substitution between domestic goods
$\delta = 0.025$	Quarterly rate of depreciation
$\Omega = 0.01$	Share of entrepreneurial labor
$\Psi_I = 12$	Investment adjustment cost
$\Psi_D = 0.0075$	Responsiveness of household risk premium to debt/GDP
$\Psi = 120$	Price adjustment costs
$\epsilon_\pi = 1.5$	Coefficient of CPI inflation in the policy rule
$\epsilon_Y = 0.5$	Coefficient of output gap in the policy rule
$\epsilon_S = 0.5$	Coefficient of exchange rate in the policy rule (Korea only)
$\rho_\varrho = 0.5$	Persistence of the perception shock

Table 2. Business cycles in Korea and the US: Data vs. Model*

i) Standard deviation (in %)

	Output	**Investment**	**Current account**	**Inflation**	**Interest rate**	**Exchange rate (Dollar/Won)**
	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model
Korea	0.52/0.52	0.92/1.45	2.6/1.93	0.32/0.21	0.75/0.57	1.31/1.31
U.S.	0.56/0.56	1.87/1.59	0.35/0.72	0.23/0.16	1.94/0.43	1.31/1.31

ii) Standard deviation relative to output

	Output	**Investment**	**Current account**	**Inflation**	**Interest rate**	**Exchange rate (Dollar/Won)**
	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model
Korea	1.00/1.00	1.76/2.78	5.01/3.71	0.63/0.41	1.46/1.11	2.52/2.52
U.S.	1.00/1.00	3.36/2.84	0.64/1.28	0.41/0.76	3.48/0.76	2.35/2.34

iii) Correlation with output and autocorrelations

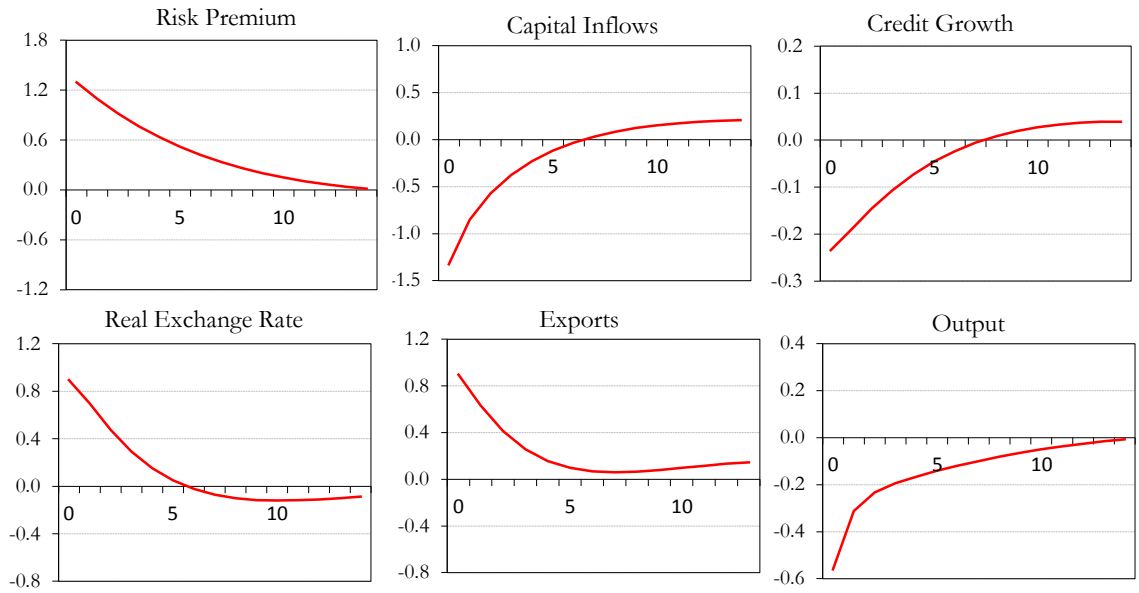
	ϱ(I,Y)	**ϱ(CA,Y)**	**ϱ(Y(t),Y(t-1))**	**ϱ(I(t),I(t-1))**	**ϱ(CA(t),CA(t-1))**	**ϱ(S(t),S(t-1))**
	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model	Data/Model
Korea	0.67/0.88	-0.38/-0.65	0.74/0.74	0.49/0.63	0.52/0.73	0.67/0.67
U.S.	0.94/0.72	-0.55/0.43	0.89/0.89	0.93/0.55	0.89/0.57	0.67/0.67

iv) Cross-country correlations

	ϱ(Y,Y*)	**ϱ(I,I*)**	**ϱ(INF,INF*)**	**ϱ(INT,INT*)**
	Data/Model	Data/Model	Data/Model	Data/Model
Korea vs. U.S.	0.42/0.64	0.07/0.79	0.49/0.70	0.78/0.68

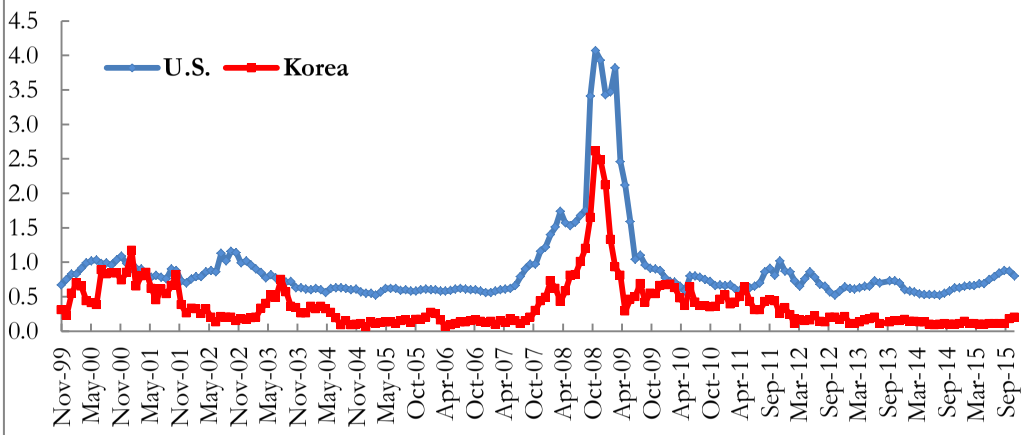
*Output and investment data moments are in percentage deviations from the HP filtered trend and their model moments are in percent deviations from their steady state values. Current account is reported as a share of GDP in both data and in the model, and inflation and interest rates are in percentage terms. Model results are calculated as empirical moments for 10,000 periods following three types of shocks: financial shocks (1 percent for Korea and 0.3 percent for the U.S.), productivity shocks (0.7 percent for Korea and 1.2 percent for the U.S.), and a shock to import prices (0.4 percent). Magnitude and persistency of the domestic and foreign productivity shocks and the terms of trade shock are set to match the volatility and persistency of domestic output, foreign output and exchange rate, respectively. Data are from IMF's WEO and IFS databases for the priod Q1: 2000-Q4: 2014. Output is represented by Y, I denotes investment, CA denotes the current account, S denotes the exchange rate, INF denotes inflation, and INT denotes interest rates.

Figure 1. Responses to a Financial Crisis
(percent deviations from the steady state)



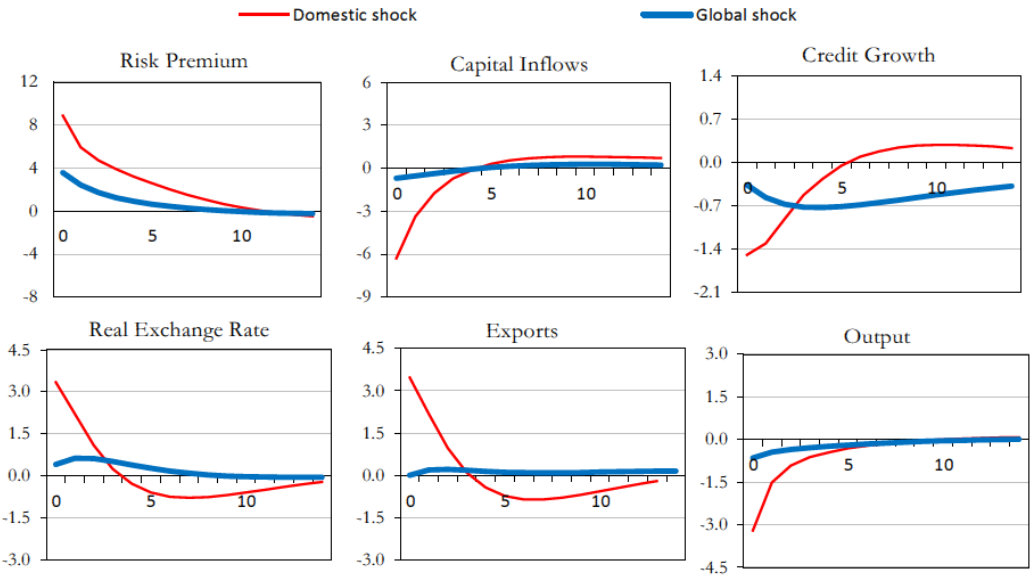
Note: The plots show the impact of a 1 % shock to the risk premium. The variables are presented as log-deviations from the steady state, multiplied by 100 to have an interpretation of percentage deviations.

Figure 2. Corporate Bond Spreads (1 year) in Korea and the U.S.



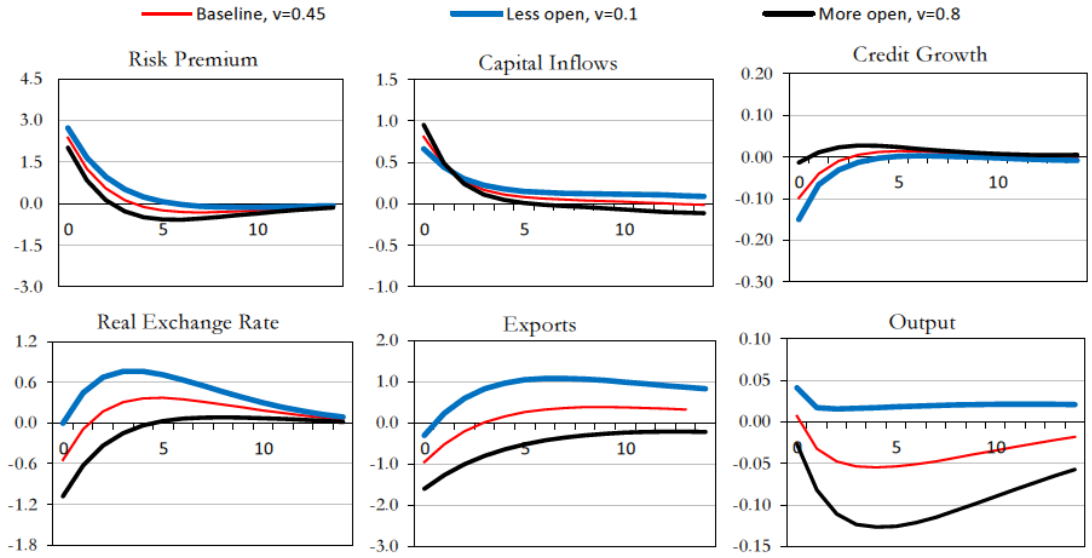
Sources: BofA Merrill Lynch; Asian Development Bank.

Figure 3. Responses to a Domestic and a Global Financial Crisis
(percent deviations from the steady state)



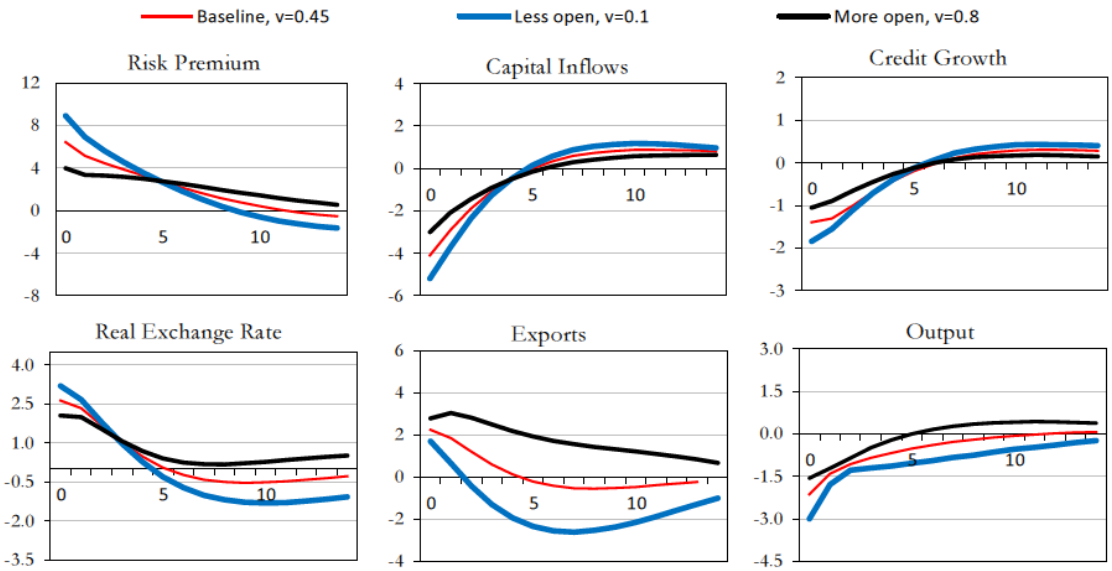
Note: The plots show the impact of a 1% and 0.3% shock to the perception of investors regarding domestic and foreign productivity, respectively. The variables are presented as log-deviations from the steady state, multiplied by 100 to have an interpretation of percentage deviations.

Figure 4. Responses to a Global Financial Crisis: No Contagion
(percent deviations from the steady state)



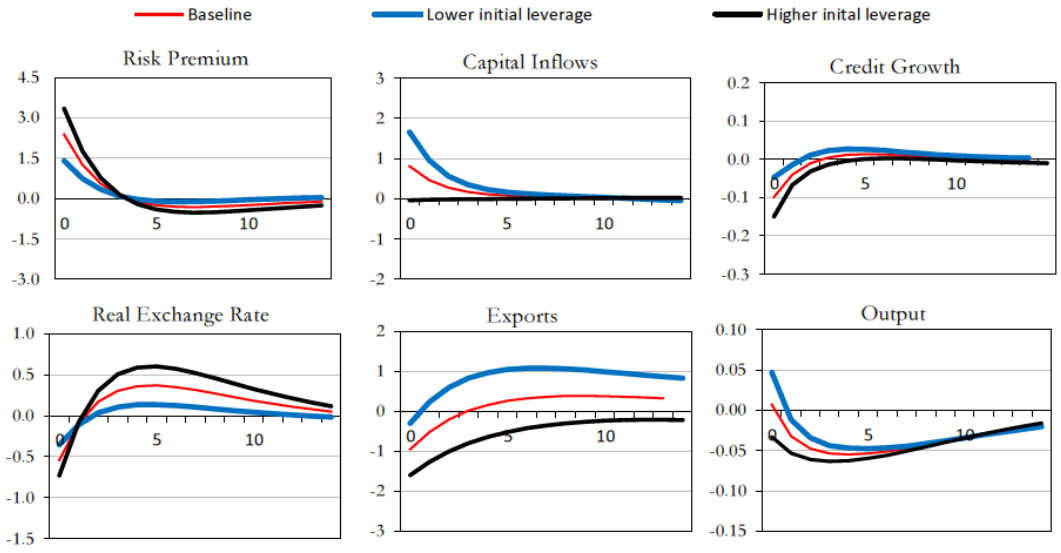
Note. The figures show the impact of a negative shock to the perception of investors regarding foreign productivity under the zero contagion assumption. The variables are presented as log-deviations from the steady state, multiplied by 100 to have an interpretation of percentage deviations.

Figure 5. Responses to a Global Financial Crisis: Full Contagion
(percent deviations from the steady state)



Note. The figures show the impact of a negative shock to the perception of investors regarding foreign productivity under the full contagion assumption. The variables are presented as log-deviations from the steady state, multiplied by 100 to have an interpretation of percentage deviations.

Figure 6. Responses to a Global Financial Crisis: No Contagion
(percent deviations from the steady state)



Note: The figures show the impact of a negative shock to the perception of investors regarding foreign productivity under the zero contagion assumption. The variables are presented as log-deviations from the steady state, multiplied by 100 to have an interpretation of percentage deviations.