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Global Financial Crisis, Financial Contagion, and Emerging Markets

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Global Financial Crisis, Financial Contagion and Emerging Markets[1]

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Abstract

The recent global financial crisis was the first in recent history that was triggered by problems in the financial system of the mature economies. Existing work on financial crisis in emerging market countries, however, almost exclusively focus on the role of financial frictions in the domestic economy. In contrast, we propose a two-country DSGE model to investigate the transmission of a global financial crisis that originates from financial frictions in the rest of the world. We find that the scale of financial spillovers from the global to the domestic economy and trade openness are key determinants of the severity of the financial crisis for the domestic economy. Our results also suggest that the welfare ranking of alternative monetary policy regimes is determined by the degree of financial contagion, the degree of trade openness as well as the scale of foreign currency denominated debt in the domestic economy.

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1 Introduction

The global financial turmoil that has gripped the world economy since August 2007 has been widely viewed as unprecedented, at least since the Great Depression of the 1930s. The turbulence in financial systems was followed by a significant reduction in real economic activity in a large number of countries. For emerging market and developing economies, financial crisis is not a new phenomenon. Indeed, since the early 1990s countries as diverse as Mexico, Russia, a number of East Asian countries, Brazil, Turkey and Argentina have all been hit by either currency or financial crises, or both. Although country experiences have varied with regard to the source of difficulty in each episode, the profile of crises has been fairly similar. A "sudden stop" of capital inflows is almost always followed by a sharp contraction in economic activity. Furthermore, many countries witnessed substantial losses in the value of their currencies, which greatly helped in recovering from the crises. In essence, these countries were able to expand net exports to alleviate or compensate for the contractionary effects of foreign currency liabilities following devaluations – the so-called balance sheet effects. For instance, sharp current account reversals were a common feature of recovery processes in most Asian countries following the 1997 crisis.

When set against this background, from the viewpoint of an emerging market economy, the recent global financial crisis has been different in two major ways.[1] First, the source of the sharp reduction in capital inflows on this occasion has been the severe liquidity squeeze in the financial markets of developed economies, unlike in any of the previous experiences. Indeed, the slowdown in financial flows to the emerging market economies followed from the virtual standstill in the credit markets in the US and the UK spreading to other major financial markets. Second, emerging market countries have also witnessed a substantial fall in their exports as the financial crisis hit consumer spending in the developed world. Hence, given the strong downturn in the global economy, countries have been unable to export their way out of the crisis even though a large number of countries experienced substantial devaluations of their currencies.

The above evaluation suggests that both financial and trade channels have been

[1] See, Reinhart and Rogoff (2009) for a comprehensive evaluation of the differences between the current and previous experiences of financial crisis.

crucial in the transmission of the global financial crisis to emerging market countries. Motivated by this observation, in this paper, we develop a two-country dynamic stochastic general equilibrium model with an explicit treatment of both trade and financial linkages between the countries. This enables us to investigate possible spillover effects of a financial crisis originating in the global economy on to a domestic, small open economy. There are three features of our model economy that are representative of emerging market economies. First, the domestic economy exhibits financial frictions in the form of high leverage; that is, a large share of investment is financed with external resources. Second, the borrowing is taken to be from abroad in foreign currency terms, as is common in emerging market countries. In the presence of such foreign currency denominated debt - widely referred to as liability dollarization - a change in the perception of foreign lenders of the current state of the economy leads to an endogenous adjustment in the cost of borrowing, generating a negative feedback loop between real and financial sectors. Moreover, the presence of liability dollarization makes the balance sheets of the financial system sensitive to the changes in exchange rates. Finally, our model gives explicit consideration to exchange rate pass-through, the scale of which distinguishes the experiences of emerging and mature economies.

The main channels through which a global financial shock impacts upon the emerging market economy are as follows. The re-pricing of credit risk increases the cost of external financing, inducing a sharp decline in output and domestic inflation, and a depreciation of the domestic currency. Since the external risk premium is tied to the leverage ratio, firms reduce new borrowing in order to decrease the endogenous component of the risk premium. Moreover, the fall in domestic inflation and the depreciation of the domestic currency increase the real debt burden for leveraged households, leading to a decrease in consumption. The depreciation of the domestic currency enables the home country to compensate, at least partly, for the decline in consumption and investment demand. However, this only applies if the financial crisis originated in the domestic economy. In contrast, when the source of the financial shock is global, the export channel works in the opposite direction with global contraction leading to a fall in export demand for the domestic output resulting in a further decline in domestic economic activity.

We also explore the role of financial contagion and trade openness on the propagation of international financial shocks. Our results reveal that the greater the financial contagion, the greater the severity of the financial crisis for the domestic economy. A higher level of financial contagion induces a greater increase in the external risk premium and thus a greater fall in capital inflows reducing investment, output and consumption. We also examine the role of the domestic economy's openness to trade on its response to the global financial shock. We find that, in contrast to the existing literature, the greater a country's trade integration with the rest of the world, the greater the response of its macroeconomic aggregates to a sudden stop of capital flows. We then provide a rigorous welfare analysis of two alternative monetary policy frameworks; an inflation targeting regime versus a fixed exchange rate regime. Our results reveal that the welfare ranking of the two regimes is determined by the degree of financial contagion, the degree of trade openness as well as the scale of foreign currency denominated debt in the domestic economy.

The remainder of the paper is organized as follows. Section 2 sets out the structure of our two-country DSGE model by describing household, firm and entrepreneurial behavior with special emphasis on the description of financial frictions. Section 3 presents the solution and the calibration of the model. Section 4 presents and discusses our quantitative results. Section 5 provides the concluding remarks.

2 The Model

Based on the financial accelerator mechanism developed by Bernanke et al. (1999), our model shares its basic features with the recent theoretical studies incorporating the financial accelerator in combination with liability dollarization such as Cespedes et al. (2004), Devereux et al. (2006), Gertler et al. (2007) and Elekdag and Tchakarov (2007). However, our framework differs from the existing general equilibrium models with financial frictions in three important ways. First, we develop a two-country sticky price DSGE model where both the trade and financial linkages between the two countries are fully specified. Modelling the foreign economy explicitly enables us to investigate the propagation of global financial crisis on the domestic economy by considering both the trade and financial channels. Given that our purpose is to explore the transmission of a global financial crisis onto an emerging market economy, we set the characteristics of the two countries in such a way that domestic (foreign) country exemplifies an emerging market (mature) economy.

Having a two-country framework also enables us to consider important transmission channels which are ignored in earlier studies.[2] Secondly, in our framework sudden stops are modeled as an unfavorable change in the perception of lenders 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 source of financial crises relative to the existing work on sudden stops which defines the initial shock as either an aggregate structural shock, such as a rise in foreign interest rates, or an adverse shock to fundamentals. Finally, in contrast to most existing New-Keynesian DSGE models, we adopt Greenwood, Hercowitz, Huffman (1988) (hereafter GHH) preferences in the specification of household utility.[3] This is motivated by the fact that the GHH preferences improve the ability of general equilibrium models in capturing business cycle facts especially in emerging market countries (see, for example, Neumeyer and Perri, 2005 among others).

The world economy consists of two economies; a domestic economy and a foreign economy. The total measure of the world economy is normalized to unity, with domestic and foreign economies measuring n and $(1-n)$, respectively. Given that our main purpose is to explore the impact of a global shock on an emerging market economy, we maintain that the domestic economy is small in size relative to the foreign one. Otherwise, domestic and foreign countries share the same preferences, technology and market structure for consumption and capital goods. The model for the domestic small economy is presented in this section. We use a similar version of

[2] Perri and Quadrini (2010) also utilize a two-country model in analyzing business cycle fluctuations across countries. However, in contrast to our model, the financial (credit) shock in their model is transmitted to the rest of the world through its effect on the borrowing capacity of firms and the resulting cost and thus employment implications. Other channels of international transmission of domestic shocks have also been investigated in the literature. These include international portfolio holdings of leverage constrained investors (Devereux and Yetman, 2010); binding enforcement constraints on credit supply (Devereux and Sutherland, 2011); syncronization of borrowing costs and credit spreads across countries (Dedola and Lombardo, 2012); and global banking (Enders et al. 2011). Our paper differs from these analyses in two major respects, in addition to many differences in the modelling structure. First, in contrast to our analysis where both financial and trade linkages are explicitly modelled and play a key role, financial interactions are treated as the main source of interdependence between countries in these studies. Second, unlike in the above mentioned studies, we explore the amplification of a global financial shock onto an emerging market economy by setting the model structure accordingly.

Among the existing studies the one that is closest to our analysis is Gilchrist (2004) who explores the role of leverage in the transmission of shocks from developed to developing countries. Although the two models share a number of features as both are based on Bernanke et al. (1999), our model differs from Gilchrist (2004) in a number of important aspects. These include the teatment of financial accelerator mechanism, the modelling of the source of shocks as well as the choice of preferences among others.

[3] Notable exceptions are Monacelli and Perotti (2008) and Gertler and Karadi (2010).

the model for the foreign economy with the exception that entrepreneurs in the domestic country borrow in foreign currency while entrepreneurs in the foreign country borrow in their domestic currency. In what follows, variables without superscripts refer to the home economy variables, while 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:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{1}{1-\sigma}(C_t - \frac{H_t^{1+\varphi}}{1+\varphi})^{1-\sigma}, \tag{1}$$

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. Our specification for household's utility allows for GHH preferences over hours, which eliminates wealth effects from labor supply.

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 (foreign goods), and $0 < \alpha < 1$ denotes the weight of imported goods in domestic consumption basket. Equation (2) suggests that the expenditure share of the imported goods in the consumption basket of households is given by $0 < \alpha < 1$. This weight, $\alpha \equiv (1-n)\upsilon$, depends on $(1-n)$, the relative size of the foreign economy, and on υ, the degree of trade openness of the domestic economy. $C_{H,t}$ and $C_{M,t}$ are consumption of domestic and foreign goods, represented by:

$$C_{H,t} = \left[\int_0^1 C_{H,t}(j)^{(\lambda-1)/\lambda} dj\right]^{\lambda/(\lambda-1)}; \ C_{M,t} = \left[\int_0^1 C_{M,t}(j)^{(\lambda-1)/\lambda} dj\right]^{\lambda/(\lambda-1)},$$

where $j \in [0,1]$ indicates the goods varieties and $\lambda > 1$ is the elasticity of substitution among goods produced within a country.

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 $P_t^* \equiv \left[\int_0^1 P_t^*(j)^{1-\lambda} dj\right]^{1/(1-\lambda)}$ is the aggregate price index for foreign country's consumption goods in foreign currency. In contrast to standard small open economy models, our two-country framework allows us to determine P_t^* endogenously in the foreign economy block.

Households have access to two types of non-contingent one-period debt; one denominated in domestic currency, B_t, and the other in foreign currency, D_t^H, with a nominal interest rate of i_t and $i_t^* \Psi_{D,t}$. Due to imperfect capital mobility, households need to pay a premium when borrowing from the rest of the world. This premium, $\Psi_{D,t}$, is defined as a function of deviations of aggregate credit over GDP from its steady state level; $\Psi_{D,t} = \frac{\Psi_D}{2}[\exp(\frac{S_t D_{t+1}^H + S_t D_t^E}{P_t GDP_t} - \frac{SD^H + SD_t^E}{PGDP}) - 1]^2$ where D_t^E is entrepreneurs' debt (see equation (11) below).[4] Households own all home production and the importing 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 interest payments on outstanding debts, both in domestic and foreign currency. Then, the representative household's budget constraint in period t can be written as follows:

$$P_t C_t + (1 + i_{t-1})B_t + (1 + i_{t-1}^*)\Psi_{D,t-1} S_t D_t^H = W_t H_t + B_{t+1} + S_t D_{t+1}^H + \Pi_t. \quad (3)$$

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

2.2 Firms

There are three types of firms in the model. Production firms produce a differentiated final consumption good using both capital and labor as inputs. These firms engage in local currency pricing and face price adjustment costs. As a result, final goods' prices are sticky in terms of the local currency of the markets in which they are sold. Importing firms that sell the goods produced in the foreign economy also have some market power and face adjustment costs when changing prices. Price stickiness in export and import prices causes the law of one price to fail such that exchange rate pass through is incomplete in the short run.[5] Finally, there are com-

[4]Following Schmitt-Grohe and Uribe (2003), this premium is introduced for technical reasons to maintain the stationarity in the economy's net foreign assets. As in Schmitt-Grohe and Uribe, we assume that the elasticity of the premium with respect to the aggregate debt is very close to zero ($\Psi_D = 0.0075$) so that the dynamics of the model are not affected by this friction.

[5]There is considerable empirical evidence of pricing-to-market and incomplete exchange rate pass-through in small open economies. See, for example, Naug and Nymoen (1996) and Campa and Goldberg (2005).

petitive firms that combine investment with rented capital to produce unfinished capital goods, that are then sold to entrepreneurs.

2.2.1 Production Firms

Each firm produces a differentiated good indexed by $j \in [0,1]$ using the production function:

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

where A_t denotes labor productivity, common to all the production firms and $N_t(j)$ is the labor input which is a composite of household, $H_t(j)$, and entrepreneurial labor, $H_t^E(j)$; defined as $N_t(j) = H_t(j)^{1-\Omega} H_t^E(j)^{\Omega}$. $K_t(j)$ denotes capital provided by the entrepreneur, as is explored in the following subsection. Assuming that the price of each input is taken as given, the production firms minimize their costs subject to (4).

Firms have some market power and they segment domestic and foreign markets with local currency pricing, where $P_{H,t}(j)$ and $P_{X,t}(j)$ denote price in domestic market (in domestic currency) and price in foreign market (in foreign currency). Firms also face quadratic menu costs in changing prices expressed in the units of consumption basket given by $\frac{\Psi_i}{2}(\frac{P_{i,t}(j)}{P_{i,t-1}(j)} - 1)^2$ for different market destinations $i = H, X$.[6] The combination of local currency pricing together with nominal price rigidities implies that fluctuations in the nominal exchange rate have a smaller impact on export prices so that exchange rate pass-through to export prices is incomplete in the short run.

As domestic firms are owned by domestic households, the individual firm maximizes its expected value of future profits using the household's intertemporal rate of substitution in consumption, given by $\beta^t U_{c,t}$. The objective function of firm j can thus be written as:

$$\begin{aligned} &E_o \sum_{t=0}^{\infty} \frac{\beta^t U_{c,t}}{P_t} [P_{H,t}(j) Y_{H,t}(j) + S_t P_{X,t}(j) Y_{X,t}(j) - MC_t Y_t(j) \\ &-P_t \sum_{i=H,X} \frac{\Psi_i}{2} (\frac{P_{i,t}(j)}{P_{i,t-1}(j)} - 1)^2], \end{aligned} \tag{5}$$

[6] This generates a gradual adjustment in the prices of goods in both markets, as suggested by Rotemberg (1982).

where $Y_{H,t}(j)$ and $Y_{X,t}(j)$ represent domestic and foreign demand for the domestically produced good j. We assume that different varieties have the same elasticities in both markets, so that the demand for good j can be written as,

$$Y_{i,t}(j) = (\frac{P_{i,t}(j)}{P_{i,t}})^{-\lambda} Y_{i,t}, \text{ for } i = H, X, \tag{6}$$

where $P_{H,t}$ is the aggregate price index for goods sold in domestic market, as is defined earlier and $P_{X,t}$ is the export price index given by $P_{X,t} \equiv [\int_0^1 P_{X,t}(j)^{1-\lambda} dj]^{1/(1-\lambda)}$.

$Y_{X,t}$ denotes the foreign aggregate export demand for domestic goods and is determined endogenously in the foreign country block, given by

$$\begin{aligned} Y_{X,t} &= C^*_{M,t} + C^{E*}_{M,t} + I^*_{M,t} + (\alpha^*)(\frac{P^*_{M,t}}{P^*_t})^{-\gamma}[\sum_{i=H,X} \frac{\Psi_i}{2}(\frac{P^*_{i,t}}{P^*_{i,t-1}} - 1)^2 \\ &+ \frac{\Psi_M}{2}(\frac{P^*_{M,t}}{P^*_{M,t-1}} - 1)^2 + \nu^*_t \frac{R^{K*}_t}{P^*_t} Q^*_{t-1} K^*_t]. \end{aligned} \tag{7}$$

where $C^*_{M,t}$ and $C^{E*}_{M,t}$ are import demand of households and entrepreneurs for consumption, $I^*_{M,t}$ denotes imported investment goods. The rest of the terms on the right hand side are imported components of price adjustment costs and the deadweight loss brought by financial frictions.

2.2.2 Importing Firms

There is a set of monopolistically competitive importing firms, owned by domestic households, who buy foreign goods at prices $P^*_{X,t}$ and then sell to the domestic market at $P^*_{M,t}$ with some mark-up. They are also subject to a price adjustment cost with $\Psi_M \succeq 0$, the price adjustment cost parameter, analogous to the production firms. This implies that there is some delay between exchange rates changes and the import price adjustments so that the short run exchange rate pass through to import prices is also incomplete.

2.2.3 Unfinished Capital Producing Firms

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

$$I_t = \left[(1-\alpha)^{\frac{1}{\gamma}} I_{H,t}^{(\gamma-1)/\gamma} + (\alpha)^{\frac{1}{\gamma}} I_{M,t}^{(\gamma-1)/\gamma}\right]^{\gamma/(\gamma-1)}, \tag{8}$$

where the domestic and imported investment goods' 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. This implies that $I_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma} I_t$ and $I_{M,t} = (\alpha)(\frac{P_{M,t}}{P_t})^{-\gamma} I_t$.

Competitive firms use investment as an input, I_t and combine it with rented capital K_t to produce unfinished capital goods. Following the existing literature, we assume that the marginal return to investment in terms of capital goods is decreasing in the amount of investment undertaken (relative to the current capital stock) due to the existence of adjustment costs, represented by $\frac{\Psi_I}{2}(\frac{I_t}{K_t} - \delta)^2$ where δ is the depreciation rate. Then, the production technology of the firms producing unfinished capital can be represented by $\Xi_t(I_t, Kt) = [\frac{I_t}{K_t} - \frac{\Psi_I}{2}(\frac{I_t}{K_t} - \delta)^2]K_t$ which exhibits constant returns to scale so that the unfinished capital producing firms earn zero profit in equilibrium. The stock of capital used by the firms in the economy evolves according to:

$$K_{t+1} = [\frac{I_t}{K_t} - \frac{\Psi_I}{2}(\frac{I_t}{K_t} - \delta)^2]K_t + (1-\delta)K_t. \tag{9}$$

The optimality condition for the unfinished capital producing firms with respect to the choice of I_t yields the following nominal price of a unit of capital Q_t:

$$\frac{Q_t}{P_t} = [1 - \Psi_I(\frac{I_t}{K_t} - \delta)]^{-1}. \tag{10}$$

2.3 Entrepreneurs

As stated earlier, entrepreneurs are key players in our model. They 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.[7] There is a continuum of entrepreneurs indexed by k in the interval [0,1]. Each entrepreneur has access to a stochastic technology in transforming $K_{t+1}(k)$ units of unfinished capital into $\omega_{t+1}(k)K_{t+1}(k)$ units of finished capital goods. The idiosyncratic productivity $\omega_t(k)$ is assumed to be *i.i.d.* (across time and across firms), drawn from a distribution $F(.)$, with p.d.f of $f(.)$ and $E(.) = 1$.[8]

[7] See, Mishkin (1998) and Eichengreen and Hausmann (2005) for the importance of foreign currency borrowing in emerging market countries.

[8] The idiosyncratic productivity is assumed to be distributed log-normally; $\log(\omega_t(k)) \sim N(\frac{-1}{2}\sigma_\omega^2, \sigma_\omega^2)$. This characterization is similar to that in Carlstrom and Fuerst (1997), Bernanke et

At the end of period t, each entrepreneur k has net worth, $NW_t(k)$. The budget constraint of the entrepreneur is defined as follows:

$$P_t NW_t(k) = Q_t K_{t+1}(k) - S_t D^E_{t+1}(k), \tag{11}$$

where D^E_{t+1} denotes foreign currency denominated debt. Equation (11) simply states that capital financing is divided between net worth and foreign debt. It is clear that the entrepreneurs are exposed to exchange rate risk, that is, fluctuations in the nominal exchange rate create balance sheet effects in the model.

Productivity is observed by the entrepreneur, but not by the lenders who have imperfect knowledge of the distribution of $\omega_{t+1}(k)$. 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. Similarly, we assume that ϱ^*_t, the perception of lenders regarding the the foreign entrepreneurs' productivity, follows an AR(1) process with persistence parameter ρ_{ϱ^*}. We take the origin of the financial 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 $\omega_{t+1}(k)$. Appendix A provides more details on the specification of the ambiguity aversion faced by lenders and the optimal contracting problem.

The optimal contract identifies the capital demand of entrepreneurs, $K_{t+1}(k)$ and a cut off value, $\overline{\omega}_{t+1}(k)$ such that the entrepreneur will maximize their expected return subject to the participation constraints of the lender. As shown in Appendix A, the first order conditions yield:

al. (1999), Cespedes et al. (2004) and Gertler et al. (2007).

[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.

$$E_t[R^K_{t+1}] = E_t[(1+i^*_t)(1+\Phi_{t+1})], \tag{12}$$

where $(1+\Phi_{t+1})$ is the external risk premium defined by:

$$1+\Phi_{t+1} = [\frac{z'(\overline{\omega}_{t+1}(k))}{g(\overline{\omega}_{t+1}(k);\varrho_t)z'(\overline{\omega}_{t+1}(k)) - z(\overline{\omega}_{t+1}(k))g'(\overline{\omega}_{t+1}(k);\varrho_t)}]E_t\{\frac{S_{t+1}}{S_t}\}. \tag{13}$$

where $z(\overline{\omega})$ and $g(\overline{\omega}(k);\varrho)$ are the borrowers' and lenders' share of the total return, respectively. As shown in Bernanke et al. (1999), this external risk premium depends on the leverage, $\frac{S_t D^E_{t+1}}{Q_t K_{t+1}}$, of the entrepreneur. A greater use of external financing generates an incentive for entrepreneurs to take on more risky projects, which raises the probability of default. This, in turn, will increase the external risk premium. Therefore, any shock that has a negative impact on the entrepreneurs' net worth increases their leverage, resulting in an upward adjustment in the external risk premium.

We follow the existing literature in assuming that a proportion of entrepreneurs die in each period to be replaced by new-comers. This assumption makes borrowing constraints on debt always binding. Given that $\omega(k)$ is independent of all other shocks and identical across time and across entrepreneurs, all entrepreneurs are identical *ex-ante.* Then, each entrepreneur faces the same financial contract specified by the cut off value and the external finance premium. This allows us to specify the rest of the model in aggregate terms.

At the beginning of period t, the entrepreneurs collect revenues and repay their debt contracted in period $t-1$. Denoting the fraction of entrepreneurs who survive each period by ϑ, the net worth can be expressed as follows:

$$P_t NW_t = \vartheta[R^K_t Q_{t-1} K_t z(\overline{\omega}_t)] + W^E_t. \tag{14}$$

Equation (14) indicates that the entrepreneur's net worth is made up of the return on investment and the entrepreneurial wage income. Given that the borrower's and the lender's share of total return should add up to $z(\overline{\omega}_t)+g(\overline{\omega}_t,\varrho_t) = 1-\nu_t$ (where ν_t is the cost of monitoring, a deadweight loss associated with financial frictions) and by using the participation constraint of the lenders, we can rewrite the net worth of the entrepreneur as:

$$P_t NW_t = \vartheta[R_t^K Q_{t-1} K_t (1-\nu_t) - (1+i_{t-1}^*) S_t D_t^E] + W_t^E. \quad (15)$$

It is clear from (15) 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 is an additional mechanism that magnifies the role of the financial accelerator in the economy through transmitting fluctuations in the nominal exchange rate to the balance sheets of entrepreneurs.

The entrepreneurs leaving the scene at time t consume their return on capital. The consumption of the exiting entrepreneurs, C_t^E, can then be written as:[10]

$$P_t C_t^E = (1-\vartheta)[R_t^K Q_{t-1} K_t (1-\nu_t) - (1+i_{t-1}^*) S_t D_t^E]. \quad (16)$$

Because of investment adjustment costs and incomplete capital depreciation, entrepreneurs' return on capital, R_t^K, is not identical to the rental rate of capital, R_t. The entrepreneurs' return on capital 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 $\left(\frac{Q_{t+1}}{Q_t}\right)$:

$$E_t R_{t+1}^K = E_t[\frac{R_{t+1}}{Q_t} + \frac{Q_{t+1}}{Q_t}\{(1-\delta) + \Psi_I(\frac{I_{t+1}}{K_{t+1}} - \delta)\frac{I_{t+1}}{K_{t+1}} - \frac{\Psi_I}{2}(\frac{I_{t+1}}{K_{t+1}} - \delta)^2\}]. \quad (17)$$

2.4 Monetary Policy

We adopt a standard formulation for the structure of monetary policy framework in the baseline calibration. We assume that the interest rate rule is of the following form:

$$1 + i_t = (1+i)\ (\pi_t)^{\epsilon_\pi} (Y_t/Y)^{\epsilon_Y}, \quad (18)$$

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

Under the fixed exchange rate regime, the monetary policy rule is given by:

$$\frac{S_t}{S_{t-1}} = 1. \quad (19)$$

[10]It is assumed that the entrepreneurs consume an identical mix of domestic and foreign goods in their consumption basket as is given by the composite consumption index in equation (2).

2.5 General Equilibrium and Balance of Payments Dynamics

Market clearing in the final good sector requires that total domestic output be equal to domestic consumption, domestic investment and exports to the rest of the world. Also, given that frictions such as adjustment and monitoring costs are expressed in terms of the final composite good, part of the output is taken up with the price adjustment costs for final consumption goods as well as those for imported and exported goods and the monitoring costs. Thus the overall resource constraint faced by the domestic economy can be written as:

$$Y_t = Y_{H,t} + Y_{X,t}, \tag{20}$$

where

$$\begin{aligned} Y_{H,t} &= C_{H,t} + C^E_{H,t} + I_{H,t} + (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma}[\sum_{i=H,X} \frac{\Psi_i}{2}(\frac{P_{i,t}}{P_{i,t-1}} - 1)^2 \\ &\quad + \frac{\Psi_M}{2}(\frac{P_{M,t}}{P_{M,t-1}} - 1)^2 + \nu_t \frac{R^K_t}{P_t} Q_{t-1} K_t], \end{aligned} \tag{21}$$

where $Y_{X,t}$ is the foreign demand for domestic goods (see equation (7)), $C_{H,t}$ and $C^E_{H,t}$ are the household and entrepreneur's consumption demand for domestic goods, and $I_{H,t}$ is the domestic investment goods used by the unfinished capital producing firms. In (21), Ψ_H, Ψ_X and Ψ_M denote price adjustment costs for domestic, exported and the imported good, respectively and ν_t is the cost of monitoring for the lenders that is passed on to the domestic economy through the external finance premium.

Equilibrium in the labor market requires that:

$$N_t = {H_t}^{1-\Omega}, \tag{22}$$

where ${H_t}^{1-\Omega}$ is the labor demand for non-entrepreneurial labour.

Substituting (20) and the profits of both the final good producing and the importing firms into the budget constraints of the households and the entrepreneurs yields the following balance of payments condition after aggregation:

$$S_t P_{X,t} Y_{X,t} - P^*_{M,t} Y_{M,t} = S_t(1 + i^*_{t-1})(D^H_t \Psi_{D,t-1} + D^E_t) - S_t(D^H_{t+1} + D^E_{t+1}), \tag{23}$$

where $P^*_{M,t}$ is the price of imports and $Y_{M,t}$ is the aggregate import demand. The first and the second terms on the left are exports and imports, and on the right is simply the change in the net foreign asset position aggregated over households and entrepreneurs.

In Appendix B, we present the equilibrium model equations for both domestic and the foreign economy.

3 Solution and Parametrization

We first transform the model to reach a stationary representation where a steady state exists. The model is then solved numerically up to a second order approximation using Sims (2005).[11]

3.1 Consumption, Production and Monetary Policy

We maintain that the structure of consumption, production and monetary policy 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 domestic economy. We set the discount factor, β at 0.99, implying a riskless annual return of approximately 4 per cent in the steady state (time is measured in quarters). 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. In the baseline case, we set the degree of openness, v, to be 0.35 which is within the range of the values used in the literature.[12] The share of capital in production, η, is taken to be 0.35, consistent with other studies.[13] Following Devereux et al. (2006), 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 for all sectors. The quarterly depreciation rate δ is taken to be 0.025, a conventional value used in the literature. Similar to Gertler et al. (2007), 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. Regarding monetary policy, we use the original Taylor estimates and set $\epsilon_\pi = 1.5$ and $\epsilon_Y = 0.5$ in the baseline calibration. We assume ρ_ϱ to be 0.5, so that it takes

[11] The non-stochastic steady state of the model is solved numerically in MATLAB, and then the second order approximation of the model and the stochastic simulations are computed using Michel Juillard's software Dynare. Details of the computation of the non-stochastic steady state and the stationary model equations are available upon request.

[12] The values for openness in the existing literature range between 0.25 (Cook, 2004; Elekdag and Tchakarov, 2007) and 0.5 (Gertler et al., 2007). We chose to set a middle value of this range, but we conduct a sensitivity analysis regarding the value of openness in Section 4.2.2.

[13] See, for example, Cespedes et al. (2004) and Elekdag and Tchakarov (2007).

9 quarters for the shock to die away. Table 1 summarizes the parametrization of the model for consumption, production, and monetary policy used in the baseline calibration.[14]

3.2 Entrepreneurs

The parameter values for the entrepreneurial sector in the domestic and foreign economies are set to reflect their defining characteristics and are listed in Table 2. 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 0.3 and 200 basis points, reflecting the historical average of emerging market economies within the last decade.[15] The monitoring cost parameter, μ, is taken as 0.2 for the domestic economy as in Devereux et al. (2006). These parameter values imply a survival rate, ϑ, of approximately 99.33 per cent in the domestic economy.

For the foreign economy, we closely follow Bernanke et al. (1999). The leverage ratio is set to 0.5. The higher leverage ratio for entrepreneurs in foreign economy reflects the fact that advanced economies have deeper and more sophisticated financial markets, and therefore better financing opportunities, leading to a higher economy-wide leverage. Moreover, having experienced dramatic financial crises at the turn of the century, emerging market economies have been more vigilant towards lending activities through tighter financial regulation, which in many cases has helped to contain leverage ratios in these economies.[16] The risk spread of 2 per cent in the steady state is reported for the US economy so we set a quarterly external risk premium, Φ_t^*, of 0.005. The cost of monitoring in the foreign economy, denoted by μ^*, is taken to be 0.12, lower than the domestic economy reflecting the presence of better institutions. Given these parameter values, the implied survival rate is 99.66 per cent in the foreign economy.

[14] We carry out a series of sensitivity analyses in order to asses the robustness of our results under the benchmark calibration. In Section 4, we report the results regarding the degree of financial contagion, trade openness, and monetary policy parameters. We also conduct sensitivity checks with regard to the degree of exchange rate pass-through, and find that our main results are not sensitive to changes in these parameters. These are not reported due to space limitations.

[15] These figures are decade averages for emerging Americas, emerging Asia, and emerging Europe between 2000-2010. Worldscope data (debt as a percentage of assets - data item WS 08236) are used for the leverage ratio. External risk premium is calculated as the difference between the lending and the policy rate for emerging market countries, where available, using data from Haver Analytics for the same time period. Variations in these parameters affect our results only quantitatively, but not qualitatively.

[16] See Kalemli-Ozcan et al. (2011) for stylized facts on bank and firm leverage for 2000- 2009 for both advanced and emerging economies.

4 Financial Crisis and the Domestic Economy

4.1 Model Dynamics

In this section, we first report a number of business cycle statistics for the model and compare them with those observed in the data from both emerging and advanced economies. In our analysis, we focus only on the response of macroeconomic aggregates to two types of financial shock: one originating in the domestic economy and the other in the foreign (global) economy. In both cases, the source of the financial shock is the change in lenders' perception of the entrepreneurs' productivity. Given the specific nature of the source of the shock in our analysis, one would not expect that the model to match the data in all dimensions. Nonetheless, in what follows we compare movements and comovements of some key variables in the data and in the model to generate confidence in the model's ability to correctly capture dynamics and in the proposed calibration of the parameters values.

Table 3 presents business cycle statistics coming from the data as well as the simulation results under our benchmark parametrization. In the top panel of Table 3, standard deviations of output, consumption, investment, current account, inflation, interest rate and exchange rate for Argentina, Brazil, Korea, Mexico and Philippines are listed, while the middle panel reports standard deviations of this set of variables relative to the standard deviation of output. In both panels, the simulation results are reported under two scenarios; a domestic shock and a global shock. A glance at the top two panels of Table 3 suggests that in most cases moments from the data are well-matched by moments from the model except in the case of inflation and the exchange rate. This is particularly the case for volatility of output, consumption, current account as well as of interest rate in terms of both individual volatilities and volatilities relative to output.

The correlations of consumption, investment and current account and autocorrelations of these variables are presented in the bottom panel of Table 3. Similar to above, it can be seen that, model results match the business cycle statistics quite well for the same group of countries.

Table 4 repeats the same exercise for an advanced economies sample which we represent by EU and the US. Similar to that in Table 3, Table 4 suggests that our simulation results match the business cycle statistics pretty well with the exception of current account and output correlations. In contrast to the case with emerging market countries, volatility of inflation in the model is also quite close to that in the data for advanced economies.

Finally, Table 5 presents cross-country correlations of output, consumption and investment from our model with those from the same sample of emerging market countries as above for two separate sample periods; 1999-2011 and 2007-2011 for the global crisis period. As can be seen from Table 5, our simulation results match the cross-correlations in the data for this group of countries quite well especially over the global financial crisis period which is our main focus in this paper.

We now turn to examining the responses of both the domestic and the foreign country in response to two types of financial shock by assessing the impulse responses in our two-country model.

4.2 Financial Crisis Originating in the Domestic Economy

We first investigate the case of a domestic financial crisis by tracing how an unanticipated (temporary) shock to investors' perception of entrepreneurs' productivity is transmitted to the rest of the economy. Such a perception shock leads to a reversal of capital flows out of the domestic country, which we refer to as the sudden stop.[17] The response of the domestic economy to the sudden stop is presented in Fig.1. When the investors' perception about the distribution of the entrepreneurs' productivity changes, lending to domestic entrepreneurs becomes more risky, leading to a rise in the external risk premium 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 a sudden stop to some extent. Lower borrowing, however, decreases the future supply of capital and hence brings about a decrease in investment in the economy. The fall in the inflow of capital also lowers the demand for domestic currency, leading to its depreciation. Since the entrepreneurs' borrowing is denominated in foreign currency, this unanticipated change in the exchange rate also creates balance sheet effects through a rise in the real debt burden. The outcome is lower investment and output in the economy following the sudden stop, in line with the experience of several emerging market countries during the 1990s.

Although the rise in the nominal exchange rate puts an upward pressure on the

[17] The magnitude of the shock is 1 percent, which causes outflow of capital by about 1.5 percent of GDP on impact.

CPI based inflation, the decrease in the domestic price level more than offsets this effect, bringing about a fall in the CPI. In spite of this lower price level, however, aggregate demand falls due to lower investment and output, resulting in lower labor demand and thereby lower real wages.

There is an additional channel through which the effect of the shock is transmitted to the rest of the economy, working through the export demand. Following the depreciation of the domestic currency, the foreign demand for domestic goods increases. On the other hand, imports decline on account of both income and exchange rate effects. 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. 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 benefitted from significant improvements in their exports following the 1997 Asian crisis, which has been widely viewed to be an important factor in their swift recoveries (see, for example, Bleaney, 2005). It is important to note, however, that this favorable impact of export demand on output recovery not only disappears but starts to work in the opposite direction when the financial crisis originates in the global economy, as is explored in the following section.

4.3 Financial Crisis in the Global Economy

In this section, we explore the channels through which a financial shock originating in the foreign country is transmitted to the domestic economy and the role of trade openness in shaping the domestic economy's responses to the financial shock. The perception shock is now faced by the foreign entrepreneurs, which we take to represent the case of a global financial crisis.

4.3.1 The impact of the financial shock on the foreign economy

Fig.2 presents responses of foreign macroeconomic variables to a 1 per cent negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. As is seen from Fig.2, the impact of the shock on the foreign economy is similar to the sudden stop experience of the domestic economy described above. Following the shock, lending to foreign entrepreneurs become risky, leading to a rise in risk premium which, through reducing borrowing and thus supply of capital leads to lower investment and output in the foreign economy. It is also clear from Fig.2 that the falls in investment, output and consumption are smaller in the foreign economy as compared with the domestic one, given that financial frictions are greater in the domestic economy - domestic entrepreneurs borrow in foreign currency and monitoring domestic entrepreneurs are more costly.

We now turn to how the foreign (global) financial shock is transmitted onto the domestic economy.

4.3.2 The transmission of the foreign shock onto the domestic economy

The global financial shock is transmitted to the domestic economy through three separate channels involving both financial and trade linkages. The first of these is through financial spillovers. We postulate that investors' perception regarding the true distribution of entrepreneurs' productivity in the foreign economy and the domestic economy are inherently related. This is based on the notion that investors optimally 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 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, a phenomenon commonly referred to as "pure contagion" (see, for example, Kaminsky and Reinhart, 2000 and Moser, 2003). Motivated by these observations, we maintain that one channel through which the financial shock spills over onto the domestic economy is through an unfavourable shift in investors' perception of the domestic entrepreneurs. In what follows, we refer to this mechanism as the financial contagion channel.

The second channel through which the global financial shock is propagated to the domestic economy is the export channel. The financial crisis in the foreign economy reduces output and thereby export demand in the foreign economy and thus net exports of the domestic economy. There is also a third channel of propagation of the global financial shock, which works through a substitution effect. The unfavourable change in investors' perception of the foreign entrepreneurs' productivity induces investors to look for alternative investment opportunities, leading to an increase in capital inflows into the domestic economy, which would, partly offset the impact of the first two channels. Clearly, the lower the financial contagion from the foreign economy to the domestic economy, the greater the impact of the favourable substitution effect. We now turn to exploring these channels separately.

Fig.3 and 4 present the domestic economy's response to a global financial shock, with and without financial contagion, respectively.[18] Fig.3 features two alternative scenarios; full contagion, $\xi = 1$ and partial contagion, $\xi = 0.5$. The deterioration in investors' perception in the domestic economy following that in the foreign economy raises the external risk premium, setting in motion the process described above. Responses presented in Fig.3 reveal that the impact of the global financial shock on the domestic economy is larger than that of a domestic one. Although the change in the perception of foreign investors about the state of the domestic economy is identical under the two scenarios, falls in capital, investment and output are greater with the global financial shock and the fall in investment is twice the size. Similarly, the decrease in foreign borrowing is larger than that of the previous case, leading to a sharper depreciation of the domestic currency. Likewise, changes in inflation and asset prices are much more pronounced under the global financial shock than with the sudden stop of domestic origin.

One main difference between this case of a foreign financial shock and the domestically originated one, as explored in the previous section, is in the way the export channel works. As is seen above, when the economy is hit by a financial crisis 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 with partial financial contagion ($\xi = 0.5$), the export channel works in the opposite direction, adding to the unfavourable impact that works through financial contagion, hence worsening the overall fall in output. This is because the global financial crisis reduces net worth, capital, investment and output in the foreign economy, and therefore decreases the domestic economy's exports and therefore output. As output in the foreign economy returns to its previous level, the export demand improves although the trade

[18] Our analysis of the amplification of the foreign financial shock onto the domestic economy, as portrayed in Figures 3-8, is based on a 0.75 % negative shock to the perception of investors regarding the productivity of foreign enterpreneurs. This shock generates an increase in the risk premium by about 1 percent quarterly on impact in the domestic economy as in the case of a financial crisis of domestic origin so that the responses are comparable to those in Fig. 1.

balance continues to deteriorate owing to the rise in imports following the recovery in domestic output. When there is full-contagion from the global to the domestic economy, however, the sharp depreciation of the exchange rate delivers an increase in exports, as is seen in Fig.3. Yet, the worsening of the risk premium and of entrepreneurs' balance sheets is much larger and thus the decline in output is almost as twice as the decline under partial financial contagion.

In order to explore the non-contagion channels more explicitly we now have a further experiment where we shut off the contagion channel and thus focus on the export and substitution channels. Fig.4 denotes the changes in the domestic economy following the financial crisis in the foreign economy, without contagion in the form of a further financial shock in the domestic economy. There are now two opposing effects of the foreign economy's financial crisis on the macroeconomic outcomes in the domestic economy. The first is through the reduced net exports due to the contraction in the foreign economy following the financial crisis. The second, in contrast, is a favourable impact leading to an increase in capital inflows. This is because lending to domestic entrepreneurs is now perceived to be more profitable as the domestic economy is in a better financial position.[19] The overall response is determined by the balance of the two effects. As is seen from Fig.4, in the absence of financial contagion, the increase in risk premium is considerably lower than that in the above two cases and that of the foreign economy. As a result, capital inflows, net worth and investment all increase following the financial shock, and thus contraction in output in the domestic economy is smaller.

The heterogeneous nature of the profile of crisis across countries, as demonstrated by Fig.2 and Fig.3, has also been highlighted by Milesi-Ferretti and Tille (2011) in their analysis of capital flows during the 2007-2009 global financial crisis episode. A glance at the capital flows diagrams, suggests that following the financial shock there is a sharp drop in capital flows into the foreign economy, which remain below steady-state levels for extended periods of time. On the other hand, capital flows to the domestic country recover relatively quickly toward the pre-shock levels, as is seen in Fig.3. Indeed, Milesi-Ferretti and Tille (2011) document that capital inflows to advanced countries exhibited a sharp reversal in the last quarter of 2008 and remained well-below pre-crisis levels until the end of their sample period, 2009.

[19] IMF (2011) shows that net capital inflows to emerging economies are highly correlated with global financing conditions, with global interest rates and risk aversion playing an important role.

They show that, in contrast, the pull-back of capital flows from emerging market countries had been much shorter lived, and inflows to these countries in 2009 reached magnitudes broadly comparable to the pre-crisis levels.

4.3.3 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, it follows that the extent of the domestic response to a global financial tightening will be determined by, among other factors, the openness of the domestic economy. We now turn to exploring the role of trade openness in the propagation of the foreign financial shock more explicitly.

Fig.5 and Fig.6 illustrate the domestic responses to a foreign financial shock under varying degrees of trade integration between the domestic economy and the foreign economy with and without financial contagion, respectively. 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 good items in the domestic consumption basket. The profile of the domestic economy in Fig.5 exhibits the important role played by the degree of trade openness in the amplification of the global financial shock. The greater the trade integration between the two countries, the more significant is the impact of the global financial crisis on the domestic economy. This holds regardless of the degree of financial contagion as is seen from the responses in Fig.5 and Fig.6. The relationship between a country's openness to trade and its vulnerability to sudden stops has already been the focus of an extensive literature (see, for example Calvo et al. 2006 and Martin and Rey, 2006). A common finding in this literature has been that openness makes countries less vulnerable to crises. In contrast, we find that when the financial shock originates in the rest of the world - when the crisis is a global one - the more open an economy, the greater the unfavorable consequences of the financial crisis for the domestic economy. Indeed, 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.[20]

[20] The fall in output in the first quarter of 2009 as compared with a year earlier was 10.1, 10.2 and 13.8 per cent 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 per cent, respectively over the same period (The Economist, July 4th, 2009).

4.4 Monetary policy options and welfare analysis

What is the role of monetary policy in determining the domestic economy's response to the global financial shock? In what follows, we attempt to answer this question by exploring the effects of the financial shock on the domestic economy under two separate monetary policy regimes. These are a fixed exchange rate regime and a flexible inflation targeting (IT) regime where monetary authority responds to both inflation and the output gap.

Before we start assessing the implications of the fixed exchange rate regime versus a flexible one (as under IT), it is important to point out the consequences of nominal exchange rate changes in our model. A rise in the nominal exchange rate improves net exports while creating a contractionary balance sheet effect for the financial (entrepreneurial) sector given financial frictions and liability dollarization in the domestic economy. As leverage and the risk premium increases, the ability of entrepreneurs to borrow and produce capital declines, reducing investment and output in equilibrium. Overall, which monetary regime does better in insulating the real economic activity from financial shocks will be determined by the relative magnitude of these two effects.

Fig.7 and Fig.8 illustrate the responses under the two regimes with and without financial contagion, respectively and offer a number of interesting insights. As is seen from Fig.7, in the presence of financial contagion, the global financial shock brings about a sharp rise in the external risk premium, a steep fall in capital inflows and thus in investment under both regimes. However, the impact of the shock on output is more pronounced under the fixed exchange rate regime than under the IT regime. In our calibration, the decline in exports under the fixed exchange rate regime is large enough to offset the favourable impact of stable exchange rate on the entrepreneurs' balance sheets leading to a sharper fall in output in response to the financial shock relative to under IT.

Interestingly, the absence of financial contagion alters the ranking of the two regimes in insulating the domestic economy from financial shocks originating in the foreign economy. In the absence of a direct financial channel through which foreign financial shocks are transmitted onto the domestic economy, output in the domestic economy rises under the fixed exchange rate regime, as is depicted by Fig.8. Since the nominal exchange rate is constant under this scenario, the increase in the risk premium is lower than under the IT regime. Lower external risk premia, in turn, lead to a rise in the net worth of firms, and thus in investment and output without increasing entrepreneurs' debt. The real appreciation of the exchange rate is greater under the IT regime, so is the decline in exports.

Overall, this experiment indicates that a global financial shock is likely to be expansionary under the fixed exchange rate regime when there is no direct financial spillovers from the global economy. However, in order to reach normative conclusions regarding the choice of the monetary policy framework one would need to carry out a rigorous welfare analysis, which we present in the next section.

Welfare analysis We now turn to an assessment of alternative monetary policy frameworks based on the evaluation of welfare, taking the utility function of consumers as the objective. Following Faia and Monacelli (2007), and Gertler and Karadi (2010), we start by expressing the household utility function in recursive form:

$$V_t = U(C_t, H_t) + \beta E_t V_{t+1} \tag{24}$$

where $V_t \equiv E_0 \sum\limits_{t=0}^{\infty} \beta^t U(C_t, H_t)$ denotes the welfare function. We take a second order approximation of V_t around the deterministic steady state. Using the second order solution of the model, we then calculate V_t under both the IT and the fixed exchange rate regimes.[21] We also calculate the fraction of consumption, Ψ, required to equate welfare under the fixed exchange rate V_t^{FX}, to the one under the IT regime, V_t^{IT}, as a welfare measure. Under our specification of utility function, and $\sigma = 1$ (log utility), Ψ can be expressed as

$$\Psi = \left(\frac{(\exp\{(V_t^{opt} - V_t)(1-\beta)\}(C - \frac{H^{1+\varphi}}{1+\varphi})) + \frac{H^{1+\varphi}}{1+\varphi}}{C}\right) - 1 \tag{25}$$

where C and H denote the steady state values of the corresponding variables.[22]

Table 6 presents the calculated values of welfare and Ψ for the two monetary policy regimes under a number of different scenarios.

As is seen from Table 6, when the source of the financial shock is domestic, the IT regime is welfare-improving, as is presented in the upper part of the table

[21] See Scmitt-Grohe and Uribe (2007) for an in depth discussion on using second order approximation to utility function to calculate the welfare.

[22] This is based on the assumption that the enterpreneurial share of consumption is negligible (see, Bernanke et al. 1999).

and the welfare gains associated with the IT regime relative to the fixed exchange rate regime is about 0.03 percent of steady state consumption (first and second columns of Table 6). The same holds in the face of foreign financial shocks when financial spillovers are strong ($\xi = 1$ and $\xi = 0.5$), as the expansionary effects of the depreciation under IT offset the contractionary balance sheet effects generated by the entrepreneurs' foreign currency borrowing, as explained above. Overall, in our calibration, fixed exchange rate regime increases welfare losses associated with the global crisis when there are strong financial spillovers between the two countries.

In contrast, when there is no contagion the fixed exchange rate regime is welfare superior (negative Ψ) by about 0.01 per cent of consumption, which derives from two factors. On the real side, the smaller appreciation in the real exchange rate under the fixed exchange rate regime brings about a less dramatic decline in exports, hence aggregate demand is less affected. On the financial side, lower external risk premia under the fixed exchange rate regime leads to a rise in the net worth of firms, and thus in investment and output.

As explained above, the ranking of the fixed exchange rate regime versus the IT regime is determined by the relative importance of the export channel versus the balance sheet channel. As potential factors underlying the importance of these channels, we consider alternative values of openness and leverage to see how the welfare comparison between the two regimes is affected. Our simulations reveal that as openness increases, the welfare cost associated with having a fixed exchange rate regime increases (third and fourth columns in Table 6). This is because the export channel is more effective in more open economies, making the absence of depreciation more costly. We also calibrate the model with an alternative level of leverage and show that the ranking of the regimes is overturned with higher leverage. For example, when the leverage is higher, $\chi = 0.5$, the fixed exchange rate regime results in higher welfare in the face of a global financial shock regardless of the level of financial contagion, as is seen in the last two columns of Table 6. When the initial leverage is high, the financial accelerator effect amplifies, so is the impact of the crisis, leading to the fixed exchange rate regime delivering a better welfare outcome (negative Ψ), despite losses in domestic demand.

5 Conclusions

This paper has developed a two-country DSGE model to investigate the transmission of a global financial crisis to a small open emerging economy. Our framework fully specifies both trade and financial linkages between the countries to study some important aspects of the recent global financial crisis experience.

We find that a small, open economy facing a sudden stop of capital inflows arising from financial distress in the global economy is likely to face a more prolonged crisis than sudden stop episodes of domestic origin. This is largely attributable to an important source of difficulty in responding to a global financial shock - the inability of countries to export their way out of a crisis due to the slump in world consumer demand initiated by the global financial distress. In contrast, when the financial shock is of domestic origin, the domestic economy benefits from the depreciation of its currency and the resulting current account reversal, which at least partly compensates for the fall in economic activity. This beneficial export channel disappears and indeed works in the opposite direction when the rest of the world also faces an unfavorable financial disturbance. The resulting contraction in output in the foreign economy is transmitted to the domestic economy through a fall in export demand, further reducing aggregate demand for home produced goods. This, in turn, is likely to increase the duration and the severity of crises for both countries in question, as mutual reductions in export demand set in motion a vicious circle, even in the absence of any protectionist policies.

Given the nature of our framework with both financial and trade linkages, our results have clear implications for the degree of both the financial and the trade integration on the amplification of a global financial crisis for the domestic economy. We find that the lower the financial contagion from the global economy, the less significant the impact of a global financial shock on the domestic economy, as expected. Low contagion enables the domestic country to recover from the global financial shock rapidly on the back of capital flows fleeing from the foreign towards the domestic economy. We argue that this finding may shed some light on why the recent financial crisis has been relatively short-lived for a number of emerging market countries, especially those with limited financial exposure to the financial distress in the global economy. As capital inflows surged, these economies have experienced rapid recovery in credit, asset prices, investment, and output. Regarding the role of trade integration, in contrast to the existing literature, we find that the greater a country's trade integration with the rest of the world, the greater the response of its macroeconomic aggregates to a sudden stop of capital flows. This is because the more open an economy the greater the impact of the fall in export demand from the rest of the world, as was experienced by countries such as Singapore, Taiwan and Turkey, all highly open economies registering among the highest output contractions in 2009.

Our results also suggest that the degree of financial contagion, the degree of trade openness and the scale of foreign currency denominated debt are key determinants of how monetary policy regimes influence the propagation of the global financial shock. In the absence of financial spillovers between countries, risk premia are lower, net worth is higher so are investment, consumption and output under the fixed exchange rate regime, a result which is overturned in the presence of financial contagion. Moreover, our welfare calculations reveal that the greater the openness of an economy, the greater the costs associated with the fixed exchange rate regime. We find that, in contrast, at high levels of liability dollarization the fixed exchange rate regime improves welfare irrespective of the degree of financial spillovers, a result deriving from the balance sheet channel dominating the export channel.

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Appendix A - Optimal Contracting Problem

Entrepreneurs observe $\omega_{t+1}(k)$ *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. As shown by Bernanke et al. (1999), the optimal contract between the lender and the entrepreneur is a standard debt contract characterized by a default threshold, $\overline{\omega}_{t+1}(k)$, such that if $\omega_{t+1}(k) \geq \overline{\omega}_{t+1}(k)$, the lender receives a fixed return in the form of a contracted interest on the debt. If $\omega_{t+1}(k) < \overline{\omega}_{t+1}(k)$, then the borrower defaults, the lender audits by paying the monitoring cost and keeps what it finds. Therefore, we can define the expected return to entrepreneur and lender, respectively, as follows:

$$
\begin{aligned}
& E_t[R^K_{t+1} Q_t K_{t+1}(k)(\int_{\overline{\omega}_{t+1}(k)}^{\infty} \omega(k) f(\omega) d\omega - \overline{\omega}_{t+1}(k) \int_{\overline{\omega}_{t+1}(k)}^{\infty} f(\omega) d\omega)] \\
= \; & E_t[R^K_{t+1} Q_t K_{t+1}(k) z(\overline{\omega}_{t+1}(k))], \qquad \text{(A1)}
\end{aligned}
$$

$$
\begin{aligned}
& E_t[R^K_{t+1} Q_t K_{t+1}(k)(\overline{\omega}^*_{t+1}(k) \int_{\overline{\omega}_{t+1}(k)}^{\infty} f(\omega^*) d\omega^* \\
& +(1-\mu) \int_0^{\overline{\omega}_{t+1}(k)} \omega^*_{t+1}(k) f(\omega^*) d\omega^*)] \\
= \; & E_t[R^K_{t+1} Q_t K_{t+1}(k) g(\overline{\omega}_{t+1}(k); \varrho_t)], \qquad \text{(A2)}
\end{aligned}
$$

where R^K_t denotes the *ex-post* realization of return to capital and $z(\overline{\omega})$ is the borrowers' share of the total return. We use the definition of the lender's perception of productivity shock $\omega^*_{t+1}(k)$ in Equation (A2) where $g(\overline{\omega}(k); \varrho)$ represents the lenders' share of the total return, itself a function of both the idiosyncratic shock and the perception factor.

We assume that each entrepreneur is subject to an idiosyncratic shock $\omega_t \in [0, \infty)$ with $E(\omega_t) = 1$ and c.d.f and p.d.f are given by $F(\omega_t)$ and $f(\omega_t)$. We define $z(\overline{\omega})$ as the expected gross share of the proceeds going to the borrower (ignoring the time subscript t and entrepreneur index k for notational simplicity):

$$
\begin{aligned}
z(\overline{\omega}) & \equiv \int_{\overline{\omega}}^{\infty} \omega f(\omega) d\omega - \overline{\omega} \int_{\overline{\omega}}^{\infty} f(\omega) d\omega \qquad \text{(A3)} \\
& \equiv 1 - \int_0^{\overline{\omega}} \omega f(\omega) d\omega - \overline{\omega} \int_{\overline{\omega}}^{\infty} f(\omega) d\omega \\
& \equiv 1 - \Gamma(\overline{\omega}),
\end{aligned}
$$

where $\Gamma(\overline{\omega}) = [1 - F(\overline{\omega})]\overline{\omega} + \int_0^{\overline{\omega}} \omega dF(\omega)$, following Bernanke et al. (1999).

Let R_t^C be the contractual rate specified by the lender. By definition, the default threshold $(\overline{\omega}_{t+1}(k))$ is set at the level of returns that is just enough to honor the debt contract obligations, satisfying the following equation:

$$\frac{\overline{\omega}_{t+1}(k) R_{t+1}^K Q_t K_{t+1}(k)}{S_{t+1}} = R_{t+1}^C(k) D_{t+1}^E(k) \tag{A4}$$

Recall that the misperception of investors regarding the distribution of ω_{t+1} is represented by ϱ_t such that $\omega_{t+1}^*(k) = \omega_{t+1}(k)\varrho_t$. As in Curdia (2008), we write the participation constraint of investors (in foreign currency):

$$\begin{aligned}(1+i_t^*) D_{t+1}^E(k) &= E_t[(1 - F^*(\overline{\omega}_{t+1}(k))) R_{t+1}^C(k) D_{t+1}^E(k)] \\ &\quad + (1-\mu) E_t\left[\int_0^{\overline{\omega}_{t+1}(k)} \omega^*(k) dF^*(\omega^*(k)) \frac{R_{t+1}^K Q_t K_{t+1}(k)}{S_{t+1}}\right] \end{aligned} \tag{A5}$$

Define:

$$\begin{aligned} F^*(\overline{\omega}) &\equiv \Pr(\omega^* \leq \overline{\omega}) \\ &= \Pr(\omega\varrho \leq \overline{\omega}) \\ &= \Pr(\omega \leq \frac{\overline{\omega}}{\varrho}) \\ &= F(\frac{\overline{\omega}}{\varrho}). \end{aligned} \tag{A6}$$

We also define $G(\overline{\omega}) \equiv \int_0^{\overline{\omega}} \omega f(\omega) d\omega \equiv \int_0^{\overline{\omega}} \omega dF(\omega)$ and note that $G(\overline{\omega}) = F(\overline{\omega}) E(\omega | \omega < \overline{\omega})$. Then we similarly express:

$$\begin{aligned} G^*(\overline{\omega}) &= F^*(\overline{\omega}) E(\omega^* | \omega^* < \overline{\omega}) \\ &= F(\frac{\overline{\omega}}{\varrho}) E(\omega | \omega < \frac{\overline{\omega}}{\varrho}) \\ &= \varrho G(\frac{\overline{\omega}}{\varrho}). \end{aligned} \tag{A7}$$

Noting that the monitoring cost (v_t) is given by $\mu G^*(\overline{\omega})$ and substituting (A4), (A6) and (A7) into (A5) we get:

$$\begin{aligned}(1+i_t^*) D_{t+1}^E(k) &= E_t\left[\frac{R_{t+1}^K Q_t K_{t+1}(k)}{S_{t+1}} \{(1 - F(\frac{\overline{\omega}_{t+1}(k)}{\varrho_t}))\overline{\omega}_{t+1}(k) \right. \\ &\quad \left. + (1-\mu)\varrho_t G(\frac{\overline{\omega}_{t+1}(k)}{\varrho_t})\}\right] \end{aligned} \tag{A8}$$

which can be re-arranged to yield:

$$(1+i_t^*)D_{t+1}^E(k) = E_t[g(\overline{\omega}_{t+1}(k);\varrho_t)\frac{R_{t+1}^K Q_t K_{t+1}(k)}{S_{t+1}}] \tag{A9}$$

In (A9) $g(\overline{\omega};\varrho)$ is defined as

$$g(\overline{\omega};\varrho) \equiv \varrho[\Gamma(\frac{\overline{\omega}}{\varrho}) - \mu G(\frac{\overline{\omega}}{\varrho})]. \tag{A10}$$

We assume that the aggregate risk in terms of the exchange rate and the return to capital is borne by lenders such that the participation constraint holds with expectations as in Cespedes et al. (2004), Elekdag and Tchakarov (2007) and Curdia (2008). Therefore, it should be clear that return to capital (R^K) and the cut off value ($\overline{\omega}$) are state contingent and the participation constraint holds *ex post* with equality at each possible state.

We can now analyze the optimal contract which determines a state contingent cut off value $\overline{\omega}_t$ and $K_{t+1}(k)$ solving the following maximization problem:

$$\max\ E_t[R_{t+1}^K Q_{t+1} K_{t+1}(k) z(\overline{\omega}_{t+1}(k))]$$

subject to the participation constraint (A8). The optimality conditions for this maximization problem are:

$$E_t[R_{t+1}^K Q_t z(\overline{\omega}_{t+1}(k))] + E_t[\Lambda_{t+1}(\frac{R_{t+1}^K Q_t g(\overline{\omega}_{t+1}(k);\varrho_t)}{S_{t+1}} - \frac{(1+i_t^*)Q_t}{S_t})] = 0 \tag{A11}$$

$$\Lambda_{t+1}(U) = -\frac{\pi(U) z'(\overline{\omega}_{t+1}^U(k)) S_{t+1}^U}{g'(\overline{\omega}_{t+1}^U(k);\varrho_t)} \tag{A12}$$

where U is the state of the world, $\pi(U)$ is the probability of the state U and Λ_{t+1} is the Lagrangian multiplier. Substituting (A12) into (A11) yields:

$$\begin{aligned} & E_t[R_{t+1}^K(\frac{z'(\overline{\omega}_{t+1}(k)) g(\overline{\omega}_{t+1}(k);\varrho_t)}{g'(\overline{\omega}_{t+1}(k);\varrho_t)} - z(\overline{\omega}_{t+1}(k)))] \qquad \text{(A13)} \\ = \quad & (1+i_t^*)E_t[\frac{S_{t+1}}{S_t}(\frac{z'(\overline{\omega}_{t+1}(k))}{g'(\overline{\omega}_{t+1}(k);\varrho_t)})] \end{aligned}$$

Given that entrepreneurs are identical *ex ante,* each entrepreneur faces the same financial contract. We can then write the external risk premium $(1+\Phi_{t+1})$ as follows:

$$1 + \Phi_{t+1} = [\frac{z'(\overline{\omega}_{t+1})}{g(\overline{\omega}_{t+1}, \varrho_t)z'(\overline{\omega}_{t+1} - z(\overline{\omega}_{t+1})g'(\overline{\omega}_{t+1}, \varrho_t)}]E_t\{\frac{S_{t+1}}{S_t}\}. \tag{A14}$$

Using (A14), (A13) can be re-written as $E_t[R^K_{t+1}] = E_t[(1 + i^*_t)(1 + \Phi_{t+1})]$. These two equations correspond to (13) and (12) in the text.

Appendix B - Model Equations

B.1. Domestic Economy

Households

$$C_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma} C_t \tag{B1.1}$$

$$C_{M,t} = \alpha(\frac{P_{M,t}}{P_t})^{-\gamma} C_t \tag{B1.2}$$

$$P_t = [(1-\alpha)P_{H,t}^{1-\gamma} + \alpha P_{M,t}^{1-\gamma}]^{1/(1-\gamma)} \tag{B1.3}$$

$$H_t^{\varphi} = W_t \tag{B1.4}$$

$$(C_t - \frac{H_t^{1+\varphi}}{1+\varphi})^{-\sigma} = \beta(1+i_t)E_t[(C_{t+1} - \frac{H_{t+1}^{1+\varphi}}{1+\varphi})^{-\sigma}\frac{P_t}{P_{t+1}}] \tag{B1.5}$$

$$(C_t - \frac{H_t^{1+\varphi}}{1+\varphi})^{-\sigma} = \beta(1+i_t^*)\Psi_{D,t}E_t[(C_{t+1} - \frac{H_{t+1}^{1+\varphi}}{1+\varphi})^{-\sigma}\frac{P_t}{P_{t+1}}\frac{S_{t+1}}{S_t}]. \tag{B1.6}$$

Production Firms

$$W_t = \frac{(1-\eta)(1-\Omega)Y_t MC_t}{N_t} \tag{B1.7}$$

$$W_t^E = (1-\eta)\Omega Y_t MC_t \tag{B1.8}$$

$$R_t = \frac{\eta Y_t MC_t}{K_t} \tag{B1.9}$$

$$MC_t = \frac{R_t^{\eta} W_t^{1-\eta}}{A_t \eta^{\eta}(1-\eta)^{1-\eta}} \tag{B1.10}$$

$$\begin{aligned} P_{H,t} \quad = \quad & \frac{\lambda}{\lambda-1}MC_t - \frac{\Psi_H}{\lambda-1}\frac{P_t}{Y_{H,t}}\frac{P_{H,t}}{P_{H,t-1}}(\frac{P_{H,t}}{P_{H,t-1}}-1) \\ & + \frac{\Psi_H}{\lambda-1}E_t[\Theta_t \frac{P_{t+1}}{Y_{H,t}}\frac{P_{H,t+1}}{P_{H,t}}(\frac{P_{H,t+1}}{P_{H,t}}-1)] \end{aligned} \tag{B1.11}$$

$$\begin{aligned} S_t P_{X,t} \quad = \quad & \frac{\lambda}{\lambda-1}MC_t - \frac{\Psi_X}{\lambda-1}\frac{P_t}{Y_{X,t}}\frac{P_{X,t}}{P_{X,t-1}}(\frac{P_{X,t}}{P_{X,t-1}}-1) \\ & + \frac{\Psi_X}{\lambda-1}E_t[\Theta_t \frac{P_{t+1}}{Y_{X,t}}\frac{P_{X,t+1}}{P_{X,t}}(\frac{P_{X,t+1}}{P_{X,t}}-1)] \end{aligned} \tag{B1.12}$$

$$\Theta_t = \beta \frac{(C_{t+1} - \frac{\chi}{1+\varphi} H_{t+1}^{1+\varphi})^{-\sigma}}{(C_t - \frac{\chi}{1+\varphi} H_t^{1+\varphi})^{-\sigma}} \frac{P_t}{P_{t+1}} \tag{B1.13}$$

Importing Firms

$$\begin{aligned} P_{M,t} \quad = \quad & \frac{\lambda}{\lambda-1} S_t P_{M,t}^* - \frac{\Psi_M}{\lambda-1} \frac{P_t}{Y_{M,t}} \frac{P_{M,t}}{P_{M,t-1}} (\frac{P_{M,t}}{P_{M,t-1}} - 1) \\ & + \frac{\Psi_M}{\lambda-1} E_t[\Theta_t \frac{P_{t+1}}{Y_{M,t}} \frac{P_{M,t+1}}{P_{M,t}} (\frac{P_{M,t+1}}{P_{M,t}} - 1)] \end{aligned} \tag{B1.14}$$

Unfinished Capital Producing Firms

$$I_{H,t} = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma} I_t \tag{B1.15}$$

$$I_{M,t} = \alpha(\frac{P_{M,t}}{P_t})^{-\gamma} I_t \tag{B1.16}$$

$$K_{t+1} = [\frac{I_t}{K_t} - \frac{\Psi_I}{2}(\frac{I_t}{K_t} - \delta)^2] K_t + (1-\delta) K_t \tag{B1.17}$$

$$\frac{Q_t}{P_t} = [1 - \Psi_I(\frac{I_t}{K_t} - \delta)]^{-1} \tag{B1.18}$$

Entrepreneurs

$$E_t[\frac{R_{t+1}^K Q_t K_{t+1}(k)}{S_{t+1}} g(\overline{\omega}_{t+1}(k); \varrho_t)] = (1 + i_t^*) D_{t+1}(k) \tag{B1.19}$$

$$P_t NW_t = \vartheta[R_t^K Q_{t-1} K_t (1-\nu_t) - (1 + i_{t-1}^*) S_t D_t] + W_t^E \tag{B1.20}$$

$$P_t C_t^E = (1-\vartheta)[R_t^K Q_{t-1} K_t (1-\nu_t) - (1 + i_{t-1}^*) S_t D_t] \tag{B1.21}$$

$$C_{H,t}^E = (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma} C_t^E \tag{B1.22}$$

$$C_{M,t}^E = \alpha(\frac{P_{M,t}}{P_t})^{-\gamma} C_t^E \tag{B1.23}$$

$$E_t[R_{t+1}^K] = E_t[(1 + i_t^*)(1 + \Phi_{t+1})] \tag{B1.24}$$

$$1+\Phi_{t+1} = [\frac{z'(\overline{\omega}_{t+1})}{g(\overline{\omega}_{t+1};\varrho_t)z'(\overline{\omega}_{t+1}) - z(\overline{\omega}_{t+1})g'(\overline{\omega}_{t+1};\varrho_t)}]E_t\{\frac{S_{t+1}}{S_t}\} \tag{B1.25}$$

$$E_t[R^K_{t+1}] = E_t[\frac{R_{t+1}}{Q_t} + \frac{Q_{t+1}}{Q_t}\{(1-\delta)+\Psi_I(\frac{I_{t+1}}{K_{t+1}}-\delta)\frac{I_{t+1}}{K_{t+1}} - \frac{\Psi_I}{2}(\frac{I_{t+1}}{K_{t+1}}-\delta)^2\}] \tag{B1.26}$$

Let $z_{1t} = \frac{\ln\omega_t + 0.5\sigma^2_\omega}{\sigma_\omega}$ and $z_{2t} = \frac{\ln(\frac{\omega_t}{\varrho_t})+0.5\sigma^2_\omega}{\sigma_\omega}$, and Θ be a c.d.f of a standard normal distribution:

$$\begin{aligned} \mathrm{erf}(x) &= 2\Theta(x\sqrt{2}) - 1 \\ \mathrm{erf}\,c(x) &= 2(1-\Theta(x\sqrt{2})) \end{aligned} \tag{B1.27}$$

$$z(\overline{\omega}_t) = 1 - (z_{1t} - \sigma_\omega) - \overline{\omega}_t(1-\Theta(z_{1t})) \tag{B1.28}$$

$$g(\overline{\omega}_t;\varrho_t) = \varrho_t[\frac{\overline{\omega}_t}{\varrho_t}(1-\Theta(z_{2t})) + (1-\mu)\Theta(z_{2t}-\sigma_\omega)] \tag{B1.29}$$

$$z'(\overline{\omega}_t) = -(1-\Theta(z_{1t})) \tag{B1.30}$$

$$g'(\overline{\omega}_t;\varrho_t) = \varrho_t[1-\Theta(z_{2t}) - \frac{\mu}{\sqrt{2\pi}\sigma_\omega}\exp(-\frac{z^2_{2t}}{2}) \tag{B1.31}$$

Monetary Policy

$$1+i_t = (1+i)\ (\pi_t)^{\epsilon_\pi}(Y_t/Y)^{\epsilon_Y} \tag{B1.32}$$

General Equilibrium

$$Y_t = Y_{H,t} + Y_{X,t} \tag{B1.33}$$

$$\begin{aligned} Y_{H,t} &= C_{H,t} + C^E_{H,t} + I_{H,t} + (1-\alpha)(\frac{P_{H,t}}{P_t})^{-\gamma}[\sum_{i=H,X}\frac{\Psi_i}{2}(\frac{P_{i,t}}{P_{i,t-1}}-1)^2 \\ &\quad + \frac{\Psi_M}{2}(\frac{P_{M,t}}{P_{M,t-1}}-1)^2 + \nu_t\frac{R^K_t}{P_t}Q_{t-1}K_t] \end{aligned} \tag{B1.34}$$

$$\begin{aligned} Y^*_{X,t} &= C_{M,t} + C^E_{M,t} + I_{M,t} + (\alpha)(\frac{P_{M,t}}{P_t})^{-\gamma}[\sum_{i=H,X}\frac{\Psi_i}{2}(\frac{P_{i,t}}{P_{i,t-1}}-1)^2 \\ &\quad + \frac{\Psi_M}{2}(\frac{P_{M,t}}{P_{M,t-1}}-1)^2 + \nu_t\frac{R^K_t}{P_t}Q_{t-1}K_t] \end{aligned} \tag{B1.35}$$

$$S_tP_{X,t}Y_{X,t} - P^*_{M,t}Y^*_{X,t} = S_t(1+i^*_{t-1})(D^H_t\Psi_{D,t-1} + D_t) - S_t(D^H_{t+1} + D_{t+1}) \quad \text{(B1.36)}$$

B.2. Model Equations: Foreign Economy

Households

$$C^*_{H,t} = (1-\alpha^*)(\frac{P^*_{H,t}}{P^*_t})^{-\gamma^*}C^*_t \quad \text{(B2.1)}$$

$$C^*_{M,t} = \alpha^*(\frac{P^*_{M,t}}{P^*_t})^{-\gamma^*}C^*_t \quad \text{(B2.2)}$$

$$P^*_t = [(1-\alpha^*)P^{*1-\gamma^*}_{H,t} + \alpha^*P^{*1-\gamma^*}_{M,t}]^{1/(1-\gamma^*)} \quad \text{(B2.3)}$$

$$H^{*\varphi}_t = W^*_t \quad \text{(B2.4)}$$

$$(C^*_t - \frac{H^{*1+\varphi}_t}{1+\varphi})^{-\sigma} = \beta(1+i^*_t)E_t[(C^*_{t+1} - \frac{H^{*1+\varphi}_{t+1}}{1+\varphi})^{-\sigma}\frac{P^*_t}{P^*_{t+1}}] \quad \text{(B2.5)}$$

Production Firms

$$W^*_t = \frac{(1-\eta)(1-\Omega)Y^*_tMC^*_t}{N^*_t} \quad \text{(B2.6)}$$

$$W^{*E}_t = (1-\eta)\Omega Y^*_tMC^*_t \quad \text{(B2.7)}$$

$$R^*_t = \frac{\eta Y^*_tMC^*_t}{K^*_t} \quad \text{(B2.8)}$$

$$\begin{aligned} P^*_{H,t} &= \frac{\lambda}{\lambda-1}MC^*_t - \frac{\Psi_H}{\lambda-1}\frac{P^*_t}{Y^*_{H,t}}\frac{P^*_{H,t}}{P^*_{H,t-1}}(\frac{P^*_{H,t}}{P^*_{H,t-1}} - 1) \\ &+ \frac{\Psi_H}{\lambda-1}E_t[\Theta^*_t\frac{P^*_{t+1}}{Y^*_{H,t}}\frac{P^*_{H,t+1}}{P^*_{H,t}}(\frac{P^*_{H,t+1}}{P^*_{H,t}} - 1)] \end{aligned} \quad \text{(B2.9)}$$

$$\begin{aligned} S^*_tP^*_{X,t} &= \frac{\lambda}{\lambda-1}MC^*_t - \frac{\Psi_X}{\lambda-1}\frac{P^*_t}{Y^*_{X,t}}\frac{P^*_{X,t}}{P^*_{X,t-1}}(\frac{P^*_{X,t}}{P^*_{X,t-1}} - 1) \\ &+ \frac{\Psi_X}{\lambda-1}E_t[\Theta^*_t\frac{P^*_{t+1}}{Y^*_{X,t}}\frac{P^*_{X,t+1}}{P^*_{X,t}}(\frac{P^*_{X,t+1}}{P^*_{X,t}} - 1)] \end{aligned} \quad \text{(B2.10)}$$

$$\Theta^*_t = \beta\frac{(C^*_{t+1} - \frac{\chi}{1+\varphi}H^{*1+\varphi}_{t+1})^{-\sigma}}{(C^*_t - \frac{\chi}{1+\varphi}H^{*1+\varphi}_t)^{-\sigma}}\frac{P^*_t}{P^*_{t+1}} \quad \text{(B2.11)}$$

Importing Firms

$$\begin{aligned} P_{M,t} &= \frac{\lambda}{\lambda-1}P_{X,t} - \frac{\Psi_M}{\lambda-1}\frac{P_t}{Y_{M,t}}\frac{P_{M,t}}{P_{M,t-1}}(\frac{P_{M,t}}{P_{M,t-1}}-1) \\ &\quad + \frac{\Psi_M}{\lambda-1}E_t[\Theta_t\frac{P_{t+1}}{Y_{M,t}}\frac{P_{M,t+1}}{P_{M,t}}(\frac{P_{M,t+1}}{P_{M,t}}-1)] \end{aligned} \tag{B2.12}$$

Unfinished Capital Producing Firms

$$I^*_{H,t} = (1-\alpha^*)(\frac{P^*_{H,t}}{P^*_t})^{-\gamma}I^*_t \tag{B2.13}$$

$$I^*_{M,t} = (\alpha^*)(\frac{P^*_{M,t}}{P^*_t})^{-\gamma}I^*_t \tag{B2.14}$$

$$K^*_{t+1} = [\frac{I^*_t}{K^*_t} - \frac{\Psi_I}{2}(\frac{I^*_t}{K^*_t}-\delta)^2]K^*_t + (1-\delta)K^*_t \tag{B2.15}$$

$$\frac{Q^*_t}{P^*_t} = [1-\Psi_I(\frac{I^*_t}{K^*_t}-\delta)]^{-1} \tag{B2.16}$$

Entrepreneurs

$$E_t[R^{K*}_{t+1}Q^*_tK^*_{t+1}g^*(\overline{\omega}^*_{t+1};\varrho^*_t)] = (1+i^*_t)D^*_{t+1} \tag{B2.17}$$

$$P^*_tNW^*_t = \vartheta[R^{K*}_tQ^*_{t-1}K^*_t(1-\nu^*_t) - (1+i^*_{t-1})D^*_t] + W^{E*}_t \tag{B2.18}$$

$$P^*_tC^{E*}_t = (1-\vartheta)[R^{K*}_tQ^*_{t-1}K^*_t(1-\nu^*_t) - (1+i^*_{t-1})D^*_t] \tag{B2.19}$$

$$C^{E*}_{H,t} = (1-\alpha^*)(\frac{P^*_{H,t}}{P^*_t})^{-\gamma}C^{E*}_t \tag{B2.20}$$

$$C^{E*}_{M,t} = \alpha^*(\frac{P^*_{M,t}}{P^*_t})^{-\gamma}C^{E*}_t \tag{B2.21}$$

$$E_t[R^{K*}_{t+1}] = E_t[(1+i^*_t)(1+\Phi^*_{t+1})] \tag{B2.22}$$

$$1+\Phi^*_{t+1}=[\frac{z^{*\prime}(\overline{\omega}^*_{t+1}(k))}{g^*(\overline{\omega}^*_{t+1}(k);\varrho^*_t)z^{*\prime}(\overline{\omega}^*_{t+1}(k))-z^*(\overline{\omega}^*_{t+1}(k))g^{*\prime}(\overline{\omega}^*_{t+1}(k);\varrho^*_t)}] \quad \text{(B2.23)}$$

Let $z^*_{1t}=\frac{\ln\omega^*_t+0.5\sigma^{*2}_\omega}{\sigma^*_\omega}$ and $z^*_{2t}=\frac{\ln(\frac{\omega^*_t}{\varrho^*_t})+0.5\sigma^{*2}_\omega}{\sigma^*_\omega}$, and Θ be a c.d.f of a standard normal distribution as above:

$$z^*(\overline{\omega}^*_t)=1-\Theta(z^*_{1t}-\sigma^*_\omega)-\overline{\omega}^*_t(1-\Theta(z^*_{1t})) \quad \text{(B2.24)}$$

$$g^*(\overline{\omega}^*_t;\varrho^*_t)=\varrho^*_t[\frac{\overline{\omega}^*_t}{\varrho^*_t}(1-\Theta(z^*_{2t}))+(1-\mu)\Theta(z^*_{2t}-\sigma^*_\omega)] \quad \text{(B2.25)}$$

$$z^{*\prime}(\overline{\omega}^*_t)=-(1-\Theta(z^*_{1t})) \quad \text{(B2.26)}$$

$$g^{*\prime}(\overline{\omega}^*_t;\varrho^*_t)=\varrho^*_t[1-\Theta(z^*_{2t})-\frac{\mu}{\sqrt{2\pi}\sigma^*_\omega}\exp(-\frac{z^{*2}_{2t}}{2}) \quad \text{(B2.27)}$$

$$E_t[R^{K*}_{t+1}]=E_t[\frac{R^*_{t+1}}{Q^*_t}+\frac{Q^*_{t+1}}{Q^*_t}\{(1-\delta)+\Psi_I(\frac{I^*_{t+1}}{K^*_{t+1}}-\delta)\frac{I^*_{t+1}}{K^*_{t+1}}-\frac{\Psi_I}{2}(\frac{I^*_{t+1}}{K^*_{t+1}}-\delta)^2\}]. \quad \text{(B2.28)}$$

Monetary Policy

$$1+i^*_t=(1+i^*)\ (\pi^*_t)^{\epsilon^*_\pi}(Y^*_t/Y^*)^{\epsilon^*_Y} \quad \text{(B2.29)}$$

General Equilibrium

$$S^*_t=1/S_t \quad \text{(B2.30)}$$

$$Y^*_t=Y^*_{H,t}+Y^*_{X,t}, \quad \text{(B2.31)}$$

$$\begin{aligned} Y^*_{H,t} &= C^*_{H,t}+C^{E*}_{H,t}+I^*_{H,t}+(1-\alpha^*)(\frac{P^*_{H,t}}{P^*_t})^{-\gamma}[\sum_{i=H,X}\frac{\Psi_i}{2}(\frac{P^*_{i,t}}{P^*_{i,t-1}}-1)^2 \\ &+\frac{\Psi_M}{2}(\frac{P^*_{M,t}}{P^*_{M,t-1}}-1)^2+\nu^*_t\frac{R^{K*}_t}{P^*_t}Q^*_{t-1}K^*_t], \end{aligned} \quad \text{(B2.32)}$$

$$\begin{aligned} Y_{X,t} &= C^*_{M,t}+C^{E*}_{M,t}+I^*_{M,t}+\alpha^*(\frac{P^*_{M,t}}{P^*_t})^{-\gamma}[\sum_{i=H,X}\frac{\Psi_i}{2}(\frac{P^*_{i,t}}{P^*_{i,t-1}}-1)^2 \\ &+\frac{\Psi_M}{2}(\frac{P^*_{M,t}}{P^*_{M,t-1}}-1)^2+\nu^*_t\frac{R^{K*}_t}{P^*_t}Q^*_{t-1}K^*_t]. \end{aligned} \quad \text{(B2.33)}$$

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
$\Psi_i, \Psi_M = 120$	Price adjustment costs for $i = H, X$
$\epsilon_\pi = 1.5$	Coefficient of CPI inflation in the policy rule
$\epsilon_Y = 0.5$	Coefficient of output gap in the policy rule
$\rho_\varrho = 0.5$	Persistence of the domestic perception shock

Table 2: Parameter Values for the Entrepreneurial Sector

Domestic Economy	
$\chi = 0.3$	Leverage
$\Phi_t = 0.02$	External risk premium
$\mu = 0.2$	Monitoring cost
$\vartheta = 0.9933$	Survival rate
Foreign Economy	
$\chi^* = 0.5$	Leverage
$\Phi_t^* = 0.005$	External risk premium
$\mu^* = 0.12$	Monitoring cost
$\vartheta = 0.9966$	Survival rate

Table 3. Business Cycles in Emerging Economies: Data vs. Model

i) Standard deviations (in %)

	Output	Consumption	Investment	Current account	Inflation	Interest rate	Exchange rate
Argentina	4.58	5.95	12.94	1.01	2.94	2.17	5.77
Brazil	1.94	1.95	4.89	2.19	2.33	2.90	11.65
Korea	2.57	3.52	5.49	3.40	1.27	1.19	9.80
Mexico	2.55	3.57	6.98	5.80	1.70	1.65	9.96
Philippines	2.58	1.93	7.03	4.24	2.13	2.17	6.75
Average	2.84	3.38	7.47	3.33	2.07	2.02	8.78
Model - Domestic shock	3.15	3.24	17.20	3.61	0.60	2.16	3.23
Model- Global shock ξ=0.5	2.91	2.23	15.95	2.12	0.67	2.27	1.60

ii) Standard deviations relative to output

	Output	Consumption	Investment	Current account	Inflation	Interest rate	Exchange rate
Argentina	1.00	1.30	2.83	0.22	0.64	0.47	1.26
Brazil	1.00	1.01	2.52	1.13	1.20	1.49	6.00
Korea	1.00	1.37	2.14	1.32	0.50	0.46	3.81
Mexico	1.00	1.40	2.74	2.27	0.67	0.65	3.91
Philippines	1.00	0.75	2.72	1.64	0.82	0.84	2.61
Average	1.00	1.16	2.59	1.32	0.77	0.78	3.52
Model - Domestic shock	1.00	1.03	5.46	1.15	0.19	0.69	1.03
Model- Global shock ξ=0.5	1.00	0.77	5.48	0.73	0.23	0.78	0.55

iii) Correlations with Output and Autocorrelations

	ϱ(C,Y)	ϱ(I,Y)	ϱ(CA,Y)	ϱ(Y(t),Y(t-1))	ϱ(C(t),C(t-1))	ϱ(I(t),I(t-1))	ϱ(CA(t),CA(t-1))
Argentina	0.92	0.83	-0.54	0.83	0.85	0.91	0.93
Brazil	0.77	0.38	-0.03	0.35	0.17	0.55	0.92
Korea	0.87	0.86	-0.72	0.80	0.82	0.79	0.86
Mexico	0.78	0.85	-0.45	0.82	0.80	0.85	0.83
Philippines	0.82	0.10	0.01	0.78	0.71	0.59	0.77
Average	0.83	0.61	-0.35	0.72	0.67	0.74	0.86
Model - Domestic shock	0.93	0.96	-0.93	0.51	0.63	0.51	0.42
Model- Global shock ξ=0.5	0.68	0.91	-0.67	0.71	0.92	0.62	0.77

Table 4. Business Cycles in Advanced (Big) Economies: Data vs. Model

i) Standard deviations (in %)

	Output	Consumption	Investment	Current account	Inflation	Interest rate	Exchange rate
E.U.	1.37	0.81	3.80	0.50	0.61	1.02	7.09
U.S.	1.22	0.88	4.26	1.26	0.16	0.28	3.01
Average	1.30	0.85	4.03	0.88	0.39	0.65	5.05
Model- Global shock ξ=0.5	0.73	0.56	5.43	0.64	0.12	0.23	1.94

ii) Standard deviations relative to output

	Output	Consumption	Investment	Current account	Inflation	Interest rate	Exchange rate
E.U.	1.00	0.59	2.77	0.36	0.45	0.74	5.18
U.S.	1.00	0.72	3.49	1.03	0.13	0.23	2.47
Average	1.00	0.66	3.13	0.70	0.29	0.49	3.82
Model- Global shock ξ=0.5	1.00	0.77	7.44	0.88	0.16	0.32	2.66

iii) Correlations with output and autocorrelations

	ϱ(C*,Y*)	ϱ(I*,Y*)	ϱ(CA*,Y*)	ϱ(Y*(t),Y*(t-1))	ϱ(C*(t),C*(t-1))	ϱ(I*(t),I*(t-1))	ϱ(CA*(t),CA*(t-1))
E.U.	0.56	0.95	-0.36	0.91	0.67	0.91	0.71
U.S.	0.88	0.91	-0.71	0.88	0.85	0.93	0.75
Average	0.72	0.93	-0.54	0.90	0.76	0.92	0.73
Model- Global shock ξ=0.5	0.43	0.80	0.66	0.71	0.76	0.47	0.77

Table 5. Cross-Country Correlations

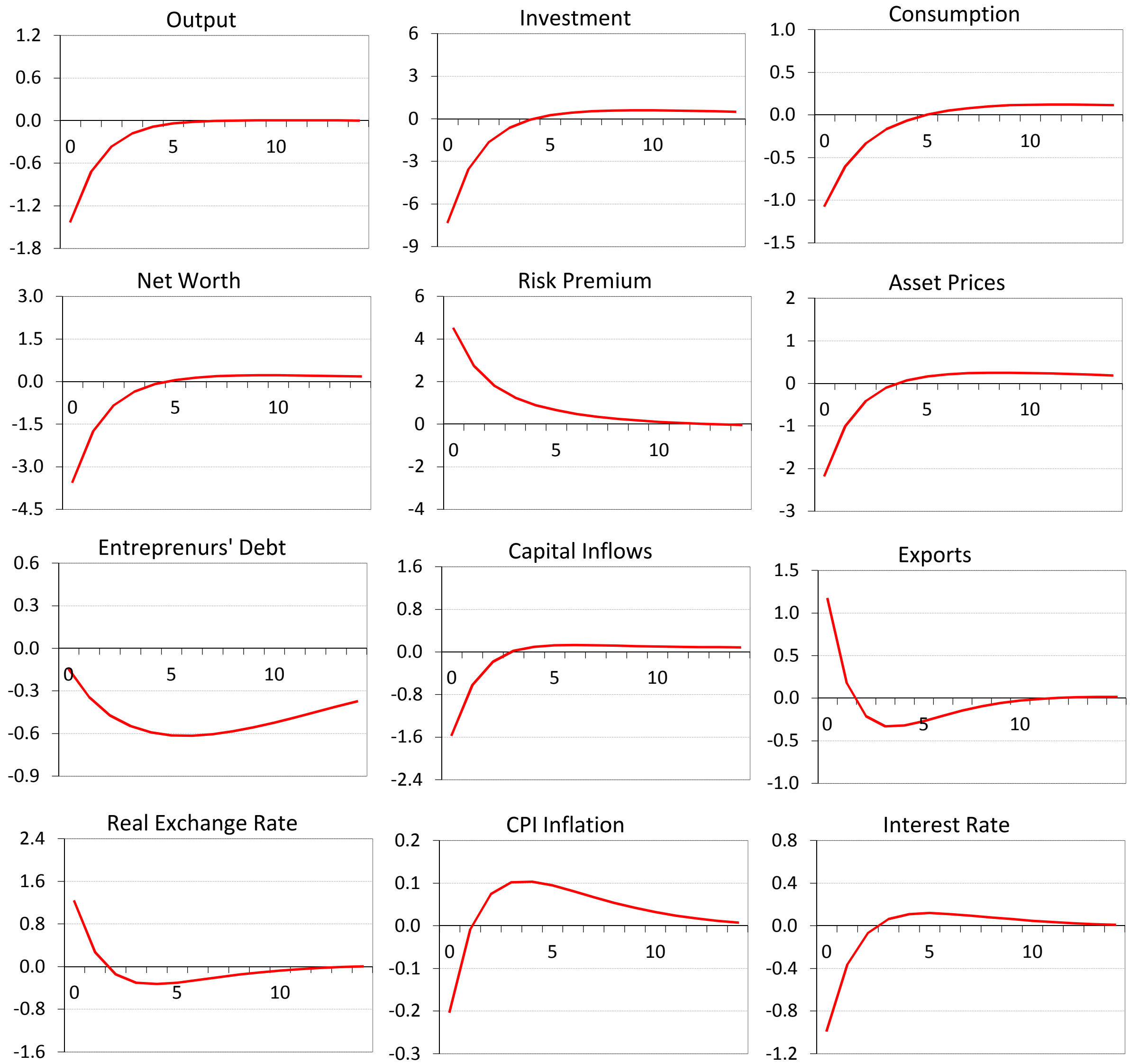
With respect to the U.S.	Full sample (1990Q1-2011Q3)			Global crisis period (2007Q1-2011Q3)		
	Output	Consumption	Investment	Output	Consumption	Investment
Argentina	0.49	0.33	0.67	0.89	0.61	0.95
Brazil	0.30	0.02	0.17	0.80	0.57	0.28
Korea	0.11	0.15	-0.14	0.86	0.82	0.16
Mexico	0.66	0.37	0.34	0.96	0.75	0.83
Phillipines	0.42	0.00	-0.12	0.66	0.34	-0.08
Average	0.40	0.17	0.19	0.84	0.62	0.43
Model- Global shock ξ=0	0.63	-0.13	-0.75	0.63	-0.13	-0.75
Model- Global shock ξ=0.5	0.94	0.35	0.96	0.94	0.35	0.96
Model- Global shock ξ=1	0.98	0.61	0.98	0.98	0.61	0.98

Table 6. Welfare Results

	Baseline (α= 0.35, $\varkappa$= 0.3)		Higher openness (α=0.6, $\varkappa$=0.3)		Higher leverage (α= 0.35, $\varkappa$=0.5)	
	Welfare	ψ	Welfare	ψ	Welfare	ψ
i) Domestic shock						
Inflation targeting	-59.1945	-	-124.5435	-	-60.9214	-
Fixed exchange rate regime	-59.2231	0.0283	-124.5585	0.0090	-60.9467	0.0146
ii) Foreign shock						
a) Contagion (ξ=1)						
Inflation targeting	-59.1854	-	-124.4821	-	-60.8783	-
Fixed exchange rate regime	-59.2345	0.0403	-124.5549	0.0434	-60.8744	-0.0025
b) Contagion (ξ=0.5)						
Inflation targeting	-59.1517	-	-124.4877	-	-60.8401	-
Fixed exchange rate regime	-59.1874	0.0324	-124.5421	0.0325	-60.8066	-0.0197
c) No contagion (ξ=0)						
Inflation targeting	-59.1367	-	-124.4968		-60.8169	-
Fixed exchange rate regime	-59.1358	-0.0121	-124.5298	0.0196	-60.7425	-0.0435

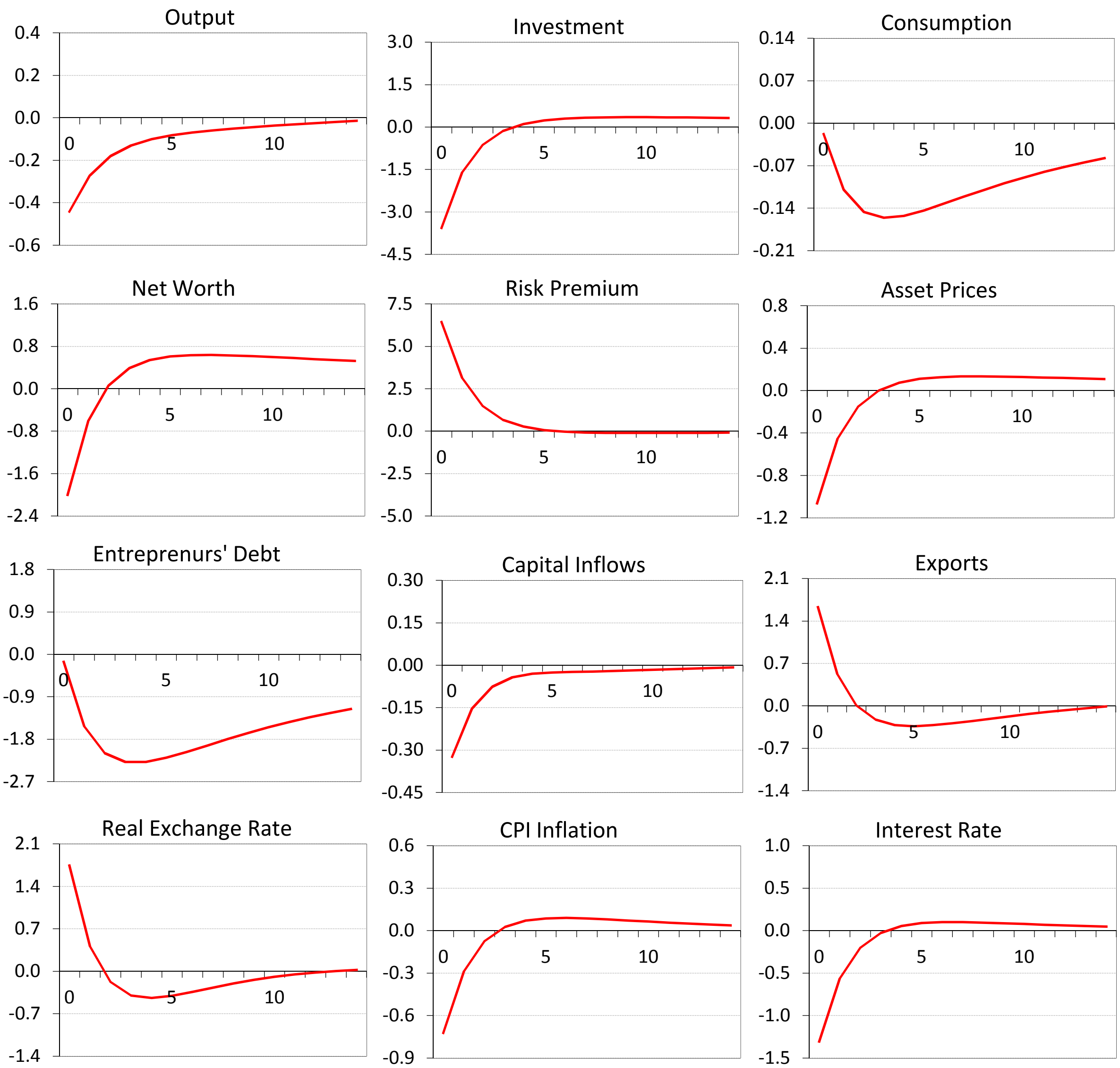
Figure 1. Responses to a Financial Crisis in Domestic Economy: Domestic Economy*

(percent deviations from the steady state)



*The figures show the impact of a 1% negative shock to the perception of investors regarding the productivity of domestic entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

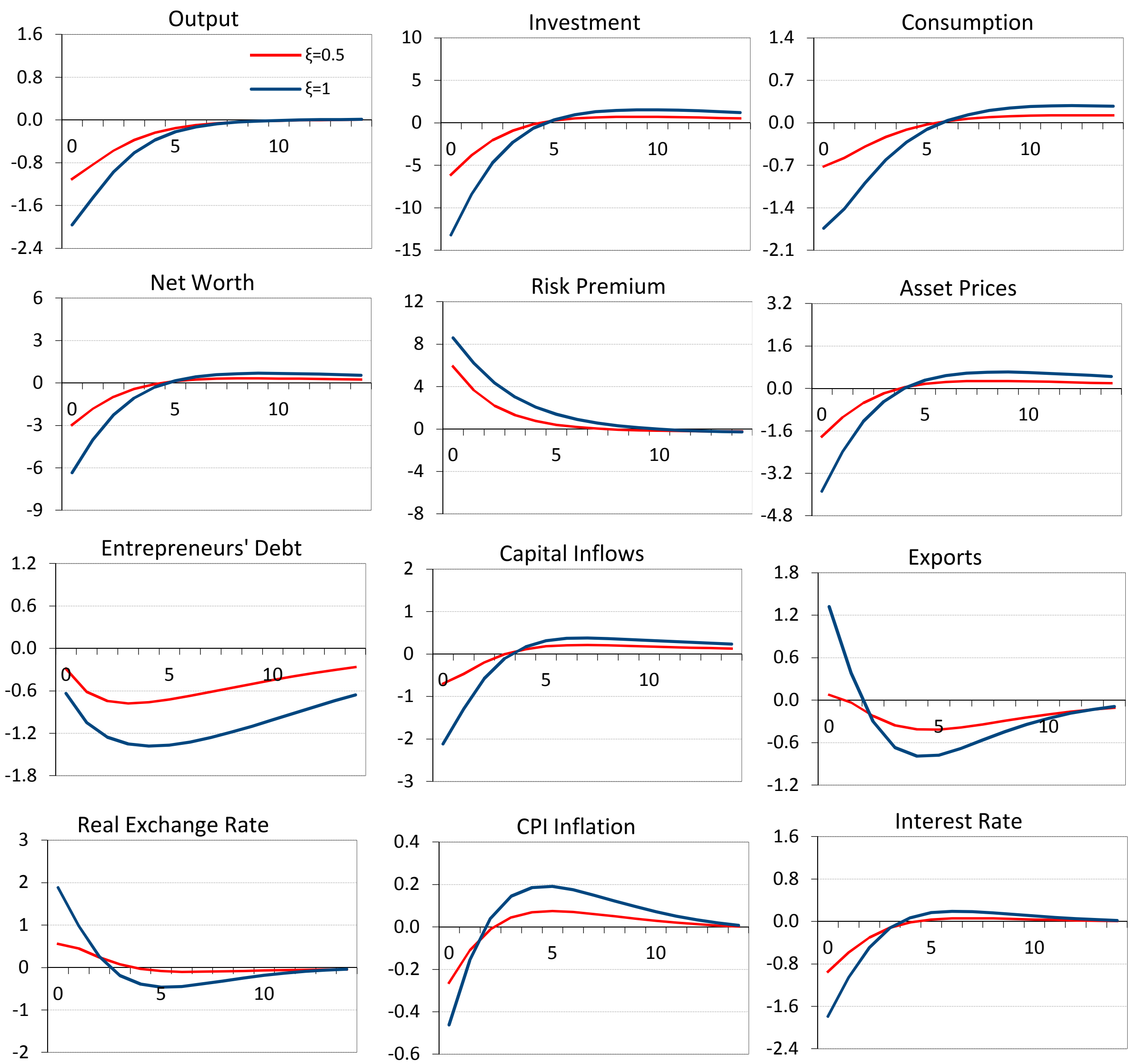
Figure 2. Responses to a Financial Crisis in Foreign Economy: Foreign Economy*
(percent deviations from the steady state)



*The figures show the impact of a 1% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

Figure 3. Responses to a Financial Crisis in Foreign Economy with Financial Contagion: Domestic Economy*

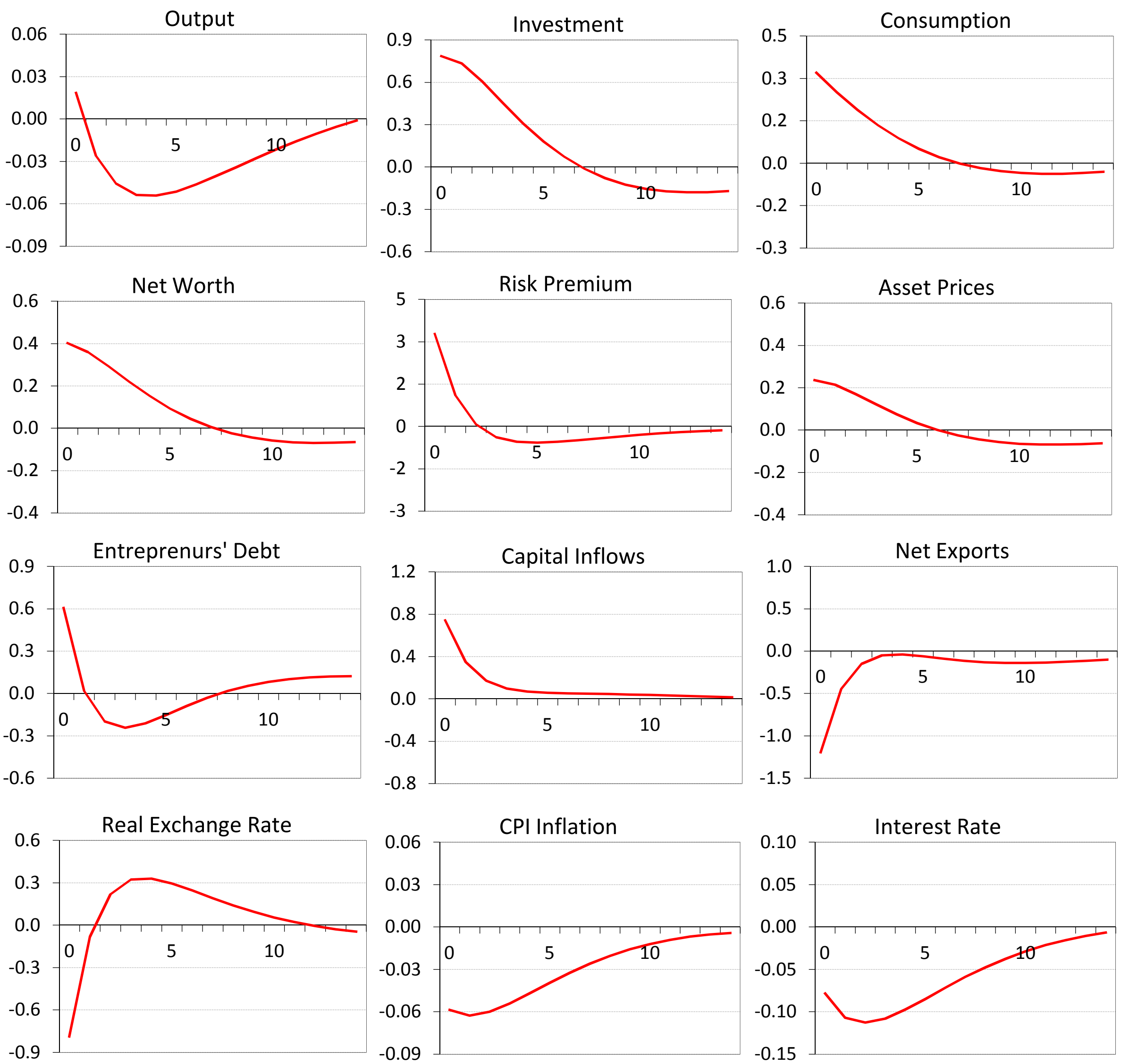
(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

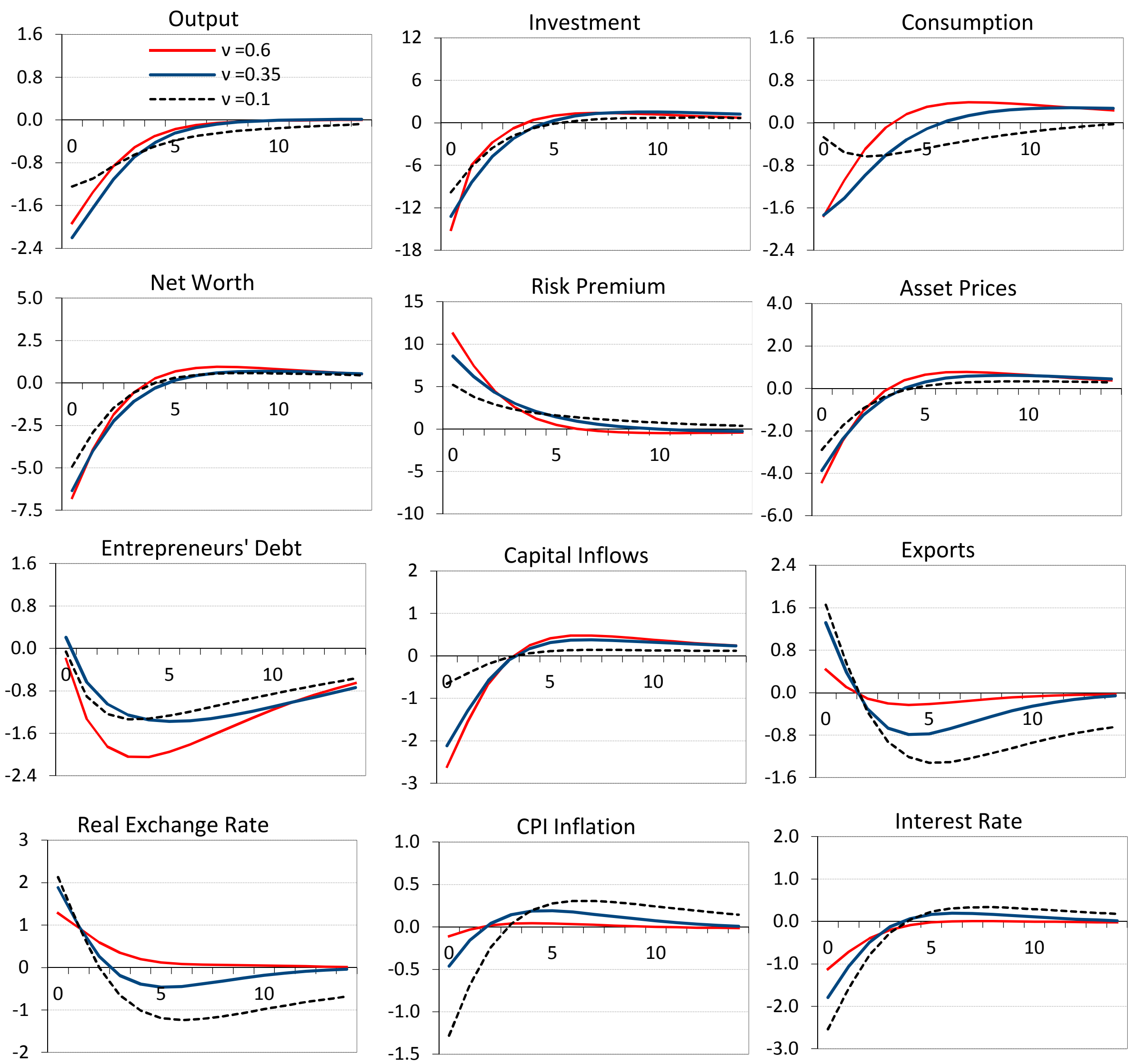
Figure 4. Responses to a Financial Crisis in Foreign Economy without Financial Contagion: Domestic Economy*

(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

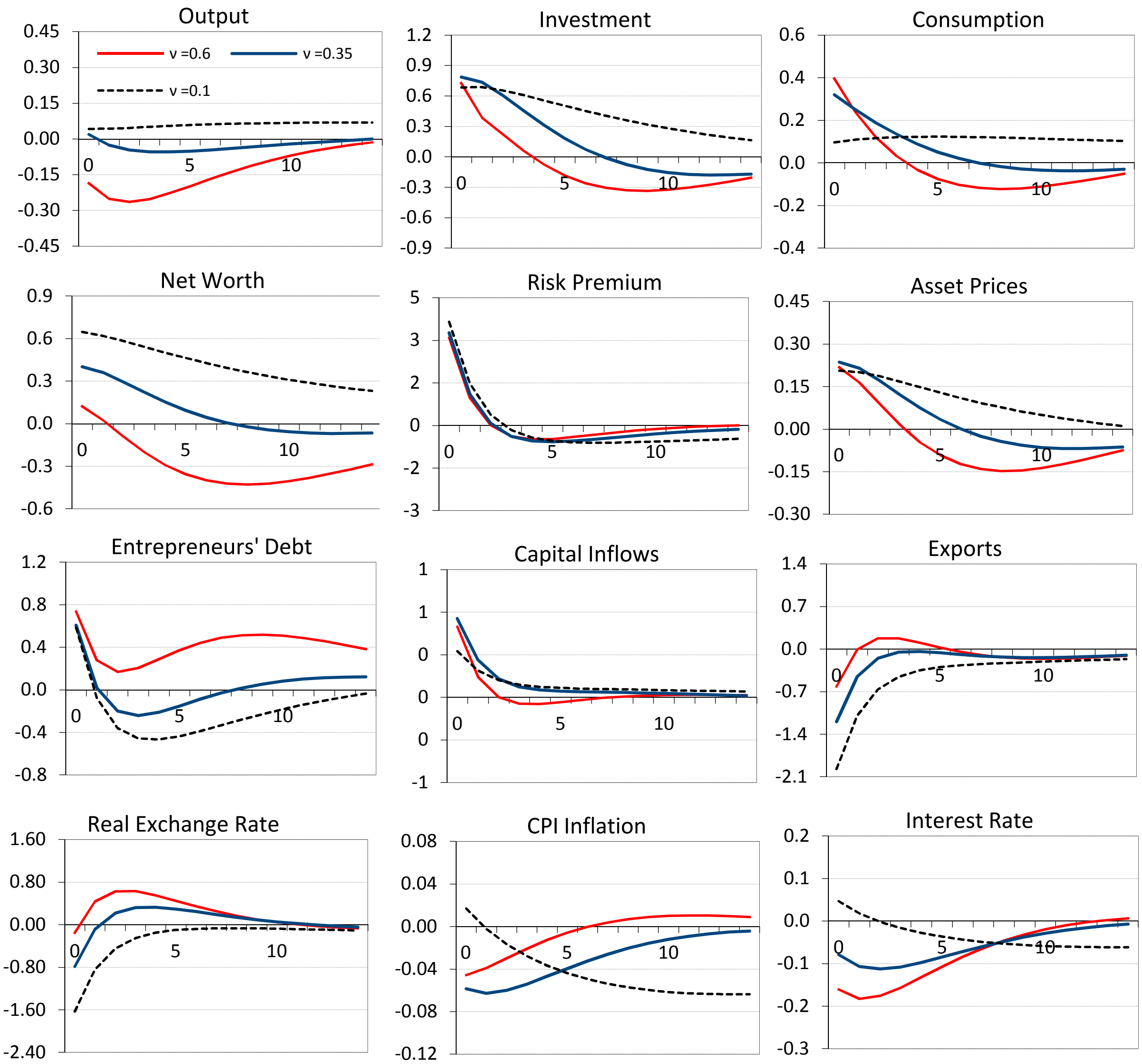
Figure 5. Responses to a Financial Crisis in Foreign Economy with Financial Contagion: Domestic Economy- The Impact of Openness*
(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

Figure 6. Responses to a Financial Crisis in Foreign Economy without Financial Contagion: Domestic Economy- The Impact of Openness*

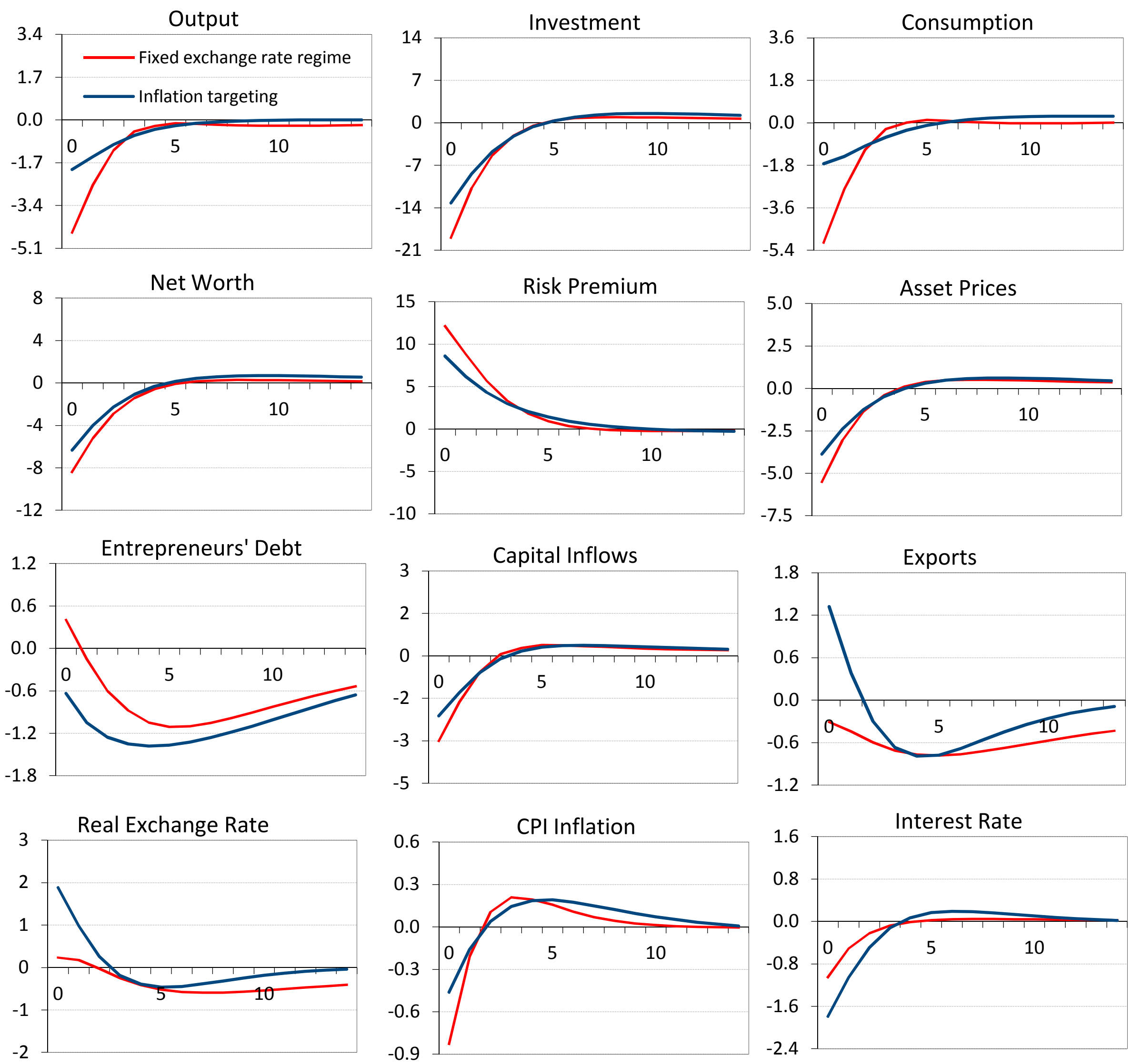
(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

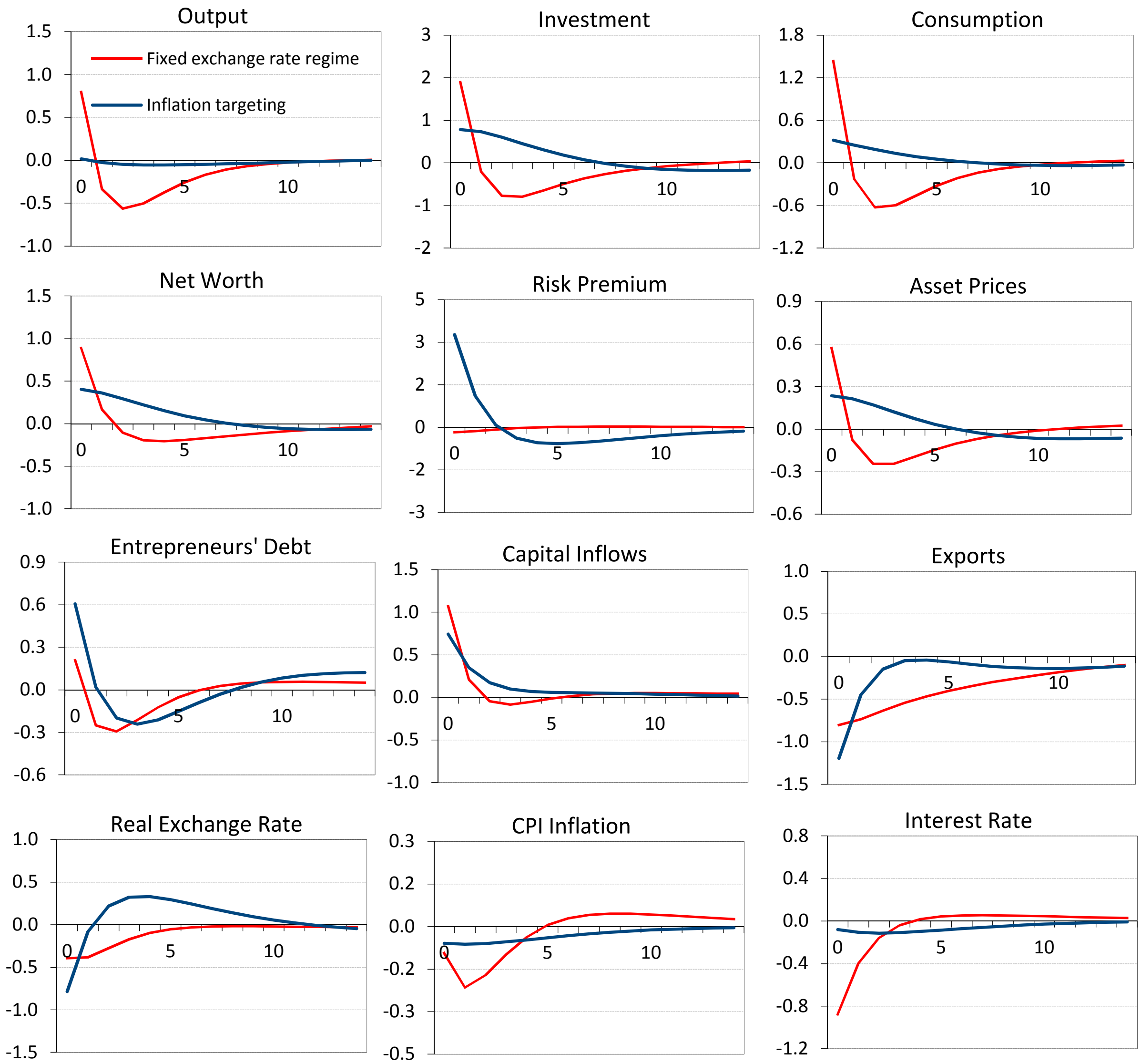
Figure 7. Responses to a Financial Crisis in Foreign Economy with Financial Contagion: Domestic Economy- The Role of Monetary Policy Strategy*

(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.

Figure 8. Responses to a Financial Crisis in Foreign Economy without Financial Contagion: Domestic Economy- The Role of Monetary Policy Strategy*
(percent deviations from the steady state)



*The figures show the impact of a 0.75% negative shock to the perception of investors regarding the productivity of foreign entrepreneurs. The variables are presented as log-deviations from the steady state (except for interest rate), multiplied by 100 to have an interpretation of percentage deviations.