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UNIVERSITY OF CALIFORNIA
SANTA CRUZ

**TRANSMISSION CHANNELS OF GLOBAL LIQUIDITY IN EMERGING
MARKET ECONOMIES**

A dissertation submitted in partial satisfaction of the
requirements for the degree of

DOCTOR OF PHILOSOPHY

in

ECONOMICS

by

Can Kadirgan

June 2018

The Dissertation of Can Kadirgan
is approved:

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Abstract

Transmission Channels of Global Liquidity in Emerging Market Economies

by

Can Kadirgan

I study the role of banks, exchange rates, and firms in the transmission of global liquidity in emerging market economies. This close examination comprises three chapters.

The first chapter investigates the importance of the bank leverage cycle in the propagation of exchange rate fluctuations. Emerging market economies can be sensitive to large currency depreciation because it may increase the default risk of firms that have their liabilities in foreign currency and assets in local currency. Since banks adjust their leverage based on the riskiness of borrowers, bank credit flows should inform us whether corporate balance sheets are affected by exchange rate fluctuations. Using country level differences in the foreign currency decomposition of bank claims, I construct an instrument to disentangle the effect of exchange rate fluctuations on bank loans. I find that a 1% real depreciation of the local currency causes a 1.36% reduction in foreign currency loans channeled by domestic banks. This significant response is however absent for direct loans by global banks. I explain this with a model that takes into account balance sheet differences of ultimate borrowers. Firms that borrow from domestic banks are more likely to be local firms subject to currency mismatch while firms that can borrow directly from global banks are multinational corporations with resources to hedge them against foreign currency fluctuations. The results have two major implications. First, the risk sensitive lending behavior of banks plays an important role in the propagation of exchange

rate fluctuations. Second, policy makers should enforce domestic banks to monitor the foreign currency exposure of their clients more closely.

DSGE models have a shortfall in simulating the sensitive nature of emerging market economies to global financial conditions. The second chapter contributes on that aspect by providing a new theoretical mechanism that amplifies the effect of world interest rates. Moral hazard arises when corporate borrowers prefer investing in riskier projects when interest rates rise, which in turn influences the financial intermediary's willingness to lend. To the extent that world interest rates are transmitted to domestic interest rates, the lending behavior of the financial intermediary amplifies the effect of world interest rates. I empirically investigate this theoretical finding using a structural VAR. Results indicate that a global financial tightening is immediately followed by a drop in domestic bank credit while investment and output also decrease significantly, consistent with the amplification of global financial shocks induced by moral hazard.

After the Global Financial Crisis (GFC), three trends highlight international financial markets for emerging market economies, historically low term premium in the yield curve, the emerging corporate bond boom in foreign markets, and the stagnation of emerging market banks cross-border liabilities. The final and third chapter links these post GFC trends to US unconventional monetary policy in a theoretical framework. In addition, I investigate whether firm size matters in terms of sensitivity to this financial spillover. The model shows that, when the term premium of corporate bond yields rise, large firms divert their funding from foreign lenders to domestic banks, crowding small firms out of domestic bank credit markets. The evolution of small firms' share in the total bank credit for a sample of emerging market economies validate

the findings of the model. Emerging market policymakers should therefore ease financing for small firms as the Fed and central banks of other advanced economies normalize the size of their balance sheet.

Chapter 1

Evidence on the balance sheet effect of emerging market firms

1.1 Introduction

Following the Great Recession, interest rates kept near the zero lower bound in developed countries have rendered investment opportunities in Emerging Market Economies (EMEs) attractive. Amid these favorable global funding conditions, further reinforced by large scale asset purchase programs in developed countries, liquidity has flown to non-financial private sector balance sheets in EMEs (Avdjiev et al, 2014; Chui et al, 2016) and accordingly the portion of debt denominated in foreign currency has risen (Chui et al, 2014). Emerging market policy makers are worried now that the FED and central banks of other advanced economies are in the process of reverting their monetary stance back to normal levels since a following tightening in global financial conditions may disrupt the financial stability in EMEs. Particularly, a large depreciation of the local currency could magnify the upward pressure on the default risk of corporate borrowers subject to currency mismatch. To what extent are corporate balance sheets affected by exchange rate fluctuations? I provide a new approach to measure this effect

by investigating foreign currency bank loans. Given that banks adjust their leverage based on the riskiness of borrowers (Adrian and Shin, 2011; Adrian and Shin, 2012), an empirical analysis on bank credit flows should provide valuable information on the balance sheet effect of corporate borrowers.

The supply of foreign currency loans is highly dependent on capital inflows. In addition, it is difficult to know whether currency movements are the cause or the effect of capital inflows as they are jointly determined. In order to overcome the resulting endogenous relationship between foreign currency bank loans and exchange rate movements characterized by two-way causality, I instrument for real exchange rate changes. Using country level differences in the foreign currency decomposition of bank claims, I construct an instrument to disentangle the effect of exchange rates on bank claims. I run a two-stage least squares on a panel data covering 16 EMEs from 2001 to 2015. The results suggest that the balance sheet of firms borrowing from domestic banks are indeed vulnerable to exchange rate changes. Accordingly, the risk elastic behavior of banks plays an important role in the propagation of exchange rate fluctuations.

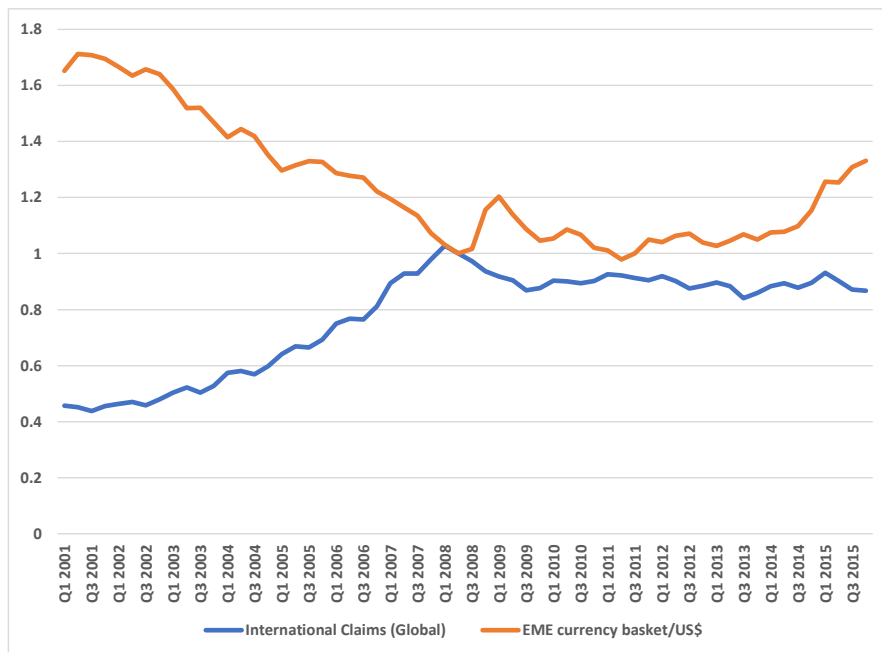
For bank credit flows, I use cross-border claims of global banks from publicly available Bank of International Settlements (BIS) data. Almost all cross-border claims on EMEs are in foreign currency, consisting exclusively of the US\$, €, £, JPY, and CHF. As the breakdown of claims by currency has recently been made publicly available, this paper is one of the first to use this new layer of information, to my knowledge.

The real exchange rate is weighted by the currency breakdown of foreign currency claims. The instrument for real exchange rate changes is based on the difference in the share

of claims denominated in US\$ across countries and across time. What distinguishes the US\$ from other major currencies is the apparent negative relationship between global liquidity and the value of US\$. Figure 1.1 shows that the US\$ appreciates against emerging market currencies during global financial downturns and depreciates during upturns (A decrease in the real exchange rate is a real depreciation of the US\$.) Figure 1.2 shows that the countercyclical value of US\$ is not only against emerging market currencies but is also valid against other major currencies (i.e., €, £, JPY, and CHF) since the exchange rate of all these currencies against the US\$ co-move strongly. As a result, emerging market currencies will generally depreciate (appreciate) more against the US\$ than against other major currencies during global liquidity tightening (expansion). Countries whose claims have a high share of US\$ should therefore have a relatively more volatile weighted real exchange rate than ones whose claims have a low share of US\$. In the construction of the instrument, I use the real exchange rate of the local currency against the US\$ as a benchmark for the weighted real exchange rate. The benchmark represents what the weighted real exchange rate would have been if all bank claims were denominated in US\$. I first calculate the growth rate difference between the actual real exchange rate and the benchmark to provide an expression for the variations stemming from differences in the share of claims denominated in US\$. This expression is an explicit function of the share of non-US\$ major currencies (i.e., €, £, JPY, and CHF) in claims and of their relative currency movements against the US\$. The use of this expression as an instrument might raise concerns about the exclusion restriction criteria since Figures 1.1 and 1.2 depict a clear pattern in the value of currencies against the US\$ and global financial conditions. In addition, the share of non-US\$ claims might be correlated with contemporaneous changes in cross-border claims other than

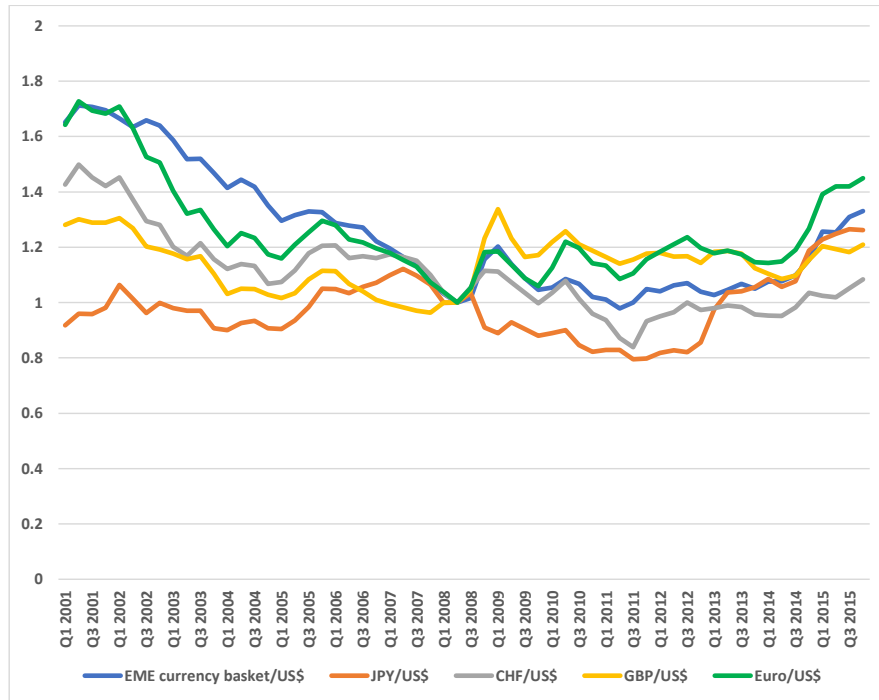
through exchange rate fluctuations even though the share of non-US\$ claims seems to vary very little within countries. In order to appease these concerns, I perform additional steps to the expression. First, I use six-year lagged share of non-US\$ claims. Specifically, I divide the sample in five-year windows and use the share from the year before the initial year of that window in the numerical evaluation of the expression. Finally, I regress the expression on time dummies and take the residual as the instrumental variable in order to tease out the time-varying component common to all countries (i.e. global financial conditions).

Figure 1.1: Global liquidity versus emerging market exchange rate index against the US\$



Notes: RER of EME Index and International Bank Claims in Foreign Currency are scaled to 1 in 2008Q2. International Bank

Figure 1.2: Real exchange rates against the US\$



Notes: Real exchange rates are scaled to 1 in 2008Q2.

In the first stage, one standard deviation increase in the instrumental variable is associated with a 0.185 standard deviation decrease in the weighted real exchange rate. This illustrates a strong first stage for the instrument and validates the amplification of weighted currency fluctuations by a higher share of claims in US\$.

Using the instrumental variable that isolates plausibly exogenous variations in the valuation effect of exchange rate movements, I find that a 1% real depreciation of the local currency reduces the growth rate of foreign currency loans channeled by domestic banks by 1.36 ppt. The implied strong balance sheet effect is consistent with the empirical findings of previous

literature. Bruno and Shin (2015) find that lagged real depreciation of the local currency is followed by a drop in cross-border bank flows. While their result is also consistent with the balance sheet effect, it also admits another interpretation: A depreciation of the local currency could be associated with a subsequent drop in capital inflows through an announcement of future unloading of LSAP in developed countries. The instrument I use correlates with real exchange rate movements through country specific balance sheet characteristics, and thus corrects for endogeneity concerns. When I compare the results from a regular OLS with 2SLS, passing from a correlation to a causal relationship, the coefficients for real exchange rate change increases in magnitude and remains significant.

The impact of currency fluctuations on foreign currency loans channeled by domestic banks not only sheds light on the balance sheet effect but also has important implications on financial stability. The reduction in foreign currency lending by risk elastic banks — acting upon deteriorating corporate balance sheets — imply fewer capital inflows, which in turn can lead to additional depreciation. This mechanism may trigger a dangerous feedback loop between capital flows and exchange rate variations, through the balance sheet effect (Bruno and Shin, 2015). My paper provides a quantitative understanding of these risks and should inform policymakers on to what extent they should be concerned about a potential reversal of global funds and the concomitant feedback loops highlighted in the theoretical literature.

The foreign currency bank loans that I use — global bank cross-border claims — reach emerging market firms either directly or through domestic banks. Bruno and Shin (2015) investigate the latter channel — by analyzing global bank cross-border claims vis-à-vis domestic banks — to portray the balance sheet effect for corporate borrowers at the receiving end

of domestic bank loans and the accompanying feedback loop. I enrich the existing theoretical framework by introducing an endogenous portfolio allocation decision for global banks between interbank and corporate lending. I thereby allow global banks to lend directly to corporations in addition to funding them through domestic banks, and thus provide a more complete picture on the transmission channels of global liquidity conditions. Should we expect firms borrowing directly in international financial markets to have balance sheets characterized by currency mismatch, similar to firms borrowing from domestic banks? Given that international/global banks tend to follow their customer around the globe and that loan sizes are much larger in international financial markets, it would be plausible to assume that direct corporate borrowers from global banks are more likely to be multinational corporations. A diversified network of subsidiaries providing more export revenues, and an easier access to financial resources should equip multinational corporations better against exchange rate fluctuations. I accordingly assume that global firms that borrow from global banks have their assets in foreign currency in contrast with local firms whose assets are denominated in local currency. This assumption is reflected in the model simulations: Cross-border claims vis-a-vis domestic banks are more sensitive to global liquidity shocks than cross-border claims vis-à-vis the corporate sector. The results from the two-stage least squares regressions validate the model's predictions. While a real depreciation causes a significant decline in cross-border claims vis-à-vis domestic banks (or equivalently foreign currency loans channeled by domestic banks), this significant response is absent for cross-border direct claims on the corporate sector.

Overall, the excessive credit built up by the corporate sector causes concern for policy makers in EMEs. The exposure of international banks to EME assets could potentially disrupt

financial stability on a global scale as financial markets are more integrated than ever, (CIEPR, 2015). My findings imply that policymakers in EMEs should further strengthen the prudential oversight of domestic banks by closely monitoring their clients' foreign currency exposure. In addition, the results suggest that the risk sensitive lending behavior of banks plays an important role in the propagation of exchange rate fluctuations.

Section 2 reviews related literature. Section 3 describes the model and demonstrates its key predictions. Finally, section 4 presents the empirical model including the construction of the instrumental variable, the results as well as its interpretations.

1.2 Review of Literature

With the gradual integration of financial markets in recent decades, financial conditions across EMEs have become highly synchronized. Global ease of financing (also described as *push* factors, or credit supply) explains variations in capital inflows significantly better than domestic fundamentals (also described as *pull* factors, or credit demand) (Calvo et al., 1996; Forbes and Warnock, 2012). Given the positive correlation between credit growth and current account imbalance, credit cycles and foreign capital flows have the potential to reinforce each other. Accordingly, a surge in capital flows is a robust ex-ante indicator of financial crises in Emerging Market Economies (Jorda et al., 2011). The assessment of the balance sheet effect of corporates in EMEs would help disentangle the effect of exchange rates in the close connection between financial stability in EMEs and global financial conditions.

In a framework where capital inflows ultimately reach local corporates (which may

be subject to currency mismatch) through domestic banks, the feedback loop between exchange rates and capital flows (Bruno and Shin, 2015) is consistent with the findings in Gourinchas and Obstfeld (2012) — Domestic credit expansion and real appreciation of local currency are strong ex-ante indicators of financial crises in EMEs.

Using country heterogeneity in the foreign currency decomposition of claims to identify the effect of real exchange rate changes is reminiscent of using bank heterogeneity in ratios of securities to assets to evaluate the bank lending channel of monetary transmission (Kashyap and Stein, 2010).

There is a wide literature about the exposure of firms to foreign exchange risk. Dominguez and Tesar (2006)¹ assess the exposure by looking at how sensitive stock returns are to currency movements. This method, relying on the efficient market hypothesis, implicitly assumes that market agents are accurately informed about firms' exchange rate exposure, and the sample is restricted to firms listed on the stock market. Small firms are more likely to be exposed than than large-and medium-sized firms.

1.3 Model

1.3.1 Motivation and context

Within the framework of this paper's research question, the ultimate borrowers at the receiving end of capital flows are firms. Corporates in EMEs obtain loans from global banks directly and/or indirectly through domestic banks. Differences in ultimate borrower character-

¹Other related papers are Dominguez (1998) and Ito & al (2015)

istics of these loans provide valuable information about currency mismatch. Firms with direct access to global funds are generally large. During 2013, the median and average issue size for Indian firms' foreign borrowing of 20 MN and 68 MN US\$ respectively,² validate the size of firms borrowing directly from global banks. Most of exported goods and services are produced by large firms. In addition to providing cash flows in foreign currency, exports counterweight the adverse balance sheet effect during the depreciation of the local currency since goods and services of the respective country become more competitive. Large firms that are multinational corporations with subsidiaries get to naturally hedge with a well diversified income basket denominated in several currencies. Finally, large corporations are likely to have more resources to use financial instruments, such as FX swap. On the other hand, local corporates are more likely to have a currency mismatch. Admittedly, firms tapping into international financial markets directly probably get some partial funding from domestic banks as well.

Table 1.1 gives us two key insights on the role of domestic banks in providing foreign currency loans in EMEs. First, domestic banks are the major source of credit in EMEs. Second, the share of foreign currency loans in total bank credit is not trivial.³

²Source: Summary statistics from External Commercial Borrowing Data shared on the RBI site

³Table 1.1: In the first row, total credit aggregates all lenders (i.e. other than domestic banks, lenders include non-financial corporations, general government, central bank, households, and the rest of the world including internationally active banks. The ratio in second row uses the foreign currency and foreign-currency-linked part of gross loans to residents and nonresidents as the numerator and total gross loans as the denominator. The sample of EMEs include Argentina, Brazil, Chile, Colombia, Croatia, Czech Republic, Indonesia, Israel, Mexico, Poland, South Africa, Turkey, Ukraine

Table 1.1: Foreign currency loans in domestic banks

Average across EMEs (in%)	2013	2014	2015
Domestic bank credit/Total credit	81.6	82.1	82
Foreign currency loans/Total bank loans	21.8	23.1	24.5

Source: IMF Financial Soundness Indicators

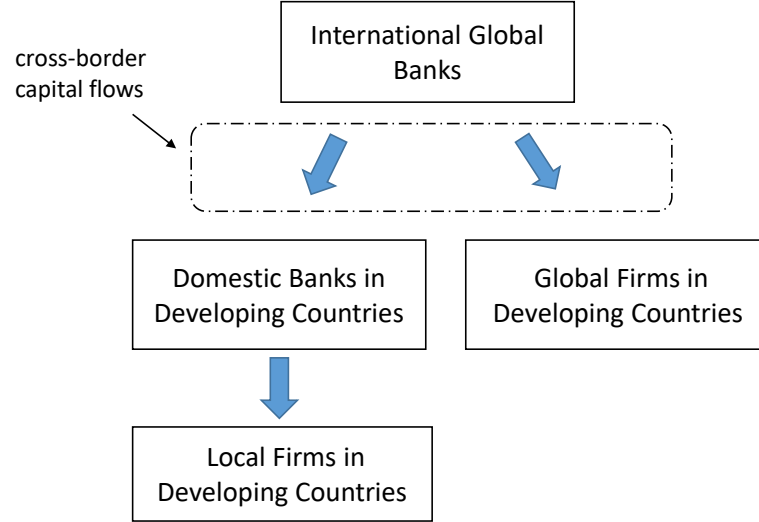
Figure 1.3 is a diagram that shows funding relationships between agents in the model. The underlying currency assumptions of flows and of agents' balance sheets are depicted in Figure 1.4.

1.3.2 Firms

I categorize firms in emerging countries into local and global ones (i.e, multinational corporations). The latter type have direct access to global banks for funds. Local corporates, on the other hand, borrow foreign currency denominated loans through domestic banks. As previously discussed, global firms have more advantages in hedging their currency risk than local corporates. This is reflected in the model by local firms dealing with currency mismatch while global firms have their foreign currency liabilities matched by foreign currency assets.

There is a continuum of local and global firms. r_{db} and r_{gb} denote interest rates charged by domestic and global banks, respectively. I assume that $r_{db} > r_{gb}$. A justifying microfoundation could be that domestic banks charge a premium for incurring costs in the process of channeling global funds. Because of cheaper funds, global firms always prefer to borrow from global banks. Local firms, on the other hand, only have access to domestic banks. This could be justified with a moral hazard story; The informational asymmetry between local firms and the global bank, as lender, is high to the point that local firms are not able to borrow

Figure 1.3: Flow of funds between agents in the model



global banks. As a result, in equilibrium, domestic bank loans are exclusive to local firms while global bank lend directly exclusively to global firms.

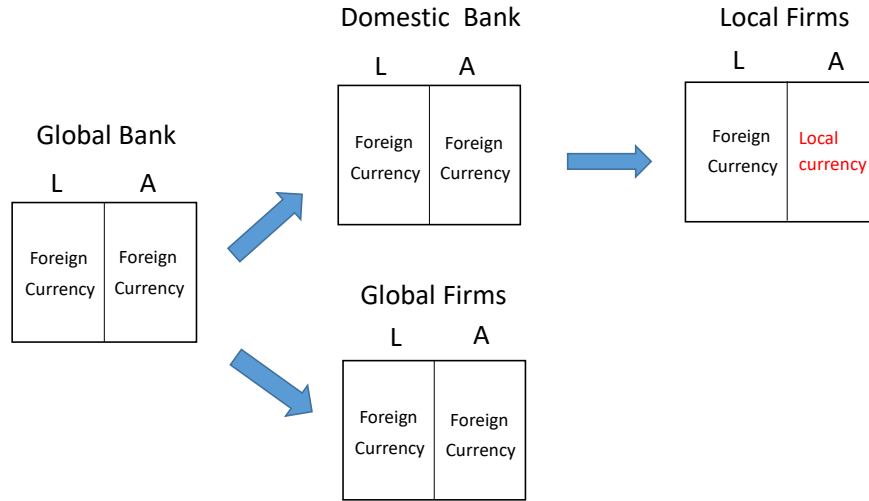
I denote aggregate credit demand by local and global firms by D_L and D_G , respectively. Aggregate demand for credit is decreasing in the interest rate.

$$\frac{dD_L}{dr_{db}} < 0, \quad \frac{dD_G}{dr_{gb}} < 0$$

Each firm undertake a project with one unit of investment. The project gross returns depends on the type of firm. For a global firm i in country j , the gross return is

$$1 + x_{ij} = \exp\left\{a - \frac{s^2}{2} + sw_{ij}\right\}$$

Figure 1.4: Currency of flows and balance sheets



where x_{ij} denote the net project return in percentage point for global firm i in country j . $a - \frac{s^2}{2}$ is a constant term in the return, common to all firms. w_{ij} , the stochastic component of the return, is the aggregate shock. s is a parameter characterizing the standard deviation of w_{ij} .

For a local firm i in country j , the gross return is

$$1 + x_{ij} = \exp\left\{a - \frac{s^2}{2} + sw_{ij} + b(r^w)\right\}$$

where x_{ij} denote the net project return in percentage point for local firm i in country j . $a - \frac{s^2}{2}$ is a constant term in the return, common to all firms. w_{ij} , the stochastic component of the return, is the aggregate shock. s is a parameter characterizing the standard deviation of w_{ij} . $b(r^w)$, the part of the return that depends on real exchange rate variations, is a function of r^w . r^w denotes

the world interest rate at which the global bank funds itself. r^w is indicative of global liquidity conditions. As global liquidity tightening (expansion) is accompanied with the real depreciation (appreciation) of the local currency, $b(r^w)$ represents the impact of real exchange rate changes on local firm's balance sheet. The aggregate shock w_{ij} is decomposed in firm level, country level and global level shocks. The return distribution — division of the return to common and idiosyncratic parts — is similar to Vasicek (2002).

$$w_{ij} = \sqrt{\rho}y_j + \sqrt{1 - \rho}v_{ij}$$

where

$$y_j = \sqrt{\beta}G + \sqrt{1 - \beta}k_j$$

v_{ij} denotes firm level idiosyncratic shock for firm i in country j . k_j denotes the country level shock common to all firms in country j . G denotes the global shock common to all countries. v_{ij}, k_j and G are mutually independent standard normal random variables. Given their relative weight, the aggregate stochastic variable, w_{ij} , is also a standard normal random variable.

1.3.3 Domestic bank

Figure 1.5 lays out the balance sheet of the domestic bank before and at maturity. On the asset side, C_{db} is the portfolio of loans to local firms. On the liabilities side, E_D and L denote equity and loans procured from the Global bank, respectively. While the domestic bank borrows at a rate of r^f from the global bank, it lends to local firms at a rate of r_{db} . ϕ denotes debt to assets ratio at maturity. The higher ϕ is, the higher the leverage. The initial equity, E_D is given exogenously.

Figure 1.5: Balance sheet of Domestic Bank

	Assets	Liabilities										
t=1	C _{db}	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 50%; height: 30px; text-align: center;">E_D</td> <td style="border: 1px solid black; width: 50%; height: 30px;"></td> </tr> <tr> <td style="border: 1px solid black; width: 50%; height: 70px; text-align: center;">L</td> <td style="border: 1px solid black; width: 50%; height: 70px;"></td> </tr> </table>	E _D		L							
E _D												
L												
	Assets	Liabilities	Normalized									
t=2	C _{db} (1+r _{db})	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 50%; height: 30px; text-align: center;">E'_D</td> <td style="border: 1px solid black; width: 50%; height: 30px;"></td> </tr> <tr> <td style="border: 1px solid black; width: 50%; height: 70px; text-align: center;">L(1+r^f)</td> <td style="border: 1px solid black; width: 50%; height: 70px;"></td> </tr> </table>	E' _D		L(1+r ^f)		<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="border: 1px solid black; width: 50%; height: 30px; text-align: center;">1</td> <td style="border: 1px solid black; width: 50%; height: 30px; text-align: center;">1-φ</td> </tr> <tr> <td style="border: 1px solid black; width: 50%; height: 70px; text-align: center;">1</td> <td style="border: 1px solid black; width: 50%; height: 70px; text-align: center;">φ</td> </tr> </table>	1	1-φ	1	φ	
E' _D												
L(1+r ^f)												
1	1-φ											
1	φ											

1.3.3.1 Default probability of local firms

Local firms default when loan repayment exceeds project return.

$$\exp\left\{a + b(r^w) - \frac{s^2}{2} + sw_{ij}\right\} < 1 + r_{db}$$

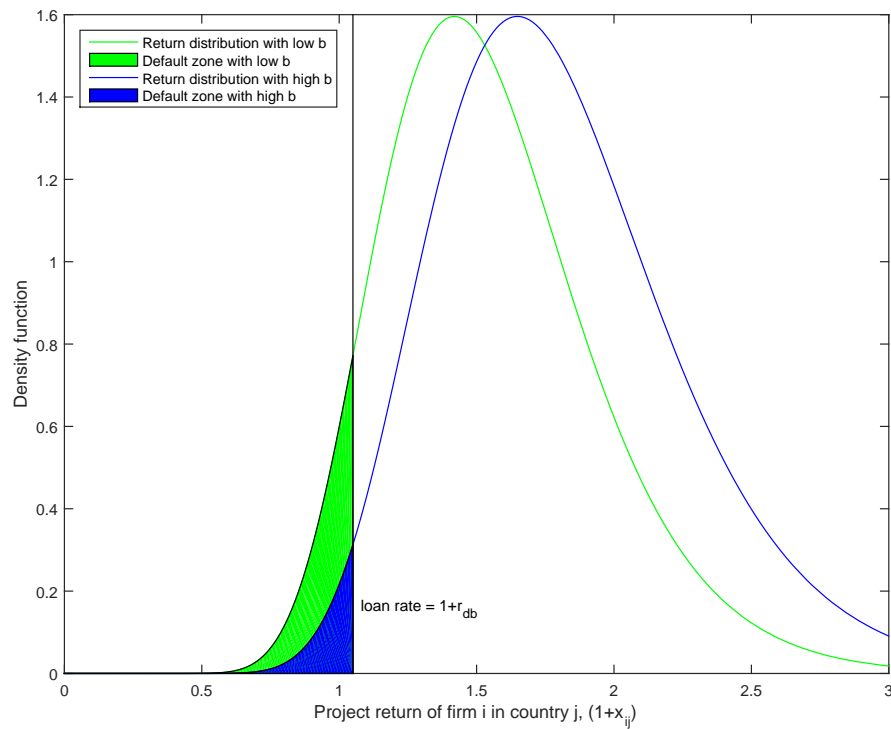
$$w_{ij} < \frac{\ln(1 + r_{db}) - a - b(r^w) + \frac{s^2}{2}}{s}$$

Let ε^L denote the probability of default for local firms.

$$\varepsilon^L = \Phi\left(\frac{\ln(1 + r_{db}) - a - b(r^w) + \frac{s^2}{2}}{s}\right)$$

where $\Phi(\cdot)$ is the cdf for standard normal distributions. Figure 1.6 illustrates how b (the component of the return that depends on exchange rate variations) and r_{db} (loan rate) map into \mathcal{E}^L . A real appreciation of the local currency, characterized by high b , shifts the project return distribution to the right. The black vertical line marks the loan repayment rate. Returns short of the loan rate $1 + r_{db}$ fall into the default zone highlighted by the colored area. Real appreciation of the local currency improves the project return distribution in foreign currency units, and thus lowers the default probability.

Figure 1.6: Exchange rate variations and Project Return



Credit risk for Domestic Bank's portfolio

Credit risk is characterized as in Vasicek (2002). The domestic bank lends to a continuum of local firms. By the law of large numbers, domestic bank's portfolio diversifies away from idiosyncratic shocks at the firm level. From the bank's perspective, credit risk originates from common risk factor in firms' returns, y_j . Figure 1.7 illustrates how different values of y_j translate into the value distribution of a loan portfolio with face value of 1 dollar.

Firms in Figure 7 have a constant expected default probability of $\varepsilon^L = 0.1$, but the *realized* default rates can vary. The transition from the top to the middle panel maps different y_j values into varying default rates in the loan portfolio. The bottom panel highlights the corresponding realized value of a loan portfolio with face value of 1 dollar⁴. Since banks have no recovery value when firms default, the realized value of the loan portfolio is simply equal to the share of firms that have not defaulted.

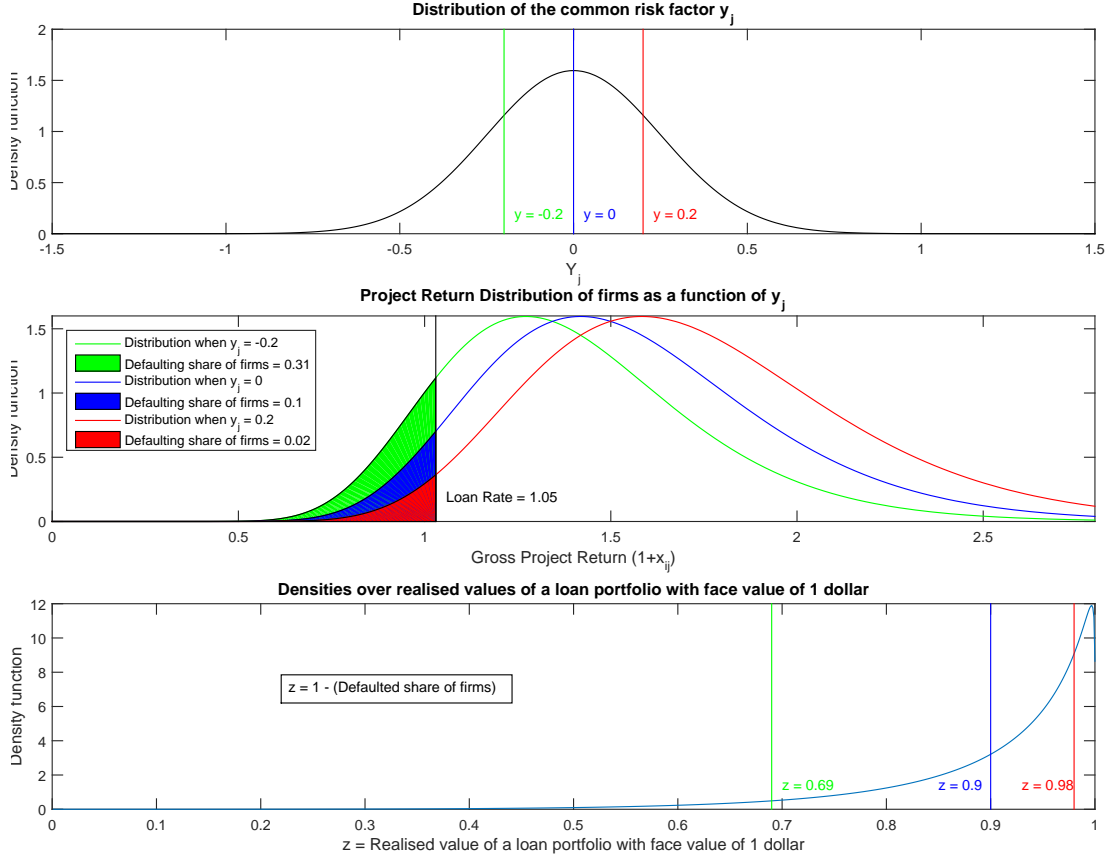
The following iterations give the analytical solution to the realized value of the loan portfolio. Conditional on y_j , the share of local firms that do not default is given by the following condition.

$$\sqrt{\bar{\rho}}y_j + \sqrt{1 - \bar{\rho}}v_{ij} > \Phi^{-1}(\varepsilon^s)$$

$$v_{ij} > \frac{\Phi^{-1}(\varepsilon^s) - \sqrt{\bar{\rho}}y_j}{\sqrt{1 - \bar{\rho}}}$$

⁴A loan portfolio with face value of 1 dollar represents the value of the portfolio at maturity normalized to 1 dollar.

Figure 1.7: Credit risk for the domestic bank's loan portfolio when $\varepsilon^L = 0.1$



Let ω , a random variable, denote the realised value of a loan portfolio with face value of 1 dollar. This random variable is a function of y_j .

$$\omega(y_j) = \Phi \left(\frac{\sqrt{\rho}y_j - \Phi^{-1}(\varepsilon^L)}{\sqrt{1-\rho}} \right)$$

The distribution of ω depends on ε^L and ρ . Figure 1.8 and 1.9 plot how the distribution of realised value of the loan portfolio changes with shifts in ε^L , the default probability of firms, and in ρ , respectively. As Figure 1.8 might hint, distributions with lower ε^L first-order

stochastically dominates ones with higher ε^L . This property is directly related to the leverage decision of banks. Figure 1.8 reaffirms that credit risk for banks originates from the common risk term, y_j . ρ is the relative weight of y_j in comparison to the firm level idiosyncratic shock, v_{ij} . Higher ρ implies a larger share of the return which the bank can not diversify away. This explains that the variance of the portfolio is increasing in ρ ⁵. It is interesting to note that all three portfolios have the same expected revenue, $E(\omega) = 1 - \varepsilon^L$.

1.3.3.2 Domestic Bank leverage

ϕ is debt to assets ratio at maturity. The higher ϕ is, the higher the leverage. The initial equity, E_D is given exogenously. I calibrate the model parameters such that bank's expected profit is increasing in loans intermediated to borrowers (L). The bank would preferably leverage its capital infinitely.

However, the leverage, or equivalently ϕ , is constrained by the Value-at-Risk rule. Value-at-Risk rule, herein after denoted VaR, consists of keeping the leverage so that the bank's probability of default on its liabilities does not exceed a fixed probability, α . Given α , ρ and ε^L , VaR rule pins the leverage (ϕ) down by the following equation⁶;

$$\phi = \Phi \left(\frac{\sqrt{\rho} \Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon^L)}{\sqrt{1 - \rho}} \right) \quad (1.1)$$

The debt-to-assets ratio, ϕ , or equivalently the leverage $1/(1 - \phi)$, is decreasing in ε^L , which is consistent with procyclical leverage.

⁵All three portfolios with different ρ values have the same expected revenue, $E(\omega) = 1 - \varepsilon^L$.

⁶The derivation of Equation (1) is shown step by step in Appendix A.

Figure 1.8: Distribution of realised values of a loan portfolio with different ϵ values

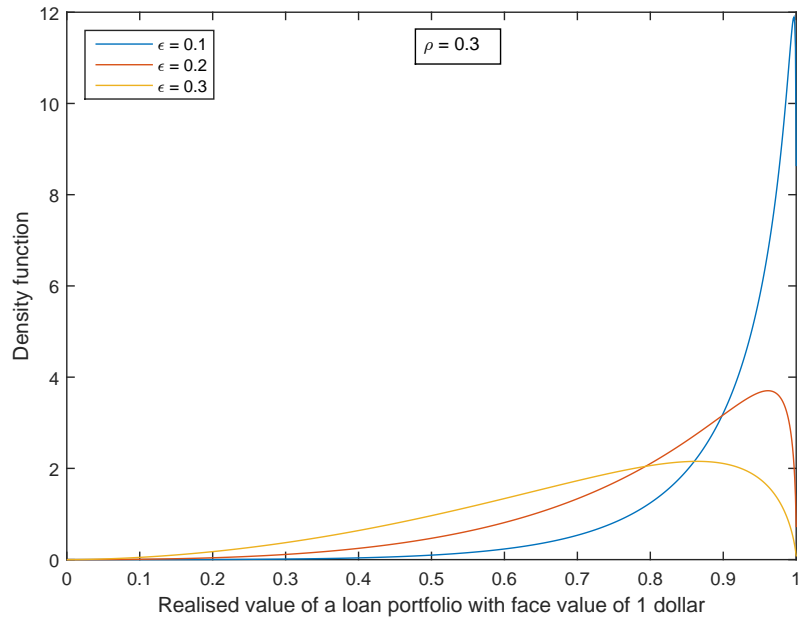
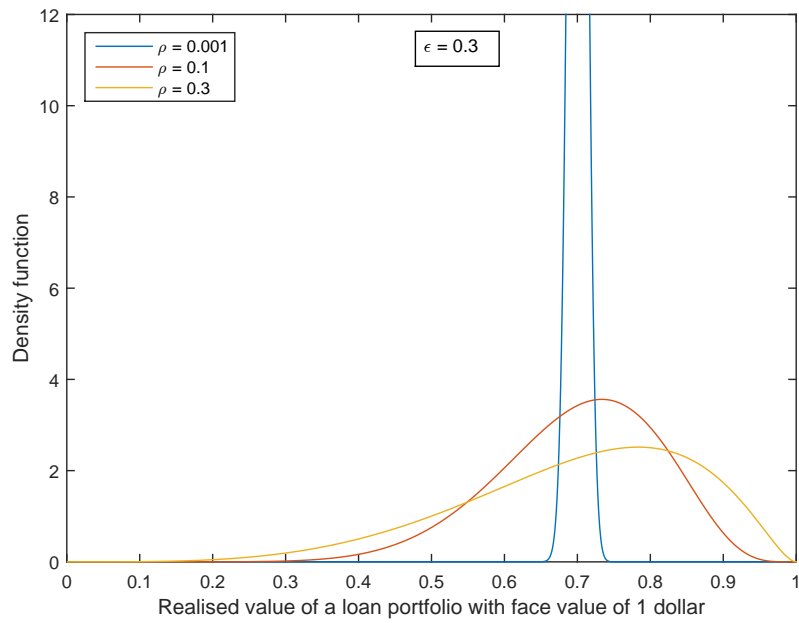


Figure 1.9: Distribution of realised values of a loan portfolio with different ρ values



The higher default probability of local firms, the lower the leverage of domestic banks is. Low ε_{low}^L portfolio distributions first-order stochastically dominating high ε_{high}^L portfolio distributions implies that

$$F_{\varepsilon_{low}^L}(\omega < z) < F_{\varepsilon_{high}^L}(\omega < z)$$

for any z . VaR rule, expressed as,

$$F(\omega < \varphi) = \alpha$$

would then lead to

$$\varphi_{\varepsilon_{low}^L} > \varphi_{\varepsilon_{high}^L}$$

1.3.4 Global Bank

Figure 1.10 lays out the balance sheet of the Global Bank before and at maturity. On the asset side, C , the portfolio of loans is allocated between global firms, C_{gb} and domestic banks, C_f . On the asset's side, E_G and M denote equity and loans procured from wholesale funds market, respectively. The global bank borrows at a rate of r^w from wholesale funds market. It intermediates a share (λ) of funds to domestic banks at a rate of r^f while the remaining share ($1 - \lambda$) of funds goes to big firms at a rate r_{gb} . ψ denotes debt to assets ratio at maturity. The higher ψ is, the higher the leverage. The initial equity, E_G is given exogenously.

1.3.4.1 Default probability of global firms and of domestic banks

As domestic banks follow the VaR rule, their default probability is fixed to α .

Global firms default when loan repayment exceeds project return.

$$\exp\left\{a - \frac{s^2}{2} + sw_{ij}\right\} < 1 + r_{gb}$$

$$w_{ij} < \frac{\ln(1 + r_{gb}) - a + \frac{s^2}{2}}{s}$$

Let ε^G denote the probability of default for global firms.

$$\varepsilon^G = \Phi\left(\frac{\ln(1 + r_{gb}) - a + \frac{s^2}{2}}{s}\right)$$

Note that big firms do not have the component in the return that depends on currency movements, $b(\cdot)$. As a result, real exchange rate changes do not have a direct impact on the default risk of global firms.

1.3.4.2 Credit risk for Global Bank's portfolio

Credit risk of global firms The global bank lends to a continuum of global firms in a continuum of countries (regions). By the law of large numbers, global bank's portfolio diversifies away from idiosyncratic shocks at both firm and country level. From the bank's perspective, credit risk originates from common global risk factor in firms' returns, G .

How different values of G result in a value distribution in the global bank's loan portfolio is analogical to the relation between y_j and z , the realized value of the domestic bank's loan portfolio. Since banks have no recovery value when firms default, the realized value of the loan portfolio is simply equal to the share of firms that have not defaulted.

Figure 1.10: Balance sheet of Global Bank

t=1	<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; padding: 2px;">Assets</th> <th style="text-align: left; padding: 2px;">Liabilities</th> </tr> <tr> <td style="padding: 5px;">$(1-\lambda)C=C_{gb}$</td> <td style="padding: 5px;">E_G</td> </tr> <tr> <td style="padding: 5px;">$\lambda C=C_f$</td> <td style="padding: 5px;">M</td> </tr> </table>	Assets	Liabilities	$(1-\lambda)C=C_{gb}$	E_G	$\lambda C=C_f$	M
Assets	Liabilities						
$(1-\lambda)C=C_{gb}$	E_G						
$\lambda C=C_f$	M						

t=2	<table style="width: 100%; border-collapse: collapse;"> <tr> <th style="text-align: left; padding: 2px;">Assets</th> <th style="text-align: left; padding: 2px;">Liabilities</th> </tr> <tr> <td style="padding: 5px;">$C_{gb}(1+r_{gb})$</td> <td style="padding: 5px;">E'_G</td> </tr> <tr> <td style="padding: 5px;">$C_f(1+r^f)$</td> <td style="padding: 5px;">$M(1+r^w)$</td> </tr> </table>	Assets	Liabilities	$C_{gb}(1+r_{gb})$	E'_G	$C_f(1+r^f)$	$M(1+r^w)$	<table style="border-collapse: collapse;"> <tr> <th colspan="2" style="text-align: center; padding: 2px;">Normalized</th> </tr> <tr> <th style="text-align: left; padding: 2px;">Assets</th> <th style="text-align: left; padding: 2px;">Liabilities</th> </tr> <tr> <td style="padding: 5px; text-align: center;">1</td> <td style="padding: 5px; text-align: center;">1-ψ</td> </tr> <tr> <td></td> <td style="padding: 5px; text-align: center;">ψ</td> </tr> </table>	Normalized		Assets	Liabilities	1	1-ψ		ψ
Assets	Liabilities															
$C_{gb}(1+r_{gb})$	E'_G															
$C_f(1+r^f)$	$M(1+r^w)$															
Normalized																
Assets	Liabilities															
1	1-ψ															
	ψ															

The following iterations give the analytical solution to the realized value of the loan portfolio for the part that is allocated to the global firms. Conditional on G , the share of big firms that do not default is given by the following condition⁷.

$$\sqrt{\rho}y_j + \sqrt{1-\rho}v_{ij} > \Phi^{-1}(\epsilon^G)$$

$$\sqrt{\rho} \left(\sqrt{\beta}G + \sqrt{1-\beta}k_j \right) + \sqrt{1-\rho}v_{ij} > \Phi^{-1}(\epsilon^G)1$$

$$\sqrt{\rho}\sqrt{1-\beta}k_j + \sqrt{1-\rho}v_{ij} > \Phi^{-1}(\epsilon^G) - \sqrt{\rho}\sqrt{\beta}G$$

$$v_{ij} > \frac{\Phi^{-1}(\epsilon^G) - \sqrt{\rho}\sqrt{\beta}G}{\sqrt{1-\rho\beta}}$$

⁷The sum of two independent normally distributed random variables is normal, with its mean being the sum of the two means, and its variance being the sum of the two variances.

The share of global firms that do not default, $\omega_g(G)$, is a function of G .

$$\omega_g(G) = 1 - \Phi\left(\frac{\Phi^{-1}(\varepsilon^G) - \sqrt{\rho}\sqrt{\beta}G}{\sqrt{1-\rho\beta}}\right) = \Phi\left(\frac{\sqrt{\rho}\sqrt{\beta}G - \Phi^{-1}(\varepsilon^G)}{\sqrt{1-\rho\beta}}\right)$$

Credit risk of regional banks The global bank lends to a continuum of domestic banks, each in a separate country (region). By the law of large numbers, global bank's portfolio diversifies away from idiosyncratic shocks at the country level, k_j . From the global bank's perspective, credit risk originates from common global risk factor, G . Since global banks have no recovery value when regional banks default, the realized value of the loan portfolio is simply equal to the share of regional banks that do not default. Conditional on G , the share of regional banks that do not default is derived as follows; Regional banks default when the realized value of their loan portfolio at a face value of 1 dollar comes short of the debt-to-asset ratio, φ .

$$z < \varphi$$

$$\omega^{-1}(z) < \omega^{-1}(\varphi)$$

$$y_j < \omega^{-1}(\varphi)$$

VaR rule implies the probability of default of a regional is pinned to α .

$$F(y_j < \omega^{-1}(\varphi)) = \Phi(\omega^{-1}(\varphi)) = \alpha$$

$$\omega^{-1}(\varphi) = \Phi^{-1}(\alpha)$$

Thus domestic bank in country j defaults when

$$y_j < \Phi^{-1}(\alpha)$$

$$\sqrt{\beta}G + \sqrt{1-\beta}k_j < \Phi^{-1}(\alpha)$$

$$k_j < \frac{\Phi^{-1}(\alpha) - \sqrt{\beta}G}{\sqrt{1-\beta}}$$

The share of regional banks that do not default, $\omega_f(G)$, is a function of the global risk factor, G .

$$\omega_f(G) = 1 - \Phi\left(\frac{\Phi^{-1}(\alpha) - \sqrt{\beta}G}{\sqrt{1-\beta}}\right) = \Phi\left(\frac{\sqrt{\beta}G - \Phi^{-1}(\alpha)}{\sqrt{1-\beta}}\right)$$

Credit risk of the combined portfolio The share of loans that do not default in the aggregate portfolio is a linear combination of $\omega_f(G)$ and $\omega_g(G)$. The face value shares of loans to regional banks and to global firms in the aggregate portfolio are λ' and $1 - \lambda'$. The relationship between the face value shares and the initial shares, λ and $1 - \lambda$, is given by the following equality;

$$\lambda' = \left(\frac{1+r^f}{1+R}\right)\lambda$$

where R is the weighted interest rate of the portfolio. $R = \lambda r^f + (1 - \lambda)r_{gb}$.

Let ω_g , a random variable, denote the realised value of the aggregate portfolio with face value of 1 dollar.

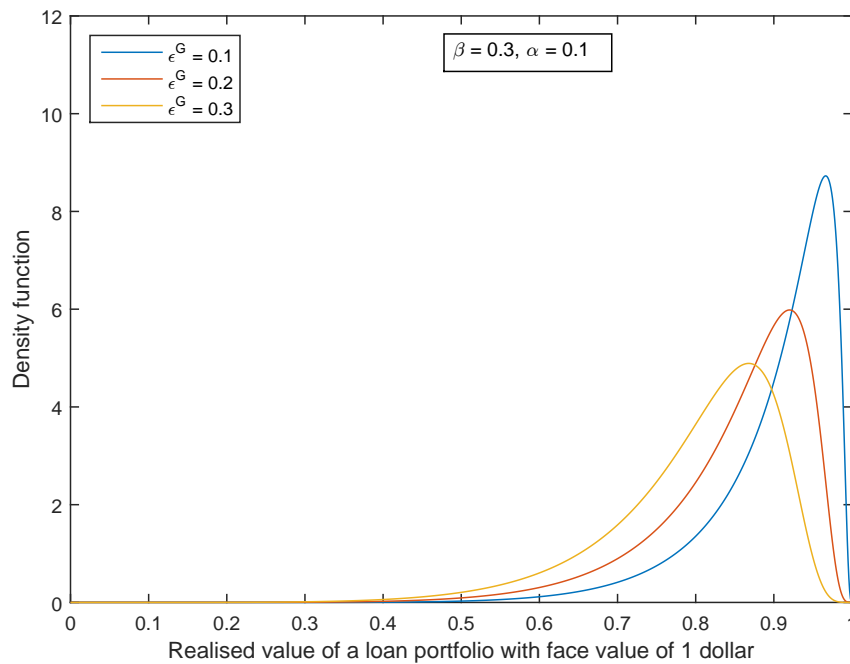
$$\omega_g(G) = \lambda'\omega_f(G) + (1 - \lambda')\omega_b(G)$$

$$\omega_g(G) = \lambda'\Phi\left(\frac{\sqrt{\beta}G - \Phi^{-1}(\alpha)}{\sqrt{1-\beta}}\right) + (1 - \lambda')\Phi\left(\frac{\sqrt{\rho}\sqrt{\beta}G - \Phi^{-1}(\epsilon^G)}{\sqrt{1-\rho\beta}}\right)$$

Figures 1.11, 1.12 and 1.13 plot how the distribution of realized value of the global bank combined portfolio changes with shifts in ϵ^G , β and α , respectively. Similar to domestic

banks' portfolios, distributions with lower probability of default for big firms, ϵ^G (domestic banks, α) first-order stochastically dominates ones with higher ϵ^G (α). Once again, this property leads to procyclical leverage. β is the relative weight of the global risk factor, G , that the global bank can not diversify. As we can see in the middle panel, the higher β is, the higher the variance of the portfolio⁸.

Figure 1.11: Distribution of realised values of a loan portfolio with ϵ^G



1.3.4.3 Global bank leverage

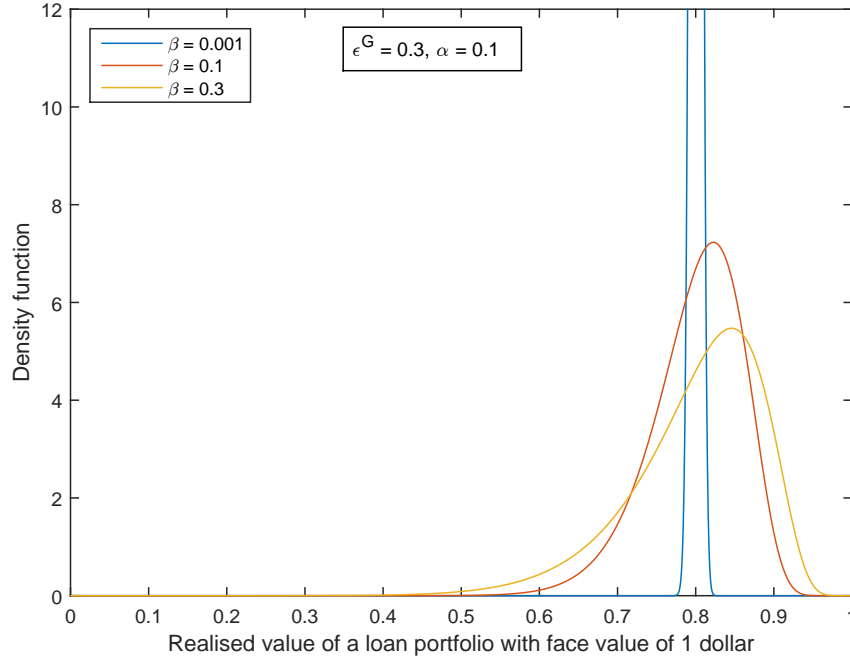
ψ is the debt to assets ratio at maturity. The higher ψ is, the higher the leverage.

The initial equity, E_G is given exogenously. I calibrate the model parameters such that bank's

⁸It is important to note that the expected revenue of all the portfolios in Figure 1.11 is given by, $E(\omega) = 1 - \epsilon^G$.

expected profit is increasing in loans intermediated to borrowers (C). The bank would preferably leverage its capital infinitely. However, the leverage, or equivalently the debt-to-asset ratio, ψ , is constrained the Value-at-Risk rule. It consists of keeping the leverage so that the bank's probability of default on its liabilities does not exceed a fixed probability, α_g . Given $\alpha, \alpha_g, \rho, \beta$ and ϵ^G , VaR rule pins the leverage (ψ) down⁹;

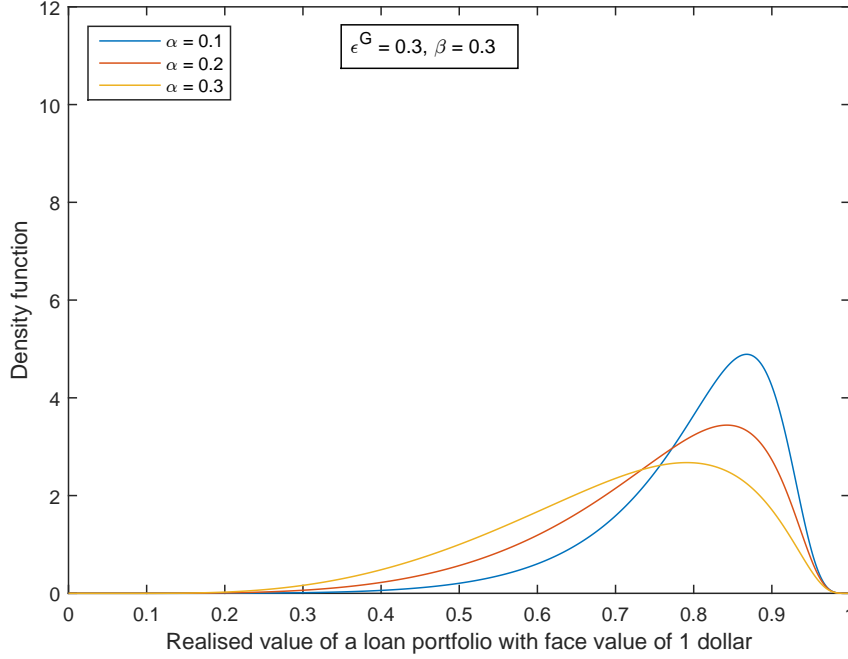
Figure 1.12: Distribution of realised values of a loan portfolio with shifts in β



$$\psi = \lambda' \Phi \left(\frac{\sqrt{\beta} \Phi^{-1}(\alpha_g) - \Phi^{-1}(\alpha)}{\sqrt{1-\beta}} \right) + (1-\lambda') \Phi \left(\frac{\sqrt{\rho} \sqrt{\beta} \Phi^{-1}(\alpha_g) - \Phi^{-1}(\epsilon^G)}{\sqrt{1-\rho\beta}} \right) \quad (1.2)$$

⁹The derivation of equations (2) and (3) is shown step by step in Appendix A.

Figure 1.13: Distribution of realised values of a loan portfolio with shifts in α



For the special case where $\alpha = \alpha_g$

$$\psi = \lambda' \Phi \left(\frac{(\sqrt{\beta} - 1) \Phi^{-1}(\alpha)}{\sqrt{1 - \beta}} \right) + (1 - \lambda') \Phi \left(\frac{\sqrt{\rho} \sqrt{\beta} \Phi^{-1}(\alpha) - \Phi^{-1}(\epsilon^b)}{\sqrt{1 - \rho\beta}} \right) \quad (1.3)$$

The debt-to-assets ratio, ψ , or equivalently the leverage $1/(1 - \psi)$, is decreasing in ϵ^G and α , which is consistent with procyclical leverage.

1.3.4.4 Allocation of loans between big firms and domestic bank - Determination of λ

C , the portfolio of loans is allocated between big firms, C_{gb} and domestic banks, C_f , with shares of $1 - \lambda$ and λ , respectively.

Per unit profit of C_f to the bank is

$$\pi_f = (1 + r^f) \int_{\psi}^1 (z - \psi) f_f(z) dz$$

Per unit profit of C_b to the bank is

$$\pi_b = (1 + r^b) \int_{\psi}^1 (z - \psi) f_b(z) dz$$

Note that when the global bank defaults ($z < \psi$), creditors have no recovery value (limited liability). However, the bank does not get to keep the residual value z of the portfolio. Thus when the bank defaults, its net profit of the bank is nul. At the optimal allocation λ^* , the global bank is indifferent to lending to either borrower.

$$\pi_f(\lambda^*) = \pi_b(\lambda^*)$$

1.3.5 Loan Markets

Interest rates r_{db}, r_{gb}, r^f and the allocation of global bank's portfolio between global firms and domestic banks, λ , clear the loan markets by equalizing

$$C_{db} = D_L$$

$$C_{gb} = D_G$$

$$C_f = L$$

$$\pi_f = \pi_b$$

1.3.6 Model Simulation: Behaviour of cross-border flows amid changing global liquidity conditions

The world interest rate, r^w , reflect global liquidity conditions in the model. An increase in the world interest rate leads to a shortage of funds for both domestic banks and big firms, putting upward pressure on the interest rates they get charged. A rise in r_{gb} and r_{db} , in turn, make firms' default more likely.

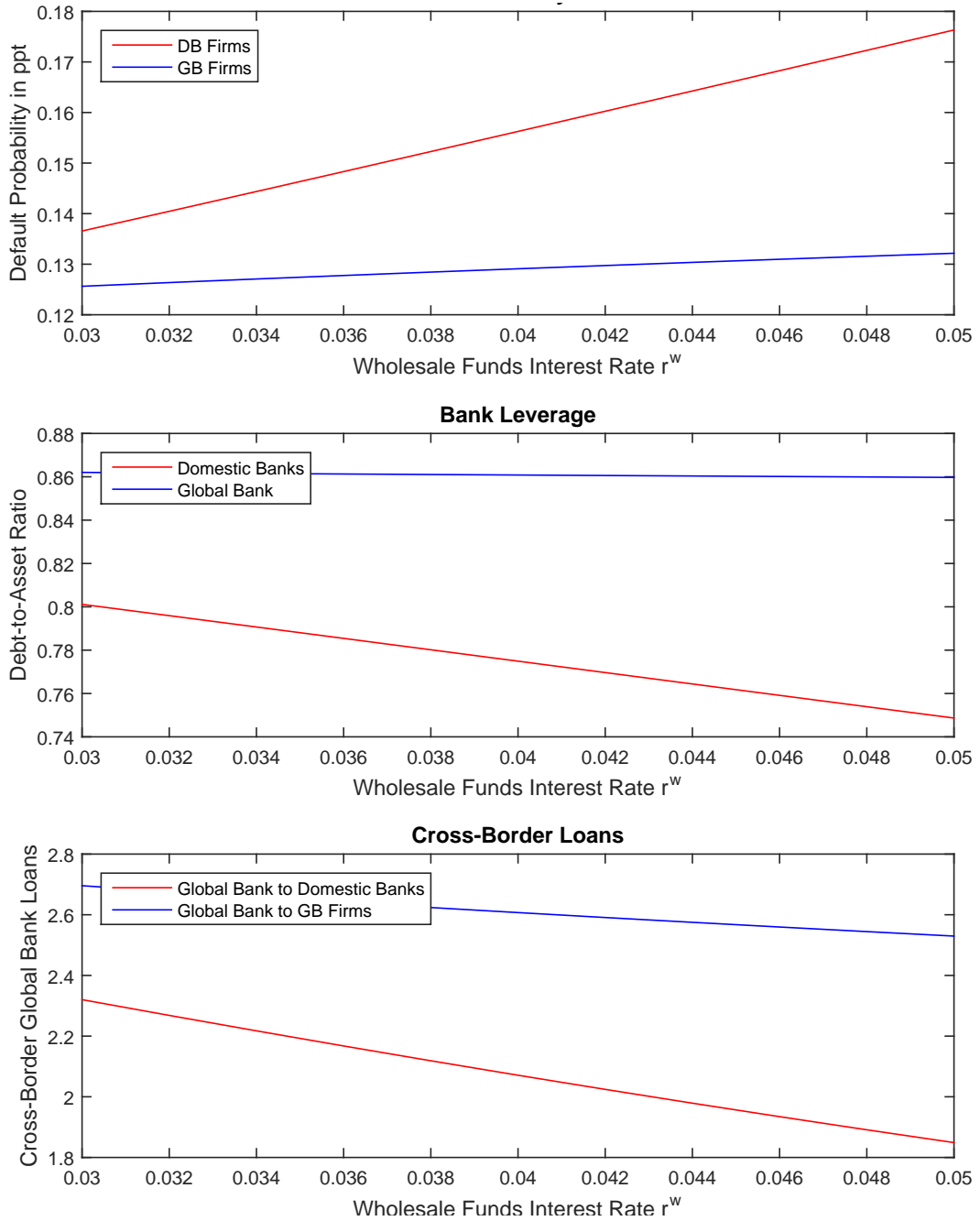
This is consistent with increasing default probabilities of both local and global firms in the upper panel of Figure 1.14. The additional surge in the default probability of local firms relative to global firms is due to real exchange rate movements. The model incorporates currency mismatch as a feature specific to local firms. As a result, the depreciation of the local currency against foreign currencies during a global financial downturn causes a larger increase in the default probability of local firms.

VaR rule followed by banks requires deleveraging as their portfolio gets riskier. The middle panel illustrates both domestic banks and global bank deleveraging. The formers' portfolio is composed of local firms in comparison to a mix of global firms and domestic banks in the portfolio of the latter. Local firms, more sensitive to external conditions, result in domestic banks deleveraging more than the global bank.

Changes in leverage have a quantitative impact on loans coming in and out of banks. Domestic banks deleveraging significantly leads to a proportional decrease in demand of loans from the global bank. When r^w goes up from 0.03 to 0.05, cross-border loans from the global bank to domestic banks decrease approximately by 20% while cross-border flows from global bank to firms goes down by less than 10%. Currency movements in tandem with global credit

cycles magnify the fall in cross-border bank-to-bank flows more than bank-to-firm flows.

Figure 1.14: Changing global liquidity conditions



1.4 Empirical analysis

1.4.1 Relationship between the share of non-US\$ denominated claims and real exchange rate changes

The instrumental variable is related to the country heterogeneity of the ratio of "loans denominated in €, £, JPY, and CHF" to "Total loans denominated in foreign currencies" in cross-border claims of international banks. In other words, it depends on how heavily an emerging economy borrows in non-US\$ foreign currencies relative to US\$. Despite the domination of US\$ as the global currency, non-US\$ foreign currencies hold a non-trivial share in cross-border claims on emerging economies. The average shares in the sample (16 EMEs from 2001 to 2015) for €, JPY, CHF, and £ are approximately 18%, 7%, 2%, and 1%, respectively, while the remaining 72% of cross border claims are denominated in US\$. Note that a very small amount of cross-border claims on emerging economies are denominated in the local currency of the host country.

The ratio of claims denominated in currency f to total cross-border claims in country j , at time t , is denoted by $w_{j,t}^f$, where $f = \{US\$, \€, \pounds, JPY, CHF\}$.

The total share of claims denominated in non-US\$ foreign currencies is given by:

$$w_{j,t}^{\neq \$} \equiv w_{j,t}^{\€} + w_{j,t}^{\pounds} + w_{j,t}^{JPY} + w_{j,t}^{CHF}$$

Let us denote the real exchange rate of currency 1 against currency 2 by $REER_1^2$. For illustration purposes, $REER_{\€}^{US\$}$ is in units of $\€/US\$$. An increase in $REER_{\€}^{US\$}$ means a real depreciation of € against the US\$ or equivalently, a real appreciation of US\$ against the €. From hereafter, when I refer to a depreciation/appreciation of a currency without indicating which

currency it is depreciating/appreciating against, the default benchmark currency is the US\$.

Figure 1.2 shows us a strong co-movement between the real exchange rates of EME index, €, CHF, JPY, and £ against the US\$. Figure 1.1, on the other hand, plots the real exchange rate of EME index against the US\$ along with the global international bank claims in foreign currency. Global international bank claims — a relevant global liquidity indicator for our context — is almost a mirror image of the real exchange rate of EME index against the US\$. Table 1.2 validates the regularities observed in Figure 1.1 and Figure 1.2 with correlation values between variables. The implication is that that the real value of US\$ against other currencies (namely, EME and non-US\$ major currencies) is inversely related to global liquidity. In other words, in periods of global liquidity expansion, EME currencies, €, CHF, JPY, and £ tend to appreciate $\Delta RER^{US\$} < 0$ while they depreciate during tightening global liquidity. Figure 1.15 validates this claim by depicting how the sign of variables covary over time.

Table 1.2: Correlations for quarterly Y-o-Y growth rates (2002Q1-2015Q4)

	$\Delta RER_{CHF}^{US\$}$	$\Delta RER_{GBP}^{US\$}$	$\Delta RER_{\text{€}}^{US\$}$	$\Delta RER_{JPY}^{US\$}$	Δ International Bank Claims
$\Delta RER_{EME}^{US\$}$	0.6581	0.6445	0.8359	0.2904	-0.6069

As long as the empirical regularities hold, countries with a relatively higher share of debt denominated in foreign currencies other than the US\$ (i.e., €, £, JPY, and CHF) tend to have smoother real exchange rate changes (thus, smoother valuation effects) than countries with a relatively higher share of debt denominated in US\$. Here is a simple example illustrating this concept. Country A has all its debt denominated in US\$ ($w_{j,t}^{\neq \$} = 0$). Country B has half of its

Figure 1.15: Sign of real exchange rate change

Quarterly Growth Rates						Quarterly Y-o-Y Growth Rates					
	ΔRER^{EME}	ΔRER^{CHF}	ΔRER^{GBP}	ΔRER^{ϵ}	CFC		ΔRER^{EME}	ΔRER^{CHF}	ΔRER^{GBP}	ΔRER^{ϵ}	CFC
2 2001	+	+	+	+	-	Q2 2001					
3 2001	-	-	-	-	+	Q3 2001					
4 2001	-	-	-	-	+	Q4 2001					
1 2002	-	+	+	+	-	Q1 2002	+	+	+	+	+
2 2002	-	-	-	-	+	Q2 2002	-	-	-	-	+
3 2002	+	-	-	-	-	Q3 2002	-	-	-	-	+
4 2002	-	-	-	-	+	Q4 2002	-	-	-	-	+
1 2003	-	-	-	-	+	Q1 2003	-	-	-	-	+
2 2003	-	-	-	-	+	Q2 2003	-	-	-	-	+
3 2003	+	+	+	+	-	Q3 2003	-	-	-	-	+
4 2003	-	-	-	-	+	Q4 2003	-	-	-	-	+
1 2004	-	-	-	-	+	Q1 2004	-	-	-	-	+
2 2004	+	+	+	+	-	Q2 2004	-	-	-	-	+
3 2004	-	-	-	-	-	Q3 2004	-	-	-	-	+
4 2004	-	-	-	-	+	Q4 2004	-	-	-	-	+
1 2005	-	-	-	-	+	Q1 2005	-	-	-	-	+
2 2005	+	+	+	+	-	Q2 2005	-	-	-	-	+
3 2005	+	+	+	+	+	Q3 2005	-	+	+	+	+
4 2005	-	+	+	+	-	Q4 2005	-	+	+	+	+
1 2006	-	-	-	-	+	Q1 2006	-	+	+	+	+
2 2006	-	-	-	-	+	Q2 2006	-	+	+	+	+
3 2006	-	-	-	-	-	Q3 2006	-	-	-	-	+
4 2006	-	-	-	-	+	Q4 2006	-	-	-	-	+
1 2007	-	-	-	-	+	Q1 2007	-	-	-	-	+
2 2007	-	-	-	-	+	Q2 2007	-	-	-	-	+
3 2007	-	-	-	-	+	Q3 2007	-	-	-	-	+
4 2007	-	-	-	-	+	Q4 2007	-	-	-	-	+
1 2008	-	-	+	-	+	Q1 2008	-	-	-	-	+
2 2008	-	-	+	-	-	Q2 2008	-	-	+	-	+
3 2008	+	+	+	+	-	Q3 2008	-	-	+	-	-
4 2008	+	+	+	+	-	Q4 2008	+	+	+	+	-
1 2009	+	-	+	+	-	Q1 2009	+	+	+	+	-
2 2009	-	-	-	-	+	Q2 2009	+	+	+	+	-
3 2009	-	-	-	-	+	Q3 2009	+	-	+	+	-
4 2009	-	-	+	-	-	Q4 2009	-	-	-	-	+
1 2010	+	+	+	+	-	Q1 2010	-	-	-	-	+
2 2010	+	+	+	+	-	Q2 2010	-	-	+	+	-
3 2010	-	-	-	-	+	Q3 2010	-	-	+	+	-
4 2010	-	-	-	-	-	Q4 2010	-	-	+	+	-
1 2011	-	-	-	-	+	Q1 2011	-	-	-	+	-
2 2011	-	-	-	-	-	Q2 2011	-	-	-	-	-
3 2011	+	-	+	+	-	Q3 2011	-	-	-	-	-
4 2011	+	+	+	+	-	Q4 2011	+	-	+	+	-
1 2012	-	+	+	+	+	Q1 2012	+	-	+	+	-
2 2012	+	+	-	+	-	Q2 2012	+	+	+	+	-
3 2012	+	+	+	+	+	Q3 2012	+	+	+	+	-
4 2012	-	-	-	-	-	Q4 2012	-	+	-	+	-
1 2013	-	-	+	-	-	Q1 2013	-	+	+	-	-
2 2013	+	+	+	+	-	Q2 2013	-	+	+	-	-
3 2013	+	-	-	-	+	Q3 2013	-	-	+	-	-
4 2013	-	-	-	-	+	Q4 2013	+	-	-	-	-
1 2014	+	-	-	-	-	Q1 2014	+	-	-	-	+
2 2014	+	-	-	-	+	Q2 2014	+	-	-	-	+
3 2014	+	+	+	+	-	Q3 2014	+	-	-	+	-
4 2014	+	+	+	+	-	Q4 2014	+	+	+	+	-
1 2015	+	-	+	+	+	Q1 2015	+	+	+	+	-
2 2015	-	-	-	+	-	Q2 2015	+	+	+	+	-
3 2015	+	+	-	-	+	Q3 2015	+	+	+	+	-
4 2015	+	+	+	+	+	Q4 2015	+	+	+	+	+

Notes: Real exchange rates are against the US\$. CFC denotes Global International Bank Claims in Foreign Currency to GDP ratio.

debt in US\$ and the other half in € ($w_{j,t}^{\neq \$} = 0.5$). Assume local currencies of both country A and B depreciate 10% against the US\$. In the meantime, € depreciates against the US\$ by 6%. The objective is to measure the balance sheet effect. Accordingly, the real exchange rate is weighted by the currency breakdown of claims. Real exchange rate changes for country A and B are then computed below;

$$\Delta RER_A^w = 10\%$$

$$\Delta RER_B^w = 0.5(10\%) + 0.5(10\% - 6\%) = 7\%$$

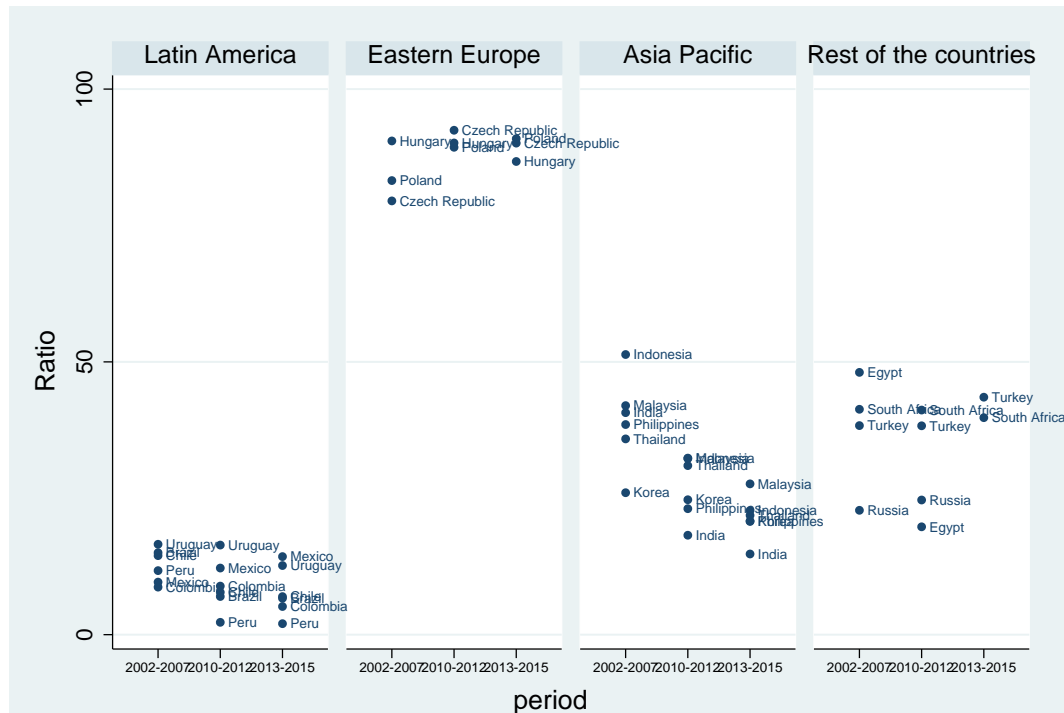
The superscript w means that the real exchange rate is weighted by the currency breakdown of claims in that country. Country B experiences a lower real depreciation than country A. Alternatively, in a period of global liquidity expansion with all currencies appreciating, we would have country B experiencing a lower real appreciation than country A.

1.4.2 Determinants of the share of non-US\$ denominated claims

The previous subsection described how $w_{j,t}^{\neq \$}$ can influence real exchange rate fluctuations through global liquidity conditions. I use these variations to instrument for changes in the weighted real exchange rate. To better understand whether these variations can satisfy the exclusion restriction, I explore factors that might explain the share of non-US\$ denominated claims. Figure 1.16 scatter plots the share of non-US\$ claims by country. The scatter plot subgroups countries by region and by period. The first striking feature is that region explains a large portion of the variation in $w_{j,t}^{\neq \$}$. For instance, EMEs in Europe have most of their claims denominated in non-US\$ (between 75% and 90%) while only 5% to 20% of claims Latin Amer-

ican countries are denominated in non-US\$. EMEs in Asia Pacific and other parts of the world lie somewhere in between where their $w_{j,t}^{\neq \$}$ range from 15% to a little above 50%.

Figure 1.16: Share of non-US\$ claims by region and by period



Regional differences suggest that a large part of the variation in the currency decomposition of claims across countries depend on geographical proximity, trading partners, and on economic partnership agreements. Evidently, It would be rational for firms to match the currency of their claims with the currency of their exports for hedging currency risk purposes. Another observation is that $w_{j,t}^{\neq \$}$ does not have a lot of variation over time. Shares are within the range of values I specified for each region through the whole sample period. This implies that firms do not seem to make significant changes on the currency decomposition of their debt over time. This appeases concerns over endogenous choice of currency over time; One could

have expected a rational firm with perfect foresight to borrow in US\$ during global liquidity expansion and switch to non-US\$ debt when global liquidity is tightening, given smoother real exchange rate fluctuations for non-US\$ denominated debt. However, $w_{j,t}^{\neq \$}$ is more and less constant and does not change with global credit cycles.

1.4.3 Construction of the instrumental variable

By construction, the smoothing impact of $w_{j,t}^{\neq \$}$ on the real exchange rate change, relative to a hypothetical benchmark of $w_{j,t}^{\neq \$} = 0$, is:

$$DIF_{j,t} \equiv \Delta RER_{j,t}^{US\$} - \Delta RER_{j,t}^w$$

Here $DIF_{j,t}$ represents the mechanically calculated smoothing effect of $w_{j,t}^{\neq \$}$. In words, this effect is the difference between the benchmark real exchange rate change if all claims of country j were hypothetically denominated in US\$ and the actual weighted real exchange rate change of country j . In the extreme case where a country has all its claims denominated in US\$, $\Delta RER_{j,t}^w = \Delta RER_{j,t}^{US\$}$ and $DIF_{j,t} = 0$.

Alternatively, the smoothing effect of $w_{j,t}^{\neq \$}$ can be expressed as a weighted average of real exchange rate changes of non-US\$ major currencies.

$$DIF_{j,t} = w_{j,t}^{\text{€}} \Delta RER_{\text{€},t}^{US\$} + w_{j,t}^{\text{JPY}} \Delta RER_{\text{JPY},t}^{US\$} + w_{j,t}^{\text{CHF}} \Delta RER_{\text{CHF},t}^{US\$} + w_{j,t}^{\text{£}} \Delta RER_{\text{£},t}^{US\$} \quad (1.4)$$

Note that the time notation for the currency shares shows t^* . Even though currency shares do not vary significantly over time, in order to reduce endogeneity concerns, I lag shares in

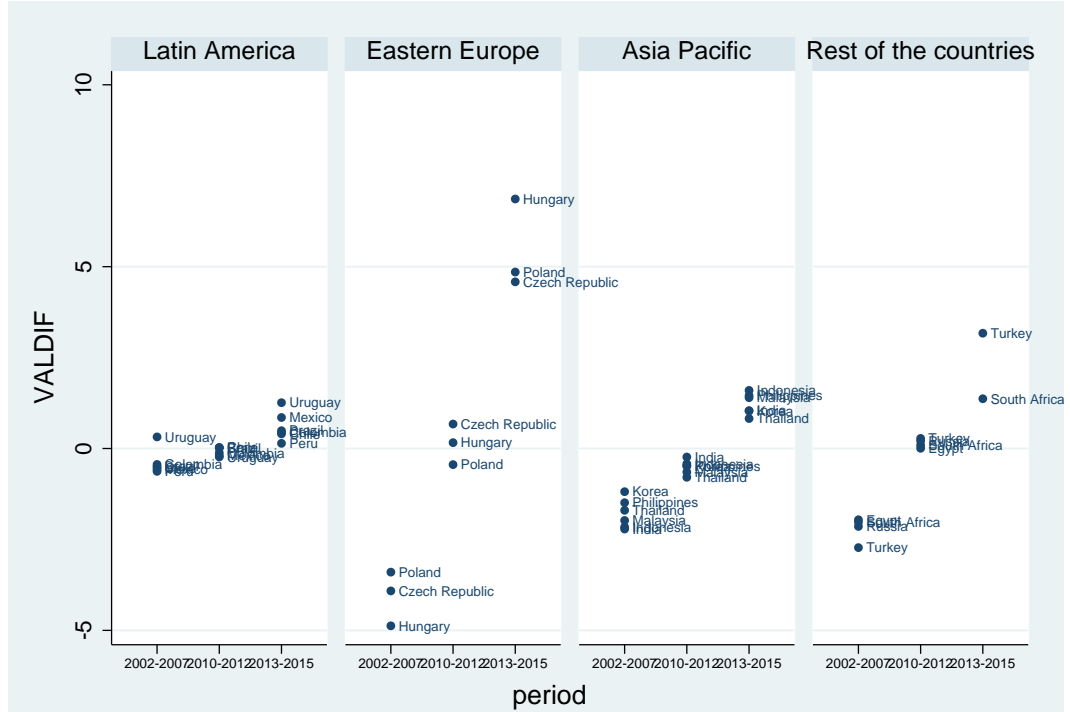
the computation of $DIFF_{j,t}$. More specifically, I make 5 year windows throughout the sample period, and I use the shares the year before the initial year of the window for that 5 year window.

A closer look at equation (4) hints that $DIFF_{j,t}$ depends positively on $w_{j,t}^{\neq \$}$ (i.e., the share of non-US\$ claims) and on $\Delta RER_{\neq \$,t}^{US\$}$ (i.e., average real exchange rate change of non-US\$ major currencies) Figure 1.17 scatter plots $DIFF_{j,t}$ by country. It subgroups countries by region and by period. The periods 2002-2007, 2010-2012, and 2013-2015, represent periods of global liquidity abundance, moderation, and tightening, respectively. As expected, $DIFF_{j,t}$ has the most variation in European countries, and the least variation in Latin American countries, consistent with the positive relationship between $DIFF_{j,t}$ and $w_{j,t}^{\neq \$}$. The other observation is that there is a common factor in $DIFF_{j,t}$ across regions. $DIFF_{j,t}$ is negative for all regions during global liquidity abundance, and positive for all regions when global liquidity tightens. This is the variation in $DIFF_{j,t}$ induced by real exchange rate changes of non-US\$ major currencies (i.e., €, JPY, CHF, and £ appreciate against the US\$ in global financial upturns, and depreciate against the US\$ in global financial downturns.)

While the direction of the smoothing effect of $w_{j,t}^{\neq \$}$ on the real exchange rate change depends on the global credit cycle (i.e., negative in downturns, positive in upturns), the effect of $DIFF_{j,t}$ on the weighted real exchange rate change is unidirectional (i.e., always negative). The convenience of a unidirectional relation in the empirical analysis led me to use variations in $DIFF_{j,t}$ induced by $w_{j,t}^{\neq \$}$ as an instrument instead of $w_{j,t}^{\neq \$}$. The last stage in constructing the instrumental variable, $RESDIFF_{j,t}$, involves taking the residual of the following regression¹⁰.

¹⁰Annual frequency data ranging from 2001 to 2015 covering 16 EMEs.

Figure 1.17: $DIFF_{j,t}$ by region and by period



$$DIFF_{j,t} = \beta_0 + \sum_i^t \beta_i D_i^{time} + \varepsilon_{j,t}$$

$$RESDIFF_{j,t} \equiv \varepsilon_{j,t}$$

The instrumental variable, $RESDIFF_{j,t}$, is the residual from regressing $DIFF_{j,t}$ on time dummy variables (D_i^{time}). This is equivalent to demeaning $DIFF_{j,t}$ in each year. Referring back to Equation (4), time dummies are meant to extract variations in $DIFF_{j,t}$ induced by $\Delta RER_{\epsilon,t}^{USS}, \Delta RER_{JPY,t}^{USS}, \Delta RER_{CHF,t}^{USS}, \Delta RER_{\text{rest},t}^{USS}$. As a result, the instrumental variable, $RESDIFF_{j,t}$, is meant to capture variations in the share of non-US\$ currencies.

1.4.4 Panel two-stage least squares with instrumental variable

The objective is to empirically test the balance sheet effect due exchange rate fluctuations. From the perspective of emerging economies, global liquidity conditions (supply driven) trigger and reinforce the feedback between real exchange rates and capital flows. It then follows that the data frequency in the empirical analysis should match with the frequency of global credit cycles. The duration of global credit cycles seems to vary from at least 1 year up to 5 years. Taking into account the trade-off between compatibility with global cycles and losing statistical power with less observations, I use annual frequency data ranging from 2001 to 2015.

There are 16 emerging economies in the sample (Brazil, Chile, Colombia, Egypt, Indonesia, India, South Korea, Mexico, Malaysia, Peru, Philippines, Russia, Thailand, Turkey, Uruguay, South Africa). The selection criterion for countries are: First one is high foreign bank penetration. This is to insure that international bank cross-border flows are of economic importance for the respective country. For this criteria, I use the ratio of number of foreign-owned banks to total number of banks from Claessens and Van Horen database on bank ownership. The second criteria for countries is not to have a fixed exchange rate regime since there cannot be a valuation effect and thus a feedback loop without any change in the real exchange rate. The panel data set is unbalanced. This is either due to lack of data availability, or to countries following a fixed exchange rate regime for only a part of the sample period, or to removing year observation when a country is in conflict. In addition, I exclude year observations with country-specific banking/financial crisis¹¹ because the dynamics between variables might be different during financial crises due to outlying observations and non-linear relationships.

¹¹Examples of banking/financial crises are 2001-Turkey and 2002-Uruguay.

The regression specification is as follows;

$$\Delta L_{j,t}^{b-b} = \beta_0 + \beta_G X_t^{global} + \beta_S X_{j,t}^{local} + \beta_1 \Delta RER_{j,t}^w$$

$$\Delta L_{j,t}^{b-nb} = \beta_0 + \beta_G X_t^{global} + \beta_S X_{j,t}^{local} + \beta_1 \Delta RER_{j,t}^w$$

where subscripts j and t denote the country and the year, respectively. If the variable in question is a growth variable with a subscript t , then it is the growth from year $t - 1$ to year t . $\Delta L_{j,t}^{b-b}$ and $\Delta L_{j,t}^{b-nb}$ denote growth of international banks' cross-border claims vis-a-vis domestic banks and growth of international banks' cross-border claims vis-a-vis non-bank sector. The variable of interest is $\Delta RER_{j,t-1}^w$, which is instrumented by $RESDIFF_{j,t}$. Thus, $\widehat{\beta}_1$ and \widehat{se}_{β_1} will infer on the causal relationship between real exchange rate changes and subsequent capital flows. The control variables are grouped into two categories. Global variables are placed in the matrix of variables X_{t-1}^{global} . Local variables are placed in the matrix of variables X_{t-1}^{local} . The key results and conclusions are robust to changing by how much I lag independent variables.. The control variables are listed with their description. Data sources are in the appendix.

Global variables Global variables — also referred to as *push* factors — are common to all the countries, and represent supply driven factors that affect cross-border capital inflows to EMEs.

ΔGB Claims, YoY quarterly growth rate of international global claims: It represents total cross-border claims of BIS-reporting global banks in all countries and all sectors. It is one of the two volume based global liquidity indicator, and captures the ease of financing in the global financial markets.

ΔClaims EME(NB), YoY quarterly growth rate of aggregate claims on the non-bank sector in EMEs: It represents total foreign currency claims by all lenders in the non-bank sector

of EMEs. It is one of the two volume based global liquidity indicator, and captures the ease of financing in the global financial markets.

$\Delta Global Leverage$, YoY quarterly change in the leverage of global banks: It represents the leverage of the dealer broker sector in US and serves as a proxy for the leverage of global banks. It is a commonly used global liquidity indicator, and captures the global risk appetite.

$\Delta Global Bank Equity$, YoY quarterly growth rate of total equity of the largest global banks: They are the largest by the size of their balance sheet. The list includes BNP Paribas, Credit Agricole, ING Groep, Societe Generale, HSBC, and Mitsubishi UFJ Financial Group. This is a structural variable from the model, and affects cross-border flows.

Local variables Local variables — also referred to as *pull* factors — are country-specific demand related factors that affect cross-border capital inflows to EMEs.

$\Delta M2$, YoY quarterly growth rate of real money supply: There is an increasing trend for multinational corporates to do carry trade (i.e., to borrow in foreign currency abroad and to make local currency deposits in domestic banks)(Shin, 2013). As these deposits would appear in the money supply, this variable is included to capture the variations in cross-border bank flows explained by this channel. Annual growth rate of real money supply is deseasonalized and winsorized at 0.5% at both ends.

$\Delta Public Debt / GDP$, YoY quarterly change in public debt to GDP ratio: The solvency of the government could affect local credit conditions.

ΔGDP , YoY quarterly growth rate of GDP: It is supposed to capture the loan demand

conditions driven by domestic fundamentals. Annual growth rate of GDP is deseasonalized and winsorized at 0.5% at both ends.

$\Delta Interest\ spread$, YoY quarterly change in the real interest rate spread: It is the change in the spread between real US FED funds rate and real short term corporate loan rate in the respective emerging economy. A higher spread should raise capital inflows by attracting foreign investors looking for a higher yield.

$\Delta local\ leverage$, YoY quarterly change in local leverage: It is the change in the domestic banking system's average bank asset to capital ratio. This is a structural variable from the model, and affects cross-border flows.

$\Delta local\ bankequity$, YoY quarterly growth rate of equity of local banks: It is the growth rate of the domestic banking system's total equity. This is a structural variable from the model, and affects cross-border flows.

ΔRER^w , YoY quarterly growth rate of weighted real exchange rate: Real exchange rate is computed by subtracting the inflation difference of the respective country from the nominal exchange rate. Both inflation difference and nominal exchange rates are weighted by the currency breakdown of cross-border claims. Annual growth rate of weighted real exchange rate is winsorized at 0.5% at both ends.

One of the conditions for a good instrument is that it is significantly correlated with the endogenous variable it is instrumenting. If variations in $RESDIF F_{j,t}$ do not cause important variations in $\Delta RER_{j,t}^w$, one cannot expect to find a significant impact on subsequent cross-border flows through real exchange rates, even if there truly is an impact. Table 1.3 provides regression results from the first stage.

Table 1.3: First Stage

<i>Dependent variable: $\Delta RE R_{j,t}^w$</i>			
$\Delta GDP_{j,t-1}$	-0.622*** (0.171)	-0.355* (0.172)	-0.576*** (0.155)
$\Delta Inflation_{j,t-1}$	-0.028 (0.299)	-0.03 (0.280)	-0.043 (0.297)
$\Delta Interest\ spread_{j,t}$	-1.131 (0.876)	-0.678 (0.910)	-1.042 (0.898)
$\Delta local\ leverage_{j,t-1}$	-2.037** (0.741)	-2.452*** (0.830)	-2.051** (0.731)
$\Delta local\ bank\ equity_{j,t-1}$	-2.308* (1.303)	-1.962 (1.252)	-2.348* (1.332)
$\Delta M2_{j,t}$	0.032 (0.085)	0.010 (0.089)	0.007 (0.085)
$\Delta Public\ Debt/GDP_{j,t}$	0.617** (0.220)	0.765*** (0.197)	0.726*** (0.216)
$RESDIFF_{j,t}$	-1.651** (0.732)	-1.672** (0.656)	-1.660** (0.701)
$\Delta GB\ Claims_t$	-0.201*** (0.067)		
$\Delta Claims\ EME(NB)_t$		-0.401*** (0.095)	
$\Delta Global\ Leverage_t$			-0.442*** (0.123)
N	833	833	833
R^2	0.2630	0.2971	0.2954

Standard errors are clustered within countries. Standard errors in parentheses. Two-tailed test.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The instrumental variable is statistically significant, which implies a strong first stage. The second condition for a good instrument is its exogeneity to capital flows other than the channel through real exchange rates. Since the model is exactly identified I cannot test the validity of our exclusion restriction. Thus, the identification strategy needs to be justified on theoretical grounds. As discussed in the previous section, in order to to reduce endogeneity concerns, I make five-year windows throughout the sample period, and when I construct the

instrumental variable, I use the shares the year before the initial year of the window for that five-year window.

Table 1.4 provides the second stage results of the panel regression on growth rate of cross-border claims vis-á-vis domestic banks. The first and third columns show coefficients from regular OLS regressions. The results from the second stage of Two-Stage least squares with the instrument are shown in the second and fourth column.

Table 1.4: OLS and 2SLS Comparison-Cross-border claims vis-á-vis domestic banks

<i>Dependent variable: Annual growth rate of cross-border claims vis-a-vis domestic banks ($\Delta L_{j,t}^{b-b}$)</i>				
	OLS	2SLS	OLS	2SLS
$\Delta GDP_{j,t-1}$	2.509*** (0.643)	2.113*** (0.752)	1.776*** (0.499)	1.192* (0.644)
$\Delta Inflation_{j,t-1}$	-0.813 (0.662)	-0.986 (0.586)	-0.513 (0.602)	-0.584 (0.528)
$\Delta Interest\ spread_{j,t}$	0.43 (1.427)	0.002 (1.561)	0.485 (1.387)	-0.693 (1.600)
$\Delta GB\ Claims_t$	0.567** (0.200)	0.429* (0.253)	0.417** (0.166)	0.231 (0.237)
$\Delta RER_{j,t}^w$	-0.455*** (0.137)	-0.899* (0.477)	-0.506*** (0.115)	-1.415** (0.682)
$\Delta local\ leverage_{j,t-1}$			-4.07** (1.745)	-5.997** (2.452)
$\Delta local\ bank\ equity_{j,t-1}$			9.499** (4.249)	7.496* (4.221)
$\Delta M2_{j,t}$			0.508** (0.257)	0.582** (0.255)
$\Delta Public\ Debt / GDP_{j,t}$			0.237 (0.765)	0.84 (0.988)
N	833	833	833	833
R^2	0.2124	0.1933	0.2573	0.1851

Standard errors are clustered within countries.
Standard errors in parentheses. Two-tailed test.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

While the coefficient for real exchange rate change from OLS regressions could simply be interpreted as correlation, the ones in the second and fourth columns can be indicative of a causal relationship between real exchange rates and cross-border claims vis-à-vis domestic banks. The statistical significance of real exchange rate variations in explaining growth of cross border loans vis-à-vis domestic banks does not disappear once I correct for endogeneity. The coefficient for real exchange rate change is statistically significant at a 10% level of significance when I use the instrument. I can infer that a real depreciation of the local currency of 1% causes cross-border claims vis-à-vis domestic banks to decrease by 1% approximately. This suggests that the balance sheet effect due to real exchange rate fluctuations has a strong influence on the foreign currency lending behavior of domestic banks.

Table 1.6 provides the second stage results of the panel regression on growth rate of cross-border direct claims on the corporate non-bank sector. The first and third columns show coefficients from a regular OLS regression. The results from the second stage of Two-Stage least squares with the instrument are shown in the second and fourth columns. While the coefficient for real exchange rate change from OLS regressions could simply be interpreted as correlation, the ones in the second and fourth columns can be indicative of a causal relationship between real exchange rates and cross-border direct claims on the corporate non-bank sector. The link between real exchange rate variations and cross border loans vis-à-vis the non-bank sector disappears once I correct for endogeneity. The coefficient for real exchange rate change is not statistically significant when I use the instrument. This suggests that the balance sheet effect due to real exchange rate fluctuations is not apparent for corporations borrowing directly from global banks.

Table 1.5: 2SLS results for cross-border claims vis-à-vis domestic banks

<i>Dependent variable: Annual growth rate of cross-border claims vis-a-vis domestic banks ($\Delta L_{j,t}^{b-b}$)</i>						
$\Delta GDP_{j,t-1}$	2.113*** (0.752)	1.096 (0.801)	2.009*** (0.780)	1.192* (0.644)	0.425 (0.582)	1.049* (0.604)
$\Delta Inflation_{j,t-1}$	-0.986 (0.586)	-0.862 (0.610)	-0.854 (0.568)	-0.584 (0.528)	-0.482 (0.532)	-0.509 (0.502)
$\Delta Interest\ spread_{j,t}$	0.002 (1.561)	-1.534 (1.109)	-0.288 (1.411)	-0.693 (1.600)	-1.737 (1.441)	-0.829 (1.540)
$\Delta RER_{j,t}^w$	-0.899* (0.477)	-0.973* (0.542)	-0.904* (0.472)	-1.415** (0.682)	-1.432* (0.737)	-1.418** (0.689)
$\Delta GB\ Claims_t$	0.429* (0.253)			0.231 (0.237)		
$\Delta Claims\ EME(NB)_t$		1.314*** (0.292)			0.948*** (0.315)	
$\Delta Global\ Leverage_t$			1.331** (0.568)			0.77* (0.47)
$\Delta local\ leverage_{j,t-1}$				-5.997** (2.452)	-4.906* (2.610)	-5.909** (2.474)
$\Delta local\ bank\ equity_{j,t-1}$				7.496* (4.221)	6.157 (4.054)	7.325* (4.195)
$\Delta M2_{j,t}$				0.582** (0.255)	0.601** (0.244)	0.609** (0.250)
$\Delta Public\ Debt/GDP_{j,t}$				0.84 (0.988)	0.754 (1.064)	0.776 (1.087)
N	833	833	833	833	833	833
R^2	0.1933	0.2413	0.194	0.1851	0.2117	0.1856

Standard errors are clustered within countries.

Standard errors in parentheses. Two-tailed test.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

1.5 Conclusion

Following the Great Recession, the excessive credit buildup of corporate sector in emerging economies causes concern for policy makers. The increased share of corporate liabilities denominated in foreign currency may worsen the solvency of these firms at a potential reversal of global funds since local currencies tend to depreciate during tightening global liq-

uidity conditions. This is a probable scenario as the FED, and central banks of other advanced economies are currently in the process of reverting their monetary stance back to the normal levels. I investigate whether the highly risk elastic bank lending propagates the adverse effect of exchange rate fluctuations — Banks, by reducing their exposure to riskier corporate borrowers, could amplify the drop in capital inflows. This could lead to further depreciation of the local currency, and thus entering a dangerous feedback loop. Global bank foreign currency funds can reach corporations either directly, or through domestic banks. Using the instrumental variable approach, I find that a real depreciation of the local currency causes a significant reduction in cross-border global bank claims vis-à-vis domestic banks but in direct claims on the corporate sector. I explain these results with a theoretical framework that captures the behavior of cross-border claims vis-à-vis both domestic banks and the non-bank sector. Model simulations indicate that cross-border claims vis-à-vis domestic banks are more sensitive to global liquidity shocks than cross-border claims vis-à-vis corporates. This reflects the fact that local firms that borrow from domestic banks are subject to currency mismatch, while global firms that borrow from global banks have their assets in foreign currency. This difference leads to a stronger balance sheet effect for local firms. Policymakers in EMEs should therefore further strengthen the prudential oversight of domestic banks by closely monitoring their clients' foreign currency exposure.

Table 1.6: 2SLS results for cross-border claims vis-à-vis the non-bank corporate sector

<i>Dependent variable: Growth rate of cross-border direct claims on the corporate sector ($\Delta L_{j,t}^{b-nb}$)</i>				
	OLS	2SLS	OLS	2SLS
$\Delta GDP_{j,t-1}$	1.364*** (0.440)	1.672 *** (0.608)	1.169** (0.402)	1.260 *** (0.488)
$\Delta Inflation_{j,t-1}$	-0.784 (0.477)	-0.649 (0.490)	-0.390 (0.494)	-0.376 (0.468)
$\Delta Interest\ spread_{j,t}$	0.022 (1.284)	0.356 (1.386)	-0.265 (1.312)	-0.006 (1.386)
$\Delta RER_{j,t}^v$	-0.184** (0.068)	0.162 (0.478)	-0.212*** (0.071)	-0.058 (0.435)
$\Delta GB\ Claims_t$	0.340* (0.184)	0.448** (0.234)	0.310* (0.158)	0.342* (0.188)
$\Delta M2_{j,t}$			0.477** (0.167)	0.465** (0.169)
$\Delta PublicDebt / GDP_{j,t}$			0.323 (0.428)	0.204 (0.472)
N	833	833	833	833
R^2	0.1949	0.1593	0.2274	0.2156

Standard errors are clustered within countries. Standard errors in parentheses. Two-tailed test.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.7: 2SLS results for cross-border claims vis-à-vis the non-bank corporate sector

<i>Dependent variable: Growth rate of cross-border direct claims on the corporate sector ($\Delta L_{j,t}^{b-nb}$)</i>						
$\Delta GDP_{j,t-1}$	1.672*** (0.608)	1.081* (0.634)	1.694*** (0.610)	1.260*** (0.488)	0.514 (0.377)	1.119** (0.457)
$\Delta Inflation_{j,t-1}$	-0.649 (0.490)	-0.573 (0.547)	-0.547 (0.528)	-0.376 (0.468)	-0.365 (0.427)	-0.321 (0.483)
$\Delta Interest\ spread_{j,t}$	0.356 (1.386)	-0.892 (1.132)	0.044 (1.31)	-0.006 (1.386)	-1.020 (1.229)	-0.241 (1.315)
$\Delta RER_{j,t}^w$	0.162 (0.478)	0.101 (0.411)	0.157 (0.450)	-0.058 (0.435)	-0.098 (0.384)	-0.066 (0.410)
$\Delta GB\ Claims_t$	0.448** (0.234)			0.342* (0.188)		
$\Delta Claims\ EME(NB)_t$		0.984*** (0.246)			0.880*** (0.220)	
$\Delta Global\ Leverage_t$			1.136** (0.554)			0.907** (0.447)
$\Delta M2_{j,t}$				0.465** (0.169)	0.477*** (0.148)	0.505*** (0.158)
$\Delta PublicDebt/GDP_{j,t}$				0.204 (0.472)	-0.015 (0.477)	0.058 (0.516)
N	833	833	833	833	833	833
R^2	0.1593	0.2487	0.15	0.2156	0.2906	0.2146

Standard errors are clustered within countries. Standard errors in parentheses. Two-tailed test.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Chapter 2

Amplification of global financial shocks in EMEs: the role of moral hazard

2.1 Introduction

When it comes to the share of business cycles explained by global liquidity conditions in small open economies (SOE), there is a gap between empirical results and quantitative simulations from SOE DSGE models. The model simulations seem to undermine the empirically shown importance of global liquidity conditions. In an effort to bridge this gap, this paper provides a new theoretical mechanism through which the effect of world interest rates on the real economy is amplified. Inspired by Stiglitz and Weiss (1981), credit interactions between the bank and corporate borrowers are exposed to moral hazard. The riskiness of projects on which firms invest depends on the lending rate. Higher interest rates make firms choose riskier projects. To the extent that world interest rates are transmitted to domestic lending rates, a global tightening of liquidity makes the domestic bank less willing to lend as it now funds riskier projects. The impact of this moral hazard on bank lending behavior amplifies the overall effect of global liquidity conditions in addition to standard price transmission. This amplifica-

tion helps close the shortfall of DSGE models in simulating the high dependence of business cycles on global credit cycles. In order to investigate the amplification, I estimate a structural VAR for a sample of emerging market economies (EMEs) relatively vulnerable to external financial conditions (Brazil, South Africa, Argentina, Turkey, and Mexico). Impulse responses indicate that a global financial upturn is followed by a significant increase in the domestic bank credit, consistent with the amplification induced by the moral hazard story.

There is a wide literature assessing the role of global financial conditions in explaining business cycles of emerging countries. Gradual integration of financial markets in the last decades seems to reinforce this effect further. Given the positive correlation between credit growth and current account imbalance, Jorda et al (2011) suggest that, in a globalized economy, domestic credit cycles and foreign capital flows have the potential to reinforce each other. Since the prior evolution of bank credit may shape business cycles (Jorda et al, 2014), it is not surprising to encounter a multitude of international finance papers attempting to quantify the share of global financial conditions in explaining deviations from the trend of real economic variables (i.e. output, investment, employment). Uribe and Yue (2006), and Akinci (2013) estimate this share to be around 20%. Chang and Fernandez (2013) find that interest rate shocks play a sizable role in variations, even when accompanied by temporary and trend productivity shocks. Even though these results support the important role played by global liquidity conditions, quantitative SOE DSGE models point to a lower effect. These models building upon the canonical SOE DSGE model of Mendoza (1991) calibrate the standard deviation of world interest rate shocks to match US interest rate shocks from an AR(1) process to find that only a small portion of variations in output is explained by these shocks. The minor role played by global finan-

cial conditions remains valid despite various types of financial frictions (i.e. working capital, collateral constraint) amplifying underlying shocks. This paper provides a new amplification mechanism for world interest shocks which helps narrow the gap between empirical findings and quantitative models.

Because global financial markets are potentially at an inflection point, a better understanding of the transmission of global liquidity conditions makes the findings of this paper policy relevant. Following the Great Recession, interest rates kept near zero along with large scale asset purchases in advanced economies have created a global abundance of liquidity. Its documented as a result that firms in emerging economies have increased their leverage to historically high levels. As central banks of developed countries are currently in the process of normalizing their interest rate and of reducing their balance sheet, policy makers in EMEs are worried that the normalization of the monetary stance in advanced economies might trigger a global reversal of funds. Given this context, the sensitivity to global liquidity shocks remains crucial for the financial stability of EMEs. This paper, by introducing and providing empirical support for a new transmission channel of global liquidity conditions, offers policymakers insights for targeting macroprudential policies more accurately.

2.2 Literature review

Mendoza (1991) is the first paper to provide a quantitative DSGE analysis to capture the impact of global financial conditions on business cycles for small open economies. The RBC SOE model of Mendoza (1991) serves as the canonical framework on which subsequent papers

of similar interest build. Global financial conditions are captured with exogenous shocks to the world interest rate. The standard deviation and persistence of the world interest rate shocks are taken from an AR(1) estimation of the U.S. real interest rate. His first exercise is to match second moments of domestic aggregates variables (mainly GDP fluctuations) with productivity shocks *only*. Mendoza calibrates the standard deviation and persistence of the productivity shock along with key parameters of the model to match Canadian data. Then, as a second step, he adds interest rate shocks to the model in addition to productivity shocks. He compares the simulations of the model with productivity shocks only versus the one including interest rate shocks to find that output responses for both models are similar. One major shortfall in this model is that the country borrows or lends at world interest rate, whereas in reality, they are exposed to individual country interest rates in the international bond market.

Neumeyer and Perri (2005), and Uribe and Yue (2006) focus on the empirical fact that business cycles in emerging markets are correlated with the interest rate that these countries face in the international financial market. There is a large literature arguing that domestic variables affect interest rates (Edwards, 1984; Cline, 1995; Cline and Barnes, 1997). Interpreting the interest rate as an exogenous variable when in fact it has an endogenous component is likely to overstate the effect of interest rates on business cycles. This is because the interest rates charged by foreign lenders could be higher during contractions given that the borrower country will be more likely to default on its payments, and vice versa during economic expansions. At this end, Neumeyer and Perri (2005) mimic this behavior with an adhoc relationship where the country spread is negatively proportional to future productivity. Despite a working capital constraint — which amplifies the effect of interest rate shocks — their quantitative model indicates that world

interest rate shocks account for only 3% of GDP volatility. Similarly, Oviedo (2005) finds that interest rate induced cycles have limited power in an open-economy neoclassical growth model. These findings further reinforce the "neutrality of interest rates" put forth by Mendoza (1991). The general consensus in papers based on quantitative models remains however in contrast with the empirical literature indicating that global financial conditions do play an important role for domestic aggregate activity at business cycle frequency.

Calvo et al (1996) is the first empirical paper among many to emphasize the growing importance of global cyclical interest rates in explaining capital inflows to developing countries. Uribe and Yue(2006), similar to Neumeyer and Perri (2005), try to disentangle the intricate relationship between business cycles, domestic interest rate, and the world interest rate. Uribe and Yue (2006) filter the endogenous component of country spread in the interest rate with a VAR following a recursive identification. The recursive identification strategy places financial variables below domestic fundamentals. This allows financial variables to be affected contemporaneously by domestic aggregate shocks whereas domestic fundamentals are affected by financial shock with a lag of one period. Using the variance decomposition method, they find that world interest rate shocks explain 20% of movements in aggregate activity. Akinci (2013) complements the empirical VAR model in Uribe and Yue (2006) by adding a proxy for global financial risk. She argues that a proxy reflecting the risk appetite of global investors might capture movements of risky debt instruments for emerging countries better than the U.S. real interest rate. Her argument is strengthened by comparing the correlation of potential proxies¹

¹Akinci offers the following as potential proxies for global financial risk: U.S. BAA corporate spread, U.S. Stock Market volatility, U.S. High Yield Corporate spread.

for global financial risk and of U.S. real interest rate with the common factor of spreads for a set of emerging countries². The correlation of the former with the common factor of spreads is significantly higher than the correlation of the latter. She finds that the contribution of U.S. real interest rate shocks to macroeconomic fluctuations is negligible. Its role, which was emphasized by the literature, is taken up by shocks to global financial indicator, ε_t^{gr} . Accordingly, global financial shocks explain 18% of aggregate activity.

Chang and Fernandez (2013) provide an encompassing analysis on the sources of aggregate fluctuations in emerging countries. They empirically evaluate the relative importance of shocks in explaining aggregate fluctuations using Bayesian estimation techniques. They categorize shocks by two branches of literature which can be seen as extensions of Mendoza (1991). The first one follows Neumeyer and Perri (2005), and Uribe and Yue (2006) that emphasize the role of interest rate shocks and financial frictions. The second branch is based on Aguiar and Gopinath (2007), that introduces stochastic productivity trends, in addition to the temporary productivity shocks already present in Mendoza's model. Their findings support the view that explaining fluctuations in emerging countries requires financial imperfections that amplify conventional productivity shocks and interest rate shocks. Overall, interest rate shocks play a sizable role in explaining variations while productivity trends add relatively little.

Quantitative models fail to reproduce the empirically shown large effect of global financial conditions on domestic fundamentals in small open economies. Even though financial frictions such as working capital and collateral constraints amplify the effect of interest rate

²The set of emerging countries is: Argentina, Brazil, Mexico, Peru, South Africa and Turkey. She uses the same set of countries as in Uribe and Yue (2006) to better compare the results.

shocks, and narrow this gap, the difference still remains significant. This paper provides a new theoretical mechanism through which the effect of world interest rates on the real economy is amplified. The key component of the mechanism is the moral hazard in the credit interactions between the bank and corporate borrowers.

2.3 Model

Consider a small open economy RBC model. The framework of the model is inspired from Mendoza (1991) but we added a financial intermediary to focus on the credit supply side.

2.3.1 Households

The economy is populated by an infinite number of identical households with preferences described by the following utility function

$$E_0 \sum_{t=0}^{\infty} \theta_t U(c_t, h_t)$$

where c_t denotes consumption, h_t denotes hours worked and U is a period utility function, which is assumed to increasing in consumption, concave, and decreasing in hours worked. Suppose that the (external) subjective discount factor, θ_t , depends on the average per capita levels of consumption and hours worked, and has the following law of motion

$$\theta_{t+1} = \theta_t \beta(\tilde{c}_t, \tilde{h}_t), t \geq 0, \theta_0 = 1$$

where \tilde{c}_t, \tilde{h}_t denote the cross-sectional averages per capita consumption and hours worked, respectively. Note that we define the subjective discount factor to be external since the individual

household take these averages as exogenously given. We will see later that since all households are identical, the average consumption and hours happen to equal the equilibrium choice of individual c_t and h_t .

In the deterministic steady state, interest rate satisfies $\beta(1 + r_{ss}) = 1$. If we were to let β be a constant, consumption and asset/debt holdings would depend on initial conditions. Subject to random shocks, these variables would follow a random walk and thus would not be stationary. By making subjective discount factor $\beta(\tilde{c}_t, \tilde{h}_t)$ depends on past consumption and hours, we induce stationarity.

Each period the household supplies h_t hours to the market in return for wage, w_t . We also assume that the household owns the stock of capital, and rents it to the firm for a rental rate of u_t . The household takes w_t and u_t as exogenously given, its period-by-period budget constraint is given by

$$d_t = (1 + r_{t-1})d_{t-1} + c_t + i_t + \Phi(k_{t+1} - k_t) - w_t h_t - u_t k_t$$

where d_t denotes debt ($d > 0$) or savings ($d < 0$) that the household holds in the financial intermediary (hereafter FI). r_{t-1} denotes the interest rate from last period that the financial intermediary charged. We assume that only the financial intermediary has access to the international financial market. The household, as owner of the capital stock, is subject to adjustment costs $\Phi(\cdot)$ for changing the amount of capital. We assume that the capital adjustment cost function is increasing, convex and $\Phi(0) = 0, \Phi'(0) = 0$. The restrictions imposed on $\Phi(\cdot)$ ensure that in the steady state adjustment costs are nil and the relative price of capital goods in terms of consumption goods is equal to 1.

2.3.2 Firms

Firms produce final goods with labor and capital and operate in perfectly competitive markets. Each period firms hire labor and rents capital to maximize their profits. The first order conditions associated the firm profit maximization problem are

$$A_t F_h(k_t, h_t) = w_t$$

and

$$A_t F_k(k_t, h_t) = u_t$$

The first one of the equations depicts the labor demand from the firms's side. In the second equation, the rental rate, u_t is equalized to the marginal product of capital. Because the production function is homogeneous of degree one, the sum of labor income and rent income for the household, $w_t h_t + u_t k_t$, is equal to total output, $A_t F(k_t, h_t)$, and thus the maximized profit is equal to zero. .

In order to create the moral hazard story similar to Stiglitz and Weiss (1991), firms should be having a choice over projects, where riskier projects have a higher return and higher probability of default. Even though this choice is not depicted in the profit maximization problem of the firm, we assume that it is in the works in the background. This way, a representative firm whose implied project return is r_t with certainty provides a simple and tractable framework. We will see in the next section that the key component allowing the amplification induced by the moral hazard is located in the profit function of the financial intermediary.

The law of motion of the productivity shock is assumed to be given by the following

AR(1) process

$$\ln(A_{t+1}) = \rho \ln(A_t) + \eta \varepsilon_{t+1}$$

2.3.3 Financial Intermediary

Households do not have access to the international financial market (foreign bonds). We calibrate the model to insure that households only want to borrow around the steady state ($\bar{d} > 0$ at the steady state), even in the presence of shocks. The financial intermediary (hereafter FI), in turn, has access to the international financial market, where foreign funds are priced at an interest rate that follows a stationary stochastic process, r_t^* . The quantity of bonds supplied by foreign lenders is price inelastic and is simply equal to the FI's demand of foreign bonds in the equilibrium. The FI's balance sheet is given by

$$D_t = b_t$$

D_t denote the loan to households by the FI. b_t denotes the foreign debt of the FI. The left-hand side of the equation above represents the assets, and the right-hand side represents the liabilities of the FI. We call r_t the domestic interest rate as it affects the credit demand by households and the credit supply by the FI. In the equilibrium, this interest rate adjusts to equate D_t (credit supply) to d_t (credit demand). The profit of the FI, π , is given by the return differential between the two sides of the balance sheet net of cost.

$$\pi_t = (r_t - r_t^*)b_t - \chi r_t b_t - z(b_t)$$

$z(b_t)$ denotes the competitiveness level in the domestic financial system. It is given by $z(b_t) = \frac{\gamma}{2} b_t^2$ where $\gamma > 0$ for $t \geq 0$. This term is therefore increasing and convex in b_t . Without this term,

the profit is linearly increasing in b_t . Thus the credit that the FI intermediates to the economy is proportional to its profit. However, as credit raises, new banks enter the financial system to take advantage of the profit surplus. This is captured by the convexity of $z(b_t)$.

The term $\chi r_t b_t$ captures the effect of the domestic interest rate on the risk level of projects undertaken by corporate borrowers. This feature is inspired from the moral hazard depicted in Stiglitz and Weiss (1991), where firms prefer to invest in riskier projects with interest rates rising, in situations where lenders cannot observe the projects. Because of firms' behavior, the probability of default of projects decrease interest rate raises, which in turn, lowers lenders' profits. The term $\chi r_t b_t$ — reflecting the moral hazard story — amplifies any underlying shock with an effect on domestic interest rates.

In the empirical literature, there is strong evidence that credit supply is highly correlated with the lending conditions from the international financial market. We illustrate this by featuring the foreign interest rate r_t^* as a stochastic AR(1) process.

$$r_{t+1}^* - r^* = \rho_r(r_t^* - r^*) + \eta^r \epsilon_{t+1}^r$$

where η^r and ρ^r characterize the persistence and the volatility of the friction shock, respectively.

Given r_t and r^* , the FI chooses the quantity of bonds b_t to maximize its profit. It is straightforward to derive the corresponding first order condition

$$b_t = \frac{(1 - \chi)r_t - r_t^*}{\gamma} \tag{2.1}$$

2.3.4 Functional Forms

We adopt the following standard functional forms.

Equation (2) gives us the FI cost function, indeed increasing and convex in intermediated funds, b_t . This cost function is similar but not identical to the one used in Uribe and Yue . They incorporate debt adjustment costs to induce stationarity in the small open economy framework. Their model does not include a financial intermediary explicitly, but they explain that debt adjustment costs can be decentralized with a financial intermediary with a similar cost function and corresponding profit maximization problem to ours.

$$z(b_t) = \frac{\gamma}{2} b_t^2 \quad (2.2)$$

The following is the standard constant return to scale production function.

$$y_t = A_t k_t^\alpha h_t^{1-\alpha}$$

As mentioned before, we induce stationarity by making subjective discount factor $\beta(\tilde{c}_t, \tilde{h}_t)$ depends on past consumption and hours. The functional form below is taken from Schmitt and Uribe (2003). They compare alternative ways to induce stationarity in small open economy DSGE models and conclude that they produce identical implications for business cycle fluctuations. Note that the only difference from the form used in Schmitt and Uribe (2003) is the term ζ instead of the scalar 1. The degree of freedom from choosing a value for ζ helps targeting a desirable value for the steady state debt, \bar{d} . Details are in the section 'Deterministic Steady State'.

$$\beta(c, h) = \left(\zeta + c - \frac{h^\omega}{\omega} \right)^{-\psi}$$

Below is the standard functional form for preferences.

$$U(c, h) = \frac{\left(c - \frac{h^\omega}{\omega} \right)^{1-\sigma} - 1}{1-\sigma}$$

Finally, the following functional form is a standard capital adjustment cost function, increasing and convex in change of capital.

$$\Phi(k_{t+1} - k_t) = \frac{\phi}{2}(k_{t+1} - k_t)^2$$

2.3.5 Equilibrium

Equilibrium conditions, deterministic steady state values, and explanations about the calibration of the parameters are given in the Appendix. The endogenous state variables are k_t, d_{t-1}, r_{t-1} . The exogenous state variables are A_t, r_t^* . The control variables are $c_t, h_t, k_{t+1}, d_t, b_t$.

The only endogenous price is r_t . A competitive equilibrium is a set of processes $\{c_t, h_t, \tilde{c}_t, \tilde{h}_t, k_{t+1}, d_t, b_t, r_t\}$ satisfying the equilibrium conditions, given $A_0, r_0^*, d_{-1}, k_0, r_{-1}$ and the stochastic process $\{\varepsilon_t, \varepsilon_t^r\}$, and the transversality condition of the household.

$$\lim_{t \rightarrow \infty} (1 + r_t)^{-t} d_t = 0$$

2.4 Quantitative Results

Figures 2.1 and 2.2 show the responses to shocks to r_t^* the international interest rate, and A_t the productivity, respectively. Note that the shocks to A_t illustrate a one percent deviation from their steady state whereas the magnitude of the shock to r_t^* is one percentage *point* from its steady state value. Responses of consumption, output, investment, hours, capital, household debt are shown in percent deviations from their respective steady state. On the other hand, responses of the ratio of trade balance to output and both interest rates are shown in level deviations from steady state. Obviously, steady state corresponds to zero in the figures. In both

figures, blue lines represent responses to shocks in the base model ($\chi = 0$) whereas red lines represent responses to shocks in the model with moral hazard ($\chi > 0$). The comparison allows the visualization of the effect of moral hazard in face of different shocks.

2.4.1 Description and Analysis

Figure 2.2 shows the impact of the productivity shock. Our framework is based on a Real Business Cycle Small Open Economy. Most of the parameters are calibrated to create business cycles consistent with emerging country data in face of a productivity shock. If the capital adjustment cost ϕ is not too high and the productivity shock is sufficiently persistent, the model produces countercyclical trade balance to output ratio, a characteristic of emerging countries. Meanwhile, the blue and red lines in Figure 2.2 are almost similar. Thus, moral hazard does not seem to make a significant difference in face of a productivity shock. This is probably because productivity shocks have a small effect on domestic interest rates, which in turn keeps the effect of moral hazard limited.

As for the shock to the world interest rate r^* , the responses are as expected. Following a negative interest rate shock, the economy enters an expansionary period until the persistent interest rate innovation dies out. As mentioned before, we did not incorporate any mechanism to the model that would propagate the effect other than the persistence of the shocks. Investment reacts strong relative to other variables despite capital adjustment costs. In the model with moral hazard, investment goes up around 72% in comparison to the base model with a smaller increase, around 50%. As a matter of fact, the comparison between the base model with the one with moral hazard highlights the same amplification for the other variables as well. Table 2.1

Figure 2.1: Responses to a Negative One-Percentage Point Shock to World Interest Rate r^* in the base model versus in the model with moral hazard

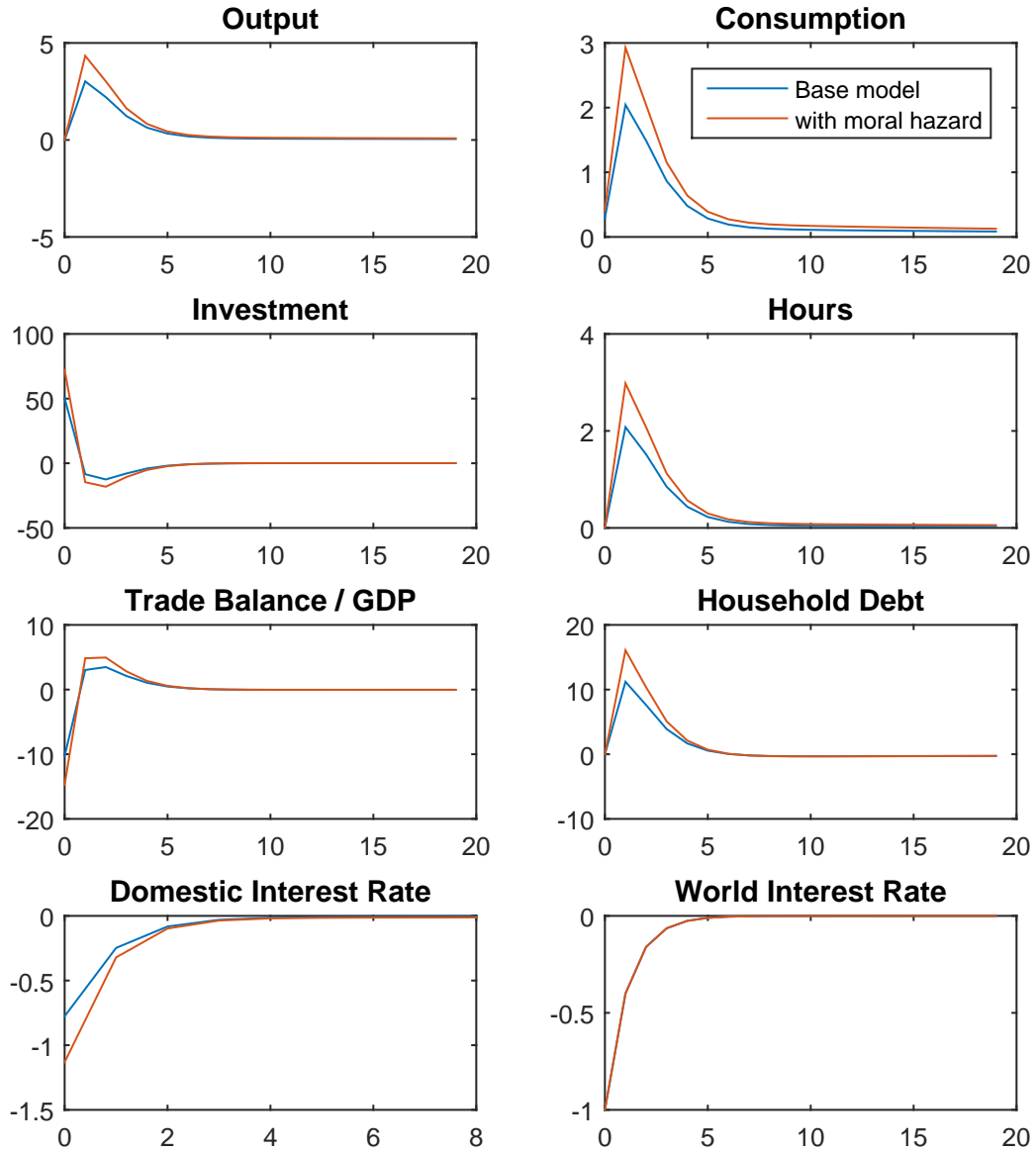
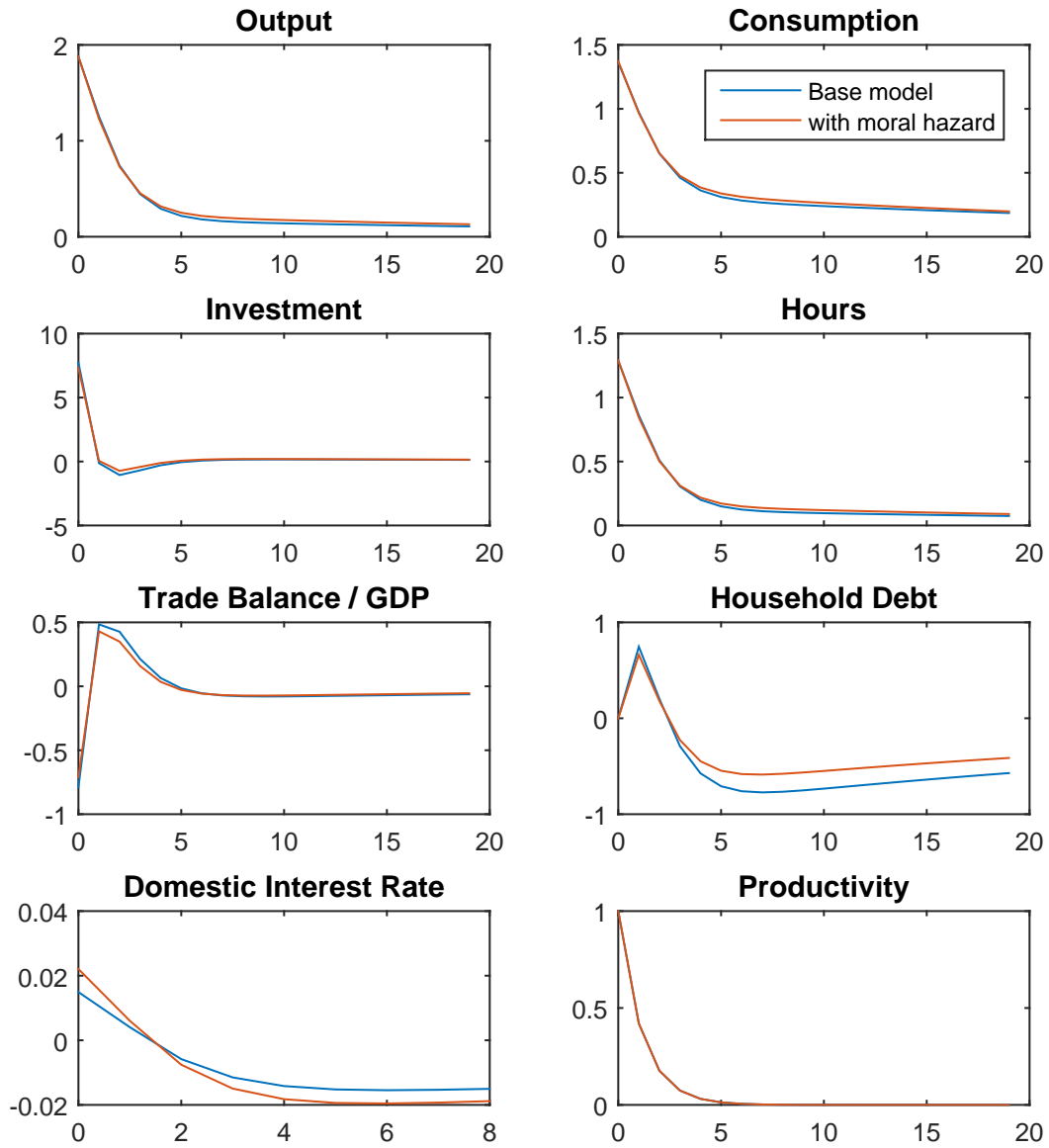


Figure 2.2: Responses to a Positive One-Percent Shock to Productivity in the base model versus in the model with moral hazard



gives the full comparison.

Table 2.1: Base model versus the one with moral hazard

Deviations at t=1 in face of a negative world interest rate shock		
Variables	Base model	Model with moral hazard
Output	3.02 %	4.34%
Consumption	2.04 %	2.93%
Investment	50.27%	72.17%
Labor	2.08 %	2.98%
Trade Balance/Output	-10.27 units	-14.74 units
Capital	5.03%	6.91%

The additional term in the profit function of the FI capturing the moral hazard is in the origin of the stark difference in responses. The base model clearly shows how abundant global liquidity conditions transmit into domestic interest rates without the moral hazard ($\chi = 0$). A one percentage point negative (expansionary) shock to the world interest rate causes domestic interest rates to drop by 0.78 percentage points. This drop in interest rates makes firms invest in less risky projects, which in turn, positively affects the profit of the FI. A financially healthier loan portfolio makes the FI willing to lend more, and causes a further decrease in the domestic interest rate, which in turn comes with with an additional boost in investment, output, consumption, and employment. Thus, the presence of the moral hazard leads to a financial amplification. In other words, the moral hazard raises the volatility of all variables without changing signs of any effects. Trade balance to output ratio remains countercyclical as in the base model, consistent with emerging markets data.

The key finding of the quantitative results is the amplification effect of the moral hazard in face of world interest rate shocks. Despite the neutrality of shocks to interest rates illustrated in the canonical model of Mendoza (1991) , numerous empirical papers state that

business cycles in emerging markets are correlated with the interest rate that these countries face in the international financial market. In general, a financial amplification mechanism is embedded in SOE models either through collaterals or working capital constraints to overcome the neutrality. Our model provides an alternative approach for the financial amplification mechanism.

2.5 Empirical Investigation

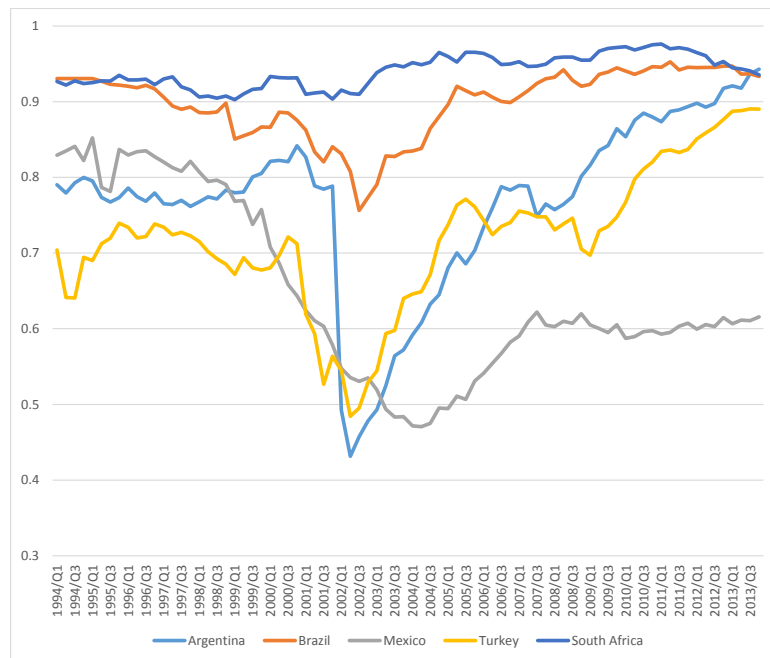
2.5.1 Domestic bank credit

The effect of moral hazard on the lender's profit makes the lender a key agent in the amplification mechanism when the economy is faced with a world interest rate shock. Since the lender is characterized as a financial intermediary in the model, an initial overlook at how domestic bank credit is related to business cycles would offer important insights about the focus of this paper.

In the empirical part, domestic bank credit to private non-financial sector is the proxy for aggregate loans to firms. For the set of emerging market economies we are focusing on, domestic banks are the main lenders in the economy. Figure 2.3 illustrates the evolution of the ratio of domestic bank credit to total credit from 1994 to 2013. The set of emerging countries includes Argentina, Brazil, Mexico, South Africa, Turkey. Domestic bank credit represent credit to private non-financial sectors by domestic banks. The borrowers include private and public non-financial corporations, households and non-profit institutions serving households. Interbank lending is excluded. Total credit has the same borrower coverage but aggregates all

lenders (i.e. other than domestic banks, lenders include non-financial corporations, general government, central bank, household and the rest of the world including internationally active banks). Domestic bank credit represent on average 80% of total credit over the sample period. In addition, there is an increasing trend in the procurement of credit from banks after the mid-2000s, for all countries. These observations are consistent with our emphasis on domestic banks as the main lender in the economy.

Figure 2.3: Ratio of domestic bank credit to total credit



Notes: Domestic bank credit represent credit to private non-financial sectors by domestic banks. The borrowers include private and public non-financial corporations, households and non-profit institutions serving households. Total credit has the same borrower coverage but aggregates all lenders (i.e. other than domestic banks, lenders include non-financial corporations, general government, central bank, household and the rest of the world including internationally active banks)

2.5.2 International capital flows and bank credit in EMEs

One of the main goals of this paper is to reproduce the empirically shown importance of global financial conditions in explaining EME business cycles in quantitative models. Shocks in international financial markets are transmitted via funding costs for domestic banks. As a matter of fact, in the model, domestic banks borrow only from foreign lenders as households do not save around the steady state. Even though this simplification is for practical reasons, this section emphasizes the importance of international financial markets as a funding source for domestic banks in EMEs.

On that Jorda(2011) suggest that, in a world with free capital mobility, credit cycles and foreign capital flows might reinforce each other. Dailami and Timmer (2009) state that net private flows to developing and emerging countries increased more than sevenfold in 2007 relative to levels in two previous decades. According to Aykut et al (2013), most of the surge in private debt flows³ is explained by a substantial increase in cross border lending where the lenders are foreign banks or financial institutions. Furthermore, they indicate that financial institutions as a borrower type constitute 21% and 52% of total cross-border loans and bond issuance, respectively.⁴ This strengthens the relevance of domestic bank credit as a channel for global financial shocks in emerging countries.

Finally Aykut et al (2013) highlights a strong negative correlation between private debt flows to developing and emerging countries to EMBIG spreads. This observation seems reasonable since EMBIG spread is the average price of sovereign bonds for emerging markets

³The two components of private debt flows are cross-border lending and international bond issuance.

⁴See Table 2 in Aykut et al (2013)

and government bonds should behave similarly to other types of debt instruments, namely cross border loans and bond issuance.

2.5.3 Credit cycles and business cycles

Jorda (2014), and Schularick and Taylor (2012) among others provide compelling evidence that private (bank) credit lead and proves to be a major determinant of business cycles.

Figure 2.4 graphs the evolution of domestic bank credit against output fluctuations for the same set of emerging countries. Both variables are log-linear detrended. Domestic bank credit is strongly procyclical in Argentina, Brazil, South Africa and Turkey. The two variables have an exceptional negative correlation in Mexico. It is interesting to point out that Mexico is also the country with the lowest bank to total credit ratio with an average of 60% over the sample period. The procyclicality is in line with the correlation values of the two variables, given in Table 2.2. The first column depicts the contemporaneous correlation between domestic bank credit and output fluctuations. We have strong positive correlations for all the countries with the exception of Mexico. The second column correlates lagged bank credit with log deviations of GDP. The lagged correlation values do not seem to contradict bank credit leading business cycles. To further investigate, we run granger causality tests in a bivariate VAR using log-linear detrended series of domestic bank credit and output. Results indicate that, with the exception of Mexico, GDP granger causes bank credit while the reverse is not true. Thus there is unidirectional granger causality from output to domestic bank credit. This, however, is not to be confused with causal relationship. It only implies that output changes is a good predictor of movements in bank credit whereas lagged domestic bank credit does not

significantly help reducing the error in predicting output fluctuations. In addition, these results are very sensitive to the inclusion of additional variables as we only consider a bivariate system.

Test results might therefore be spurious with the omission of an important third variable.

Table 2.2: Contemporaneous and lagged correlation between domestic bank credit and output fluctuations

	$\text{corr}(\hat{y}_t, \hat{BC}_t)$	$\text{corr}(\hat{y}_t, \hat{BC}_{t-1})$
Argentina	0.68	0.61
Brazil	0.82	0.77
Mexico	-0.44	-0.47
South Africa	0.75	0.69
Turkey	0.58	0.49

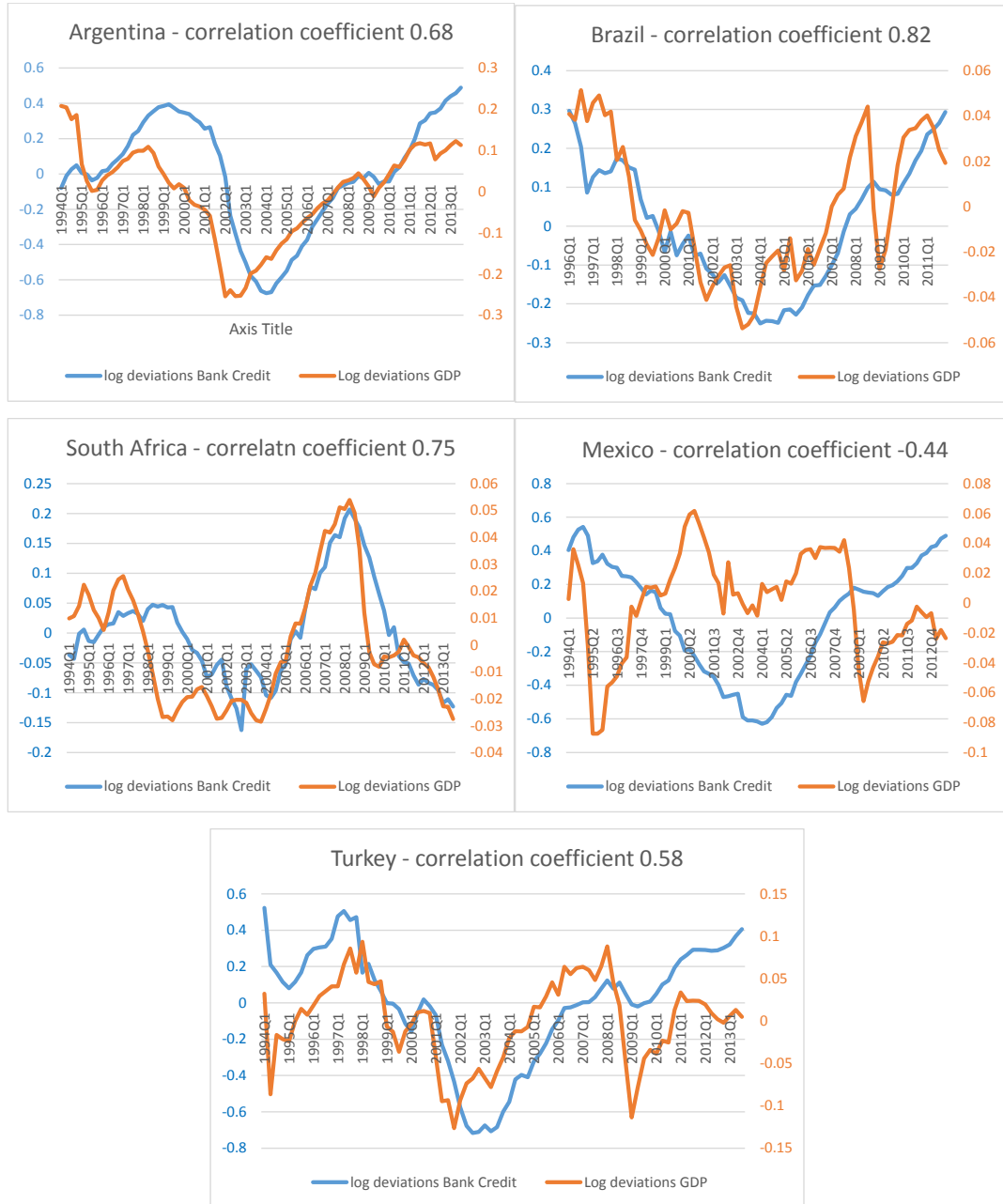
Notes: \hat{BC}_t and \hat{y}_t denote log-linear detrended domestic bank credit and output, respectively.

Following a preliminary outlook at the relationship between international financial markets, domestic bank credit, and business cycles, the next section provides a complete empirical investigation of the model's implications.

2.5.4 Empirical model: Structural VAR

In order to assess whether there is empirical evidence that supports the implications of our SOE DSGE model, we estimate a vector autoregression model (VAR). Impulse responses and variance decomposition from a VAR model inform us of the interactions between key business cycle variables, bank credit, and global financial conditions as each variable in the vector is regressed on lagged of its own and of other variables. More particularly, we want to analyze the evolution of domestic bank credit and key fundamentals in EMEs following global financial shocks to see if we can support the moral hazard story empirically as an amplification mechanism of global financial shocks.

Figure 2.4: Domestic bank credit and business cycles



Log deviations GDP and log deviations BC are log linear de-trended and are taken from IMF-IFS and BIS, respectively. "Bank Credit" is defined as credit to private non-financial sectors by domestic banks. Both series are real and seasonally adjusted.

The reduced form of the VAR is the following;

$$y_t = \sum_{k=1}^p A_k y_{t-k} + \varepsilon_t$$

where

$$y_t = [g\hat{d}p_t, \hat{i}nv_t, tby_t, \hat{G}R_t, \hat{B}C_t, \hat{R}_t]$$

$$\varepsilon_t = [\varepsilon_t^{gdp}, \varepsilon_t^{inv}, \varepsilon_t^{tby}, \varepsilon_t^{GR}, \varepsilon_t^{BC}, \varepsilon_t^R]$$

gdp denotes real gross domestic product, inv denotes real gross investment, tby denotes the trade balance-to-output ratio, BC denotes real domestic bank credit, GR is a global financial risk indicator (U.S. BAA corporate spread), and R denotes the country specific interest rate. A hat on gdp , inv , BC denotes log deviations from a log-linear trend. A hat on GR and R denotes the log. The trade balance-to-output ratio, tby , is expressed in percentage points. We measure U.S. BAA corporate spread as the difference between the U.S. BAA corporate borrowing rate by Moody's and long term U.S. Treasury bond rate. The country borrowing rate in the international financial markets, R , is measured as the sum of J.P. Morgan's EMBI+ sovereign spread and the U.S. real interest rate. Output, investment, the trade balance and domestic bank credit are seasonally adjusted. The variable, GR , is common across countries included in the sample. More details on the data are provided in the Appendix.

The empirical VAR model bears similarities to the one used in Akinci (2013) with a few exceptions. For instance, the global financial risk indicator is used as a measure for global financial conditions instead of the US real interest rate as Akinci (2013) shows that the impact of the latter is taken away by the former. In addition, domestic bank credit is used instead of

bank lending spread since bank credit is directly what we want to measure whereas bank lending spread might be more rigid and might spuriously be affected by other dynamics.

Our data set consists of five countries with quarterly data spanning over a little less than twenty years. The set of emerging countries include Argentina, Brazil, Mexico, South Africa and Turkey. A vector autoregression model allows us to incorporate exogenous stationary processes with exclusion restrictions, which then can be described as a system of dynamic simultaneous equations. The AR process for the global financial risk indicator is structurally placed as an exclusion restriction since small open economies are by assumption exogenous to global financial conditions. The recursive identification of the empirical VAR model provides a partially structural framework. Financial variables (i.e. global financial risk indicator, country spread, bank credit) are placed below fundamentals (i.e. output, investment, trade balance to output ratio) in the recursive ordering. The implicit assumption is that any shock affect financial variables within the same quarter whereas shocks to financial variables affect fundamentals with a lag. The interpretation of all the residual shocks other than the global financial shocks is limited to being orthogonal to endogenous variables, however, they do not contain a structural meaning. For instance, shocks to domestic bank credit, ε_t^{BC} , are orthogonal to contemporaneous and lagged endogenous variables (output, investment, trade balance to output ratio, global financial risk indicator, lagged domestic bank credit), implying at best that it is less related to credit demand as it is orthogonal to current and lagged fundamentals.

2.5.5 Empirical results

Figure 2.5 shows the impulse responses of the variables in the VAR model following a global financial shock. As mentioned before, we use U.S. BAA corporate spread as a proxy for global financial risk. The graphs depict the behavior of key variables after a 0.35 percentage point shock to the corporate spread. The shock is quite persistent and dies away after 40 periods. Following a global financial tightening, output, investment, and bank credit decrease significantly, consistent with the simulations from the DSGE model. The purple and yellow line accompanying responses represent confidence intervals at 95% significance level. They indicate that drops in output and investment are significantly different from zero for about 20 periods while bank credit tightening stays significant for around 40 periods. The immediate drop in domestic bank credit following a global financial tightening comes with simultaneous drops in investment and output. These observations support the amplification of global financial shocks with the moral hazard story in the credit interactions between the bank and corporate borrowers.

In the meantime, trade balance to output ratio is countercyclical, as expected. The post shock hike in the country spread reinforces an empirical regularity emphasized by Uribe and Yue (2006) and Neumeyer and Perri (2005) — the negative correlation between business cycles and country spreads —. This empirical regularity is also highlighted in Figure B.1 (in Appendix B) for Turkey, Mexico, Argentina, Brazil, and South Africa. The responses of trade balance to output ratio and of country spread to global financial shocks do not however seem to be significant.

Figure 2.6 shows the share of forecast error variance of fundamental variables ex-

Figure 2.5: Impulse responses to a global financial risk shock from the VAR estimation

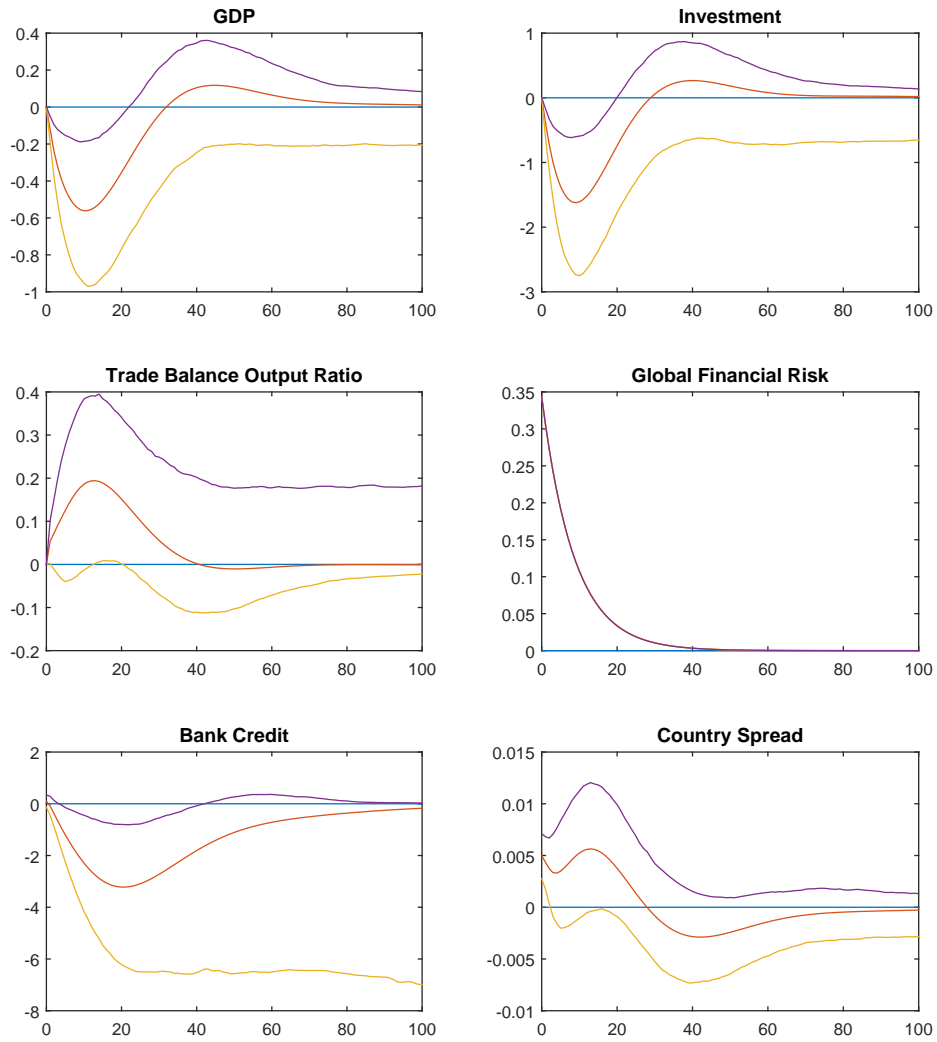
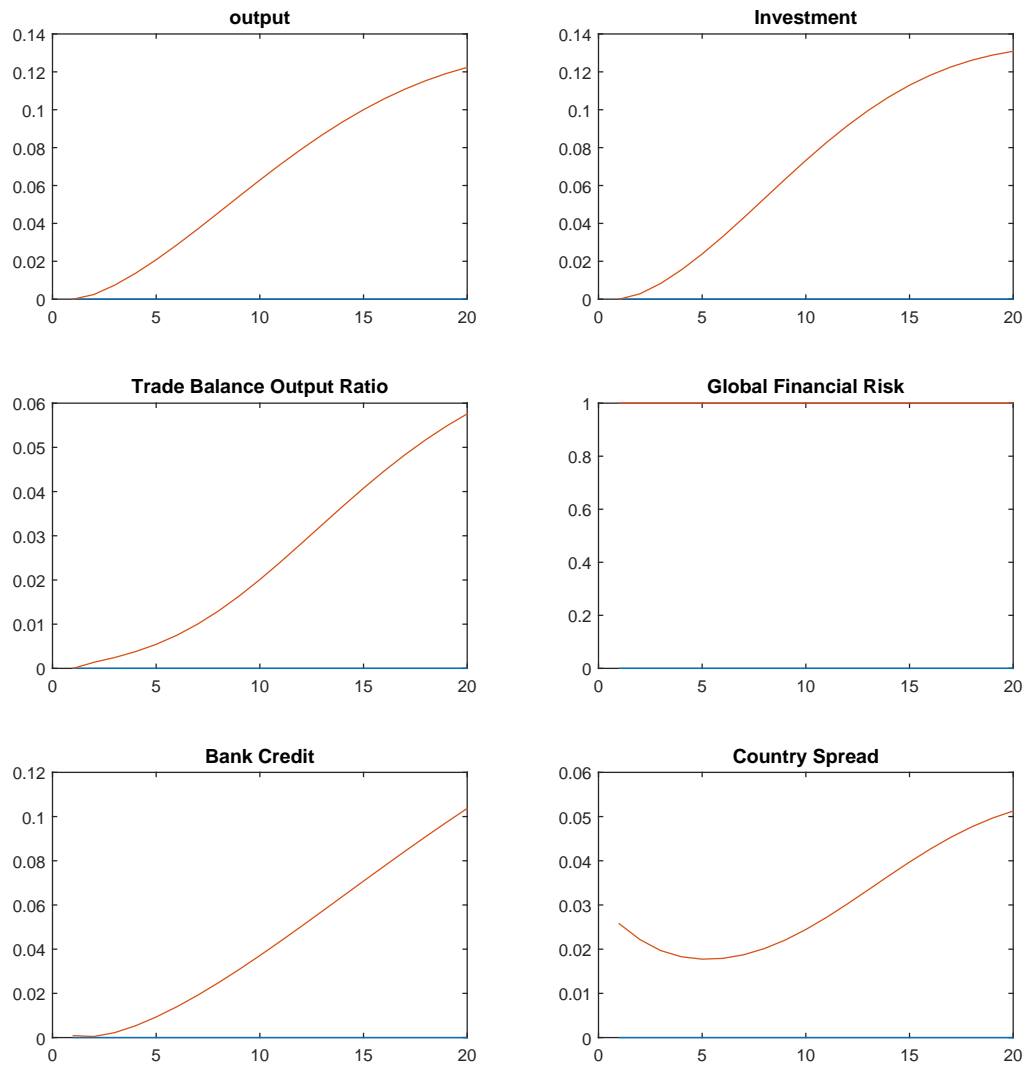


Figure 2.6: Forecast error variance decomposition following a global financial risk shock from the VAR estimation



plained by global financial shocks. At 20 quarters after the shock, global financial shocks account for a large portion of forecast error variances of key variables. Namely, global financial shocks explain 12% of the variance in output and investment and 10% of the variance in domestic bank credit. These values seem in line with results in other empirical papers (i.e. Uribe and Yue (2006) and Akinici (2013)). It is interesting to note that global financial shocks take a more important role over time. In addition, these shocks play a minor role in the forecast error variance of country spread and trade balance to output ratio. Overall, high shares taken by global financial shocks in the forecast error variance decomposition of bank credit, output, and investment provide complementary empirical evidence consistent with the amplification of global financial shocks with the moral hazard story.

2.6 Conclusion

There is a wide literature trying to quantify the importance of various shocks for explaining business cycles in EMEs. Many papers proceed by calibrating a SOE DSGE model, matching the simulations into the data, and finally by assessing the relative weight of shocks in explaining deviations of important variables from the trend. Even though they provide a thorough analysis, these quantitative models have a shortcoming. Their simulations do not assign as much weight to global financial environment as the consensus reached by empirical papers. In this paper, we provide a new theoretical mechanism through which the effect of the world interest rate is amplified. Inspired by Stiglitz and Weiss (1981), moral hazard is incorporated in an otherwise canonical SOE DSGE model. To the extent that the world interest rate gets

transmitted into the domestic interest rate, a global financial tightening results in firms choosing riskier projects, which in turn, adversely affects the willingness of the financial intermediary. Simulations from the DSGE model indicate that moral hazard accounts for an approximately 40% amplification of real fundamentals (i.e. investment, output, employment, and consumption) responses to global financial shocks. This paper then empirically investigates this finding by estimating a structural VAR. Impulse responses to a global financial shock are consistent with the amplification induced by moral hazard. Specifically, there is an immediate drop in domestic bank credit following a global financial tightening. This credit crunch is accompanied by significant drops in investment, output, and employment. Even though results from the empirical part are consistent with the theoretical finding, the data used for the analysis remains aggregate. Future research should focus on improving the identification of this channel, as firm level data becomes available.

Chapter 3

International spillovers of US unconventional monetary policy: Implications on emerging market small firms

3.1 Introduction

Following the Global Financial Crisis (GFC), large scale asset purchase programs initiated by the FED lowered the term premium of long-term security yields, resulting in historically low global long-term interest rates. In the meantime, the access of Emerging Market Economies (EMEs) to international financial markets has been transformed in two ways. First, emerging market corporate bond issuance surged in foreign markets. Second, cross-border claims of global banks on emerging market banks have either stagnated or decreased.

I provide a theoretical framework that links these post GFC trends. In addition, I investigate the implications of these trends on the portfolio composition of domestic banks. The model shows that, below a certain threshold, global long-term interest rate affects the access of small firms to domestic bank credit. When global long-term interest rate hikes, large firms revert back to domestic banks to fund their investment, which in turn crowds out small firms. I

examine the share allocated to Small and Medium Enterprises (herein after SMEs) in total bank credit for Peru, Poland, and Turkey in parallel with unconventional FED monetary policies. There is a clear break in the trend of SME bank credit shares around when markets start to expect a future termination (or a reversal) of Quantitative Easing (QE), consistently with the predictions of the model.

QEs are Large Scale Asset Purchase (LSAP) programs aimed to boost the economy in an environment where short-term interest rates are already near zero. Letting long-term treasury bonds be the main target (especially for QE2 and QE3) of LSAPs allowed the Fed to exert downward pressure on long-term interest rates. In addition, *operation twist*, executed between QE2 and QE3, had a similar goal as it used the sale proceedings of short-term treasury notes to buy long-term treasury bonds. By characterizing this period with a drop in the term premium in international financial markets, the model in this paper reproduces both of the post GFC trends (i.e. Stagnation in the cross-border liabilities of emerging market banks, and boom of emerging market corporate bond issuance in foreign markets). In the model, since banks are financial entities which transform short-term liabilities to long-term assets, foreign claims on domestic banks are one period loans (i.e. short-term loans). In contrast, the direct foreign loans on the corporate sector are two period loans (i.e. illiquid, long-term loans) capturing the longer maturity of emerging market corporate bonds in foreign markets. In the model, because of its effect on the global term premium, a global liquidity expansion triggered by large-scale purchase of US treasury bills lowers the interest rate for direct loans to the corporate sector while it has no significant effect on domestic banks' short-term foreign funding.

In addition, the model investigates whether firm size matters in terms of sensitivity to

US unconventional monetary policy. I find analytically that small firms are more sensitive, and risk financial exclusion in a global liquidity tightening. In the model, the key difference between small and large firms is the financial transparency level — the moral hazard originating from the informational asymmetry between lenders and corporate borrowers is more accentuated for small firms. This lack of transparency gets more punitive with foreign lenders (with higher informational asymmetry relative to domestic banks) to the point that small firms are not able to tap into international financial markets. For a low enough range of global long-term interest rate, large firms choose to fund investments from foreign lenders and domestic banks combined, while small firms' only financial recourse is domestic banks. In case of a positive (tightening) shock to the global term premium, interest rates for long-term loans to large firms increase while the interest rate of domestic banks' short-term foreign funding does not change. Given less favorable conditions in foreign markets, large firms finance a larger share of its investment with domestic bank loans, which in turn crowds out small firms from the domestic bank credit market. To empirically investigate this phenomenon, I compare the share allocated to SMEs in total bank credit for Peru, Poland, and Turkey before and after the second quarter of 2013 — when the Fed gave the signal of slowing down bond purchases for the first time. While pre 2013Q2 represents a period where the term premium for global long-term bonds decrease (is even negative at times), post 2013Q2 represents the reversal of that process (i.e long-term bond yields are increasing). A simple visual check illustrates the regime change clearly. For all of the three countries, the upward trend in the share allocated to SMEs in total bank credit becomes downward right around 2013Q2 (i.e. when financial markets started expecting a slowing down and a future termination of FED LSAP programs), validating model's predictions.

This paper sheds light on a channel by which domestic bank credit access of small firms depends heavily on US unconventional monetary policy. This topic is relevant because there is an upcoming US quantitative easing reversal. After having kept a stable balance sheet since 2014, the FED is finally going through with a balance sheet reduction in 2018 by selling large amounts of long-term treasury bills. A resulting rise in the term premium of long-term bond yields may disrupt the financial stability in EMEs if large firms deviate their funding from foreign lenders to domestic banks, which in turn crowds out SMEs. The risk of credit rationing for SMEs is particularly concerning since SMEs are more likely to be credit constrained than large firms (Kuntchev et al, 2014). In addition, they expand their external financing less easily when they are credit-constrained (Beck et al, 2008). Emerging policymakers should therefore ease SME financing when this external events occur. This could be accomplished either by granting SMEs a tax credit and/or by giving domestic banks incentives to expand financing to SMEs.

The next section reviews the literature. I, then, present the model and highlight the main finding. This is then followed by the empirical investigation of the model's key prediction. At the end, the conclusion recapitulates the findings and includes suggestions for future research.

3.2 Review of literature

My paper provides a theoretical foundation that links three post GFC trends in international financial markets (i.e. historically low long-term bond yields, the emerging corporate

bond boom in foreign markets, and the stagnation of emerging market banks cross-border liabilities). Empirical literature has already established a strong connection between unconventional monetary policy in advanced economies, low long-term bond yields and corporate bond boom. For instance, Turner (2014) found a strong empirical connection between the low or negative term premium in the yield curve in the advanced economies and the escalation in emerging market corporate bond issuance in international markets. On a similar note, Lo Duca et al (2015) support the “gap-filling” theory (Greenwood et al, 2010) where corporate bonds replace long-term treasury bills removed by large-scale asset purchase programs. Gilchrist and Zakrajsek (2015) indicate that large-scale treasury bill purchases lowered US corporate bond yields significantly. In my model, these findings serve as a basis to explain the corporate bond boom with a price effect. As a matter of fact, the reproduction of the third post GFC trend in the model (stagnation in the cross-border liabilities of emerging market banks) also relies on the price effect. Even though LSAPs lowered long-term bond yields, it has not had such a significant impact on short-term interest rates. Since banks, in general, borrow with short-term loans, they have not experienced a drop in prices as emerging market corporations did. By putting forth the price effect, my paper provides an alternative explanation for the financial disintermediation in international markets after the global financial crisis. (Garralda, 2014), on the other hand, points to shifts in global banks funding structure. He claims that regulations intended to achieve more stable funding patterns for global banks led to a contraction in wholesale funding, which in turn reduced cross-border banking.

The key finding of my paper is the impact of unconventional monetary policies in advanced economies on the access of emerging market SMEs to domestic bank loans. Carabarin et

al.(2015), is probably the closest paper in spirit. They empirically investigate whether the choice of large firms between domestic financing sources and international bond issuance significantly affects the ability of commercial banks in Mexico to funnel residual resources to SMEs. The authors find that tightening global liquidity conditions push large firms toward domestic banks, which in turn crowds out SMEs, in accordance with our findings. The shortfall of this paper though is that global liquidity conditions can affect the access of SMEs to domestic bank credit from a different channel. Apart from an emerging market corporate bond boom, an abundance of global liquidity can ease financing for emerging market domestic banks. Cheaper foreign funds might, in turn, drive a credit expansion creating favorable conditions for SMEs access to domestic bank credit (Baskaya et al, 2017). Thus, using global liquidity conditions does not clearly identify the channel that both our paper and Carabarin et al. (2015) use to explain the access of SMEs to bank credit. The fact that I use unconventional monetary policies with its impact on the term premium of the yield curve as the trigger of origin overcomes this identification problem. This is because the term premium of the yield curve — with its effect on long-term interest rates — only affects long-term corporate bonds, and does not have an impact on short-term domestic bank foreign funding.

In order to allow a varying wedge between short-term and long-term interest rates, the model assumes imperfect substitution. I intend to capture how the Fed changes the term spread in the yield curve by purchasing or selling long-term treasury bills. Some examples of models with limited arbitrage in the literature include Vayanos and Vila (2009) , Hamilton and Wu (2011), as well as Holmstrom et al (1997) .

I find that emerging market SMEs are more vulnerable to quantitative easing poli-

cies in advanced economies than large firms. Emerging market policymakers should therefore synchronize these external events with policies aiming to ease financing for SMEs. This is particularly important since SMEs are more likely to be credit-constrained (Kuntchev et al, 2014; Beck, 2007). Furthermore, SMEs have a harder time to resort to external financing when they are credit-constrained (Beck et al, 2008; Beck et al, 2006).

3.3 Model

The setup of the model — particularly, the characterization of the domestic bank as an entity that transforms short-term liabilities to long-term assets as well as some financiers are exposed to liquidity shocks — is inspired by the famous bank run model of Diamond and Dybvig (1983). The model has three periods, $t = \{0, 1, 2\}$.

3.3.1 Financiers

Financiers decide how to allocate their consumption given their initial endowment and save accordingly. Financiers are either domestic or foreign. There are two types of financiers depending on the maturity of the loans they give away. The first type might only be able to lend for one period (i.e. from $t = 0$ to $t = 1$) if they receive a liquidity shock at $t = 1$. In other words, some of their loans are short-term. The second type of financiers is not exposed to liquidity shocks and thus solely provide long-term loans (i.e. from $t = 0$ to $t = 2$). The utility function of financiers is the following;

$$U_F = C_0 + C_1 + C_2$$

The linearity of the utility function and the equality of the coefficients equalize the marginal benefit of consuming for any level of consumption at any period. As a result, utility maximization is obtained through the set of consumption that maximizes return on savings.

3.3.1.1 Domestic financiers

There is a continuum of domestic financiers aggregating to a normalized sum of 1. Each is endowed with D at $t = 0$. All domestic financiers are of the first type (i.e. they have a probability of λ of receiving a liquidity shock at $t = 1$). To save their endowment for future consumption, they deposit it in the domestic bank. The domestic bank's asset is composed of firm loans, and firms take two periods to produce. Banks compensate depositors with a gross return greater than 1 ($R^d > 1$) if financiers keep their deposit for two periods. If exposed to a liquidity shock, the domestic financier is forced to consume all of her endowment within the same period. Shocked financiers who withdraw their deposit at $t = 1$, get a gross return of only $R = 1$ (i.e the net return is equal to zero). As a result, their consumption set is $\{C_0, C_1, C_2\} = \{0, D, 0\}$. Domestic financiers who do not receive liquidity shock hold their deposit until $t = 2$. Their consumption set is $\{C_0, C_1, C_2\} = \{0, 0, D.R^d\}$.

3.3.1.2 Foreign financiers

Foreign financiers can be of either type. Some have a probability of λ of receiving a liquidity shock at $t = 1$. The others is not exposed to liquidity shocks. From here on out, let us call them short-term loan and long-term loan foreign financiers, respectively.

3.3.1.3 Short-term loan foreign financiers

There is a continuum of short-term loan foreign financiers aggregating to a normalized sum of 1. Each is endowed with F^f . They have a probability of λ of receiving a liquidity shock at $t = 1$. To save their endowment for future consumption, they deposit it in the domestic bank. The domestic bank's asset is composed of firm loans, and firms take two periods to produce. Banks compensate depositors with a gross return greater than 1 ($R^d > 1$) if financiers keep their deposit for two periods. If exposed to a liquidity shock, the short-term loan foreign financier is forced to consume all of her endowment within the same period. Shocked financiers who withdraw their deposit at $t = 1$, get a gross return of only $R = 1$ (i.e the net return is equal to zero). As a result, their consumption set is $\{C_0, C_1, C_2\} = \{0, D, 0\}$. Short-term loan financiers who do not receive liquidity shock hold their deposit until $t = 2$. Their consumption set is $\{C_0, C_1, C_2\} = \{0, 0, F^f \cdot R^d\}$.

3.3.1.4 Long-term loan foreign financiers

There is a continuum of long-term loan foreign financiers aggregating to a normalized sum of 1. Each is endowed with F^\dagger . They do not receive liquidity shocks. They can fund firms either by lending to them directly or by going through domestic banks. Returns on loans are R^F and R^d , respectively. Since $R^d < R^F$ around the equilibrium, long-term foreign financiers prefer lending to firms directly. Their consumption set is $\{C_0, C_1, C_2\} = \{0, 0, F^\dagger \cdot R^F\}$.

3.3.2 Domestic banks

Firms need loans in order to invest. It takes two periods for firms to produce and to pay back the loans. Financiers of second type (i.e. ones who never receive liquidity shocks) can fund firms by lending to them directly. Financiers of first type (i.e. ones who have a probability of λ of receiving a liquidity shock) would not be able to invest on the firms at $t = 0$ since loans to firms are illiquid; they would not be able to liquid that asset at $t = 1$ if they receive a liquidity shock. Domestic banks play a crucial role for this type of financiers as by facing a continuum of financiers, banks diversify the idiosyncratic risk of financiers and thus can channel deposits to firms. This welfare increasing feature highlights banks as entities that transform short-term liabilities (funds from financiers) to long-term assets (loans to firms). Figure 3.1 depicts the balance sheet of domestic banks. Since the bank knows that $1 - \lambda$ of deposits will not be withdrawn at $t = 1$, it invests it on firms. λ of deposits are however kept in form of liquid cash for financiers that withdraw their deposit at $t = 1$ following a liquidity shock.

There is a continuum of domestic banks. They compete among each other to give financiers the best deal. They provide financiers a return of R^d on their deposits while they charge firms R^D . The interest rate differential $R^D - R^d$ covers bank's internal costs (denoted as γ) leaving banks with zero profit, a result of the perfect competitive environment. Note that internal costs of the bank is proportional to the loans channeled by the bank.

$$R^D = R^d + \gamma$$

Figure 3.1: Balance sheet of domestic banks

Liabilities	Assets
Deposits from foreign financiers F^S	Loans to firms $(1-\lambda)(D+F^S)$
Deposits from domestic financiers D	Cash (liquid) $\lambda(D+F^S)$

3.3.3 Firms

There are two types of firms. $i = \{1, 2\}$ refers to the firm type, where 1 and 2 represent small and large firms, respectively. The sole difference between small and large firms is the easiness of monitoring from the lender's perspective. It is easier to monitor large firms than small firms. Firms have two sources of external funds (Foreign lenders and domestic banks). There is a continuum of each firm type. An individual firm is indexed by j . The production of firm j of type i is linear in its capital k_{ij} .

$$Y_{ij} = z_{ij} A k_{ij}$$

Note that even though individual firms take productivity A as given, we assume that productivity exhibits decreasing marginal return to aggregate capital, K .

$$\frac{dA}{dK} < 0$$

Firms receive idiosyncratic return shocks, z_{ij} . Capital depreciates fully in one period ($\delta = 1$).

Their gross return is

$$R_{ij}^K = z_{ij}A$$

- $z_{ij} = 1$ with probability p
- $z_{ij} = 0$ with probability $1 - p$

The idiosyncratic shock to the return, z_{ij} , is private information to the entrepreneur. The lenders can only observe the return when they monitor. The informational asymmetry between the borrower and the lender leads to a moral hazard; Entrepreneurs can misreport the outcome, default on the loan and steal/divert a share s of the misreported return, i.e. sAk_{ij} . If there is no monitoring, the entrepreneur steals/diverts the whole amount Ak_{ij} ($s=1$). When the lender monitors though, a fraction ϕ_i^l of diverted funds get lost in the process, i.e. type i firms divert $(1 - \phi_i^l)Ak_{ij}$. $l = \{D, F\}$ denote the lender, where D and F represent domestic banks and foreign lenders, respectively. The fraction of diverted funds that get lost in the process depends on the borrower and on the lender.

While the informational asymmetry in the lending relationship is present for both types of firms, I assume type 2 firms to be more transparent than type 1 firms. Type 2 firms divert/steal a lower share when monitored by lenders (i.e. $\phi_2^l \geq \phi_1^l$). This difference can be justified by the fact that large firms have in general more resources in to keep lenders informed about projects than small firms. Large firms are generally publicly listed, and they are required to have their records more accessible.

Moreover, given the type of firm, the monitoring process also depends on the lender.

Foreign lenders have less information about firms than domestic banks. The fraction of misreported returns that disappears during monitoring is lower by k when firms borrow from foreign lenders. Or another way to say this is, k is the additional fraction that borrowers can steal/divert by misreporting when interacting with foreign lenders.

$$\phi_1^F = \phi_1^D - k$$

$$\phi_2^F = \phi_2^D - k$$

3.3.3.1 Firm type 2 (Large firm) borrowing decision

Funds can reach firms either directly or through domestic banks. Since banks reflect some of its operating costs on the interest rate, the interest rate charged by domestic banks, R^D , is higher than the foreign interest rate, R^F . The higher domestic interest rates is consistent with our focus on emerging market economies where saving rates are relatively lower and financial markets are less developed relative to advanced economies.

While R^D clears the domestic credit market, R^F is exogenous. The implicit assumption is that the domestic country is small enough that the foreign interest rate does not depend on what is happening in the domestic country.

Given that $R^F < R^D$, firms first choice of external funding is to borrow from foreign lenders. A contract between lenders and entrepreneurs will only happen if the latter report truthfully. Such contracts will have to satisfy the incentive compatibility constraint. The contract offers a payment contingent on the announcement (\hat{z}_{ij}) of the shock z_{ij} . The incentive

compatibility constraint, in a loan contract between type 2 firms and foreign lenders, is;

$$R^F(\hat{z}_{2j} = 1)F_j^\uparrow - R^F(\hat{z}_{2j} = 0)F_j^\uparrow \leq \phi_2^F Ak_{2j}$$

where F_j^\uparrow denotes the long term loan borrowed by firm j from foreign lenders. $R^F(\hat{z}_{2j} = 1)F_j^\uparrow$ is the payment when the entrepreneur announces a positive return shock whereas $R^F(\hat{z}_{2j} = 0)F_j^\uparrow$ is when the entrepreneur announces a negative return shock. The LHS is the benefit of reporting truthfully whereas the RHS is the cost. We normalize $R^F(\hat{z}_{2j} = 0)$ to zero. At the equilibrium, the incentive compatibility between the foreign lenders and type 2 firms is always binding. The foreign loan demand by firms of type 2 is then pinned down by;

$$F_j^\uparrow = \frac{\phi_2^F Ak_{2j}}{R^F}$$

Note that the foreign loan demand by firm type 2 is decreasing in the foreign interest rate.

$$\frac{F_j^\uparrow}{dR^F} < 0$$

Foreign lenders and domestic banks do not share information gathered from monitoring. Firms of type 2 will choose to borrow from domestic banks, as long as the expected return to capital exceeds the loan rate, $R^D \leq E(R_2^K)$. When the domestic bank monitors, the share of income that can be collateralized equals ϕ_2^D . The resulting incentive compatibility in a loan contract between type 2 firms and the domestic bank is then;

$$R^D(\hat{z}_{2j} = 1)L_{2j} - R^D(\hat{z}_{2j} = 0)L_{2j} \leq \phi_2^D(1 - \phi_2^F)Ak_{2j}$$

$R^D(\hat{z}_{2j} = 1)L_{2j}$ is the payment when the entrepreneur announces a positive return shock whereas $R^D(\hat{z}_{2j} = 0)L_{2j}$ is when the entrepreneur announces a negative return shock. Similar to the

previous example, $R^D(\hat{z}_{2j} = 0)$ is normalized to zero. In contrast with the relationship to foreign lenders, we assume that ϕ_2^D is high enough that the incentive compatibility constraint between domestic banks and type 2 firms does not bind (i.e. Firms of type 2 keep borrowing from the domestic bank until the marginal product of capital, $A(K)$ equals R^B without having the incentive compatibility constraint binding).

A type 2 firm's total investment need, k_{2j} is pinned down by the following condition;

$$h_k(k_{2j}) = R^D$$

where $h(\cdot)$ and $h_k(\cdot)$ denote the production function and the marginal product of capital, respectively. Remember that capital exhibits decreasing return to scale on the aggregate level. A firm of type 2 finances its investment by borrowing from the domestic bank as well as from foreign lenders.

$$k_{2j} = L_{2j} + F_{2j}^\uparrow = L_{2j} + \frac{\phi_2^F A k_{2j}}{R^F}$$

Rearranging this equation gives the expression for the loan demand of a firm of type 2 from the domestic bank.

$$L_{2j} = h_k^{-1}(R^D) - \frac{\phi_2^F A k_{2j}}{R^F}$$

where $h_k^{-1}(\cdot)$ denotes the inverse function of marginal productivity of capital (i.e. the capital demand function). Note that the domestic bank credit demand by firm type 2 is increasing in the foreign interest rate and decreasing in the interest rate charged by domestic banks. These properties are consistent with domestic bank credit and foreign loans being substitutes with each

other.

$$\frac{L_{2j}}{dR^F} > 0; \frac{L_{2j}}{dR^D} < 0$$

3.3.3.2 Firm type 1 (Small firm) borrowing decision

This section will explain loan demands for small firms. One of the key assumptions of the model is that small (type 1) firms are not transparent enough to borrow from foreign lenders. The higher informational asymmetry specific to transactions with foreign lenders prevent more opaque firms (type 1 firms) from tapping into international financial markets. The mathematical translation of this is;

$$\phi_1^F = \phi_1^D - k \leq 0$$

Since ϕ_1^F is negative, there is no positive amount of foreign loan for which the incentive compatibility condition where type 1 firms reports truthfully is satisfied.

$$R^F(\hat{z}_{1j} = 1)L_{1j}^F - R^F(\hat{z}_{1j} = 0)L_{1j}^F \leq \phi_1^F A k_{1j} \leq 0$$

As for the domestic bank credit, the situation for type 1 firms is similar to type 2 firms. The incentive compatibility condition under which type 1 firms reports to domestic banks truthfully is satisfied and not binding.

$$R^D(\hat{z}_{1j} = 1)L_{1j} - R^D(\hat{z}_{1j} = 0)L_{1j} \leq \phi_1^D A k_{1j}$$

We assume that ϕ_1^D is high enough that the incentive compatibility constraint between domestic banks and type 1 firms does not bind (i.e. firms of type 1 keep borrowing from the domestic bank until the marginal product of capital, $A(K)$ equals R^D without having the incentive compatibility

constraint binding). Once again, the payment when the firm misreports the outcome, $R^D(\hat{z}_2j = 0)$, is normalized to zero.

A type 1 firm's investment need, k_{1j} is pinned down by the following condition;

$$h_k(k_{1j}) = R^D$$

The loan demand of a firm of type 1 from the domestic bank equals

$$L_{1j} = h_k^{-1}(R^D)$$

3.3.4 Aggregate loans and market clearance in the domestic financial market

The aggregate loan demand for type 2 (i.e. large) firms from domestic banks is denoted L_2 , and is given by

$$L_2 = \frac{H_k^{-1}(R^D)}{2} - \frac{\phi_2^F AK_2}{R^F} \quad (3.1)$$

where $H_k^{-1}(\cdot)$ denotes the inverse function of marginal productivity of aggregate capital (i.e. capital demand function), and K_2 denotes the aggregate capital held by type 2 firms.

Note that half of the firms in the economy are type 1 and the other half are type 2. That is why the aggregate amount of capital demanded by the economy given R^D (i.e. $H_k^{-1}(R^D)$) is divided by two to express the aggregate capital demand of type 2 firms.

The aggregate loan demand for type 1 (i.e. small) firms from domestic banks is denoted L_1 , and is given by

$$L_1 = \frac{H_k^{-1}(R^D)}{2} \quad (3.2)$$

3.3.4.1 Market clearance

The domestic bank credit market clears at the equilibrium domestic interest rate, R^{D*} . At the equilibrium interest rate, the aggregate loan demand by firms is equal to the aggregate loan supply of domestic banks.

$$L_1 + L_2 = (1 - \lambda)(F^J + D) \quad (3.3)$$

$$H_k^{-1}(R^{D*}) - \frac{\phi_2^F AK_2}{R^F} = (1 - \lambda)(F^J + D) \quad (3.4)$$

In the market for long-term maturity assets, when the Fed executes a large scale asset purchase program for long-term maturity treasury bonds, it pushes foreign investors to seek higher return in emerging market economies, lowering R^F . The above equation hints us on how the equilibrium domestic interest rate (R^{D*}) is affected by the long-term foreign interest rate (R^F). As R^F goes down, large firms finance a larger share of their investment from international financial markets, which in turn leads to them borrowing less from domestic banks. As domestic bank supply would, as a result, exceed the aggregate loan demand, R^{D*} drops to clear the market. This can be observed in the left hand side of the above equation. A lower R^F decreases the LHS of the equation. A drop in R^{D*} can compensate by increasing the LHS for the equality to hold again (i.e. so that the market clears).

This phenomenon explains the mechanism behind the sensitivity of type 1 (small) firms to changes in R^F . We can observe this analytically by rearranging equation (4) and plugging it into equation (2).

Rearranging equation (2) gives

$$R^{D*} = H_k \left((1 - \lambda)(F^J + D) + \frac{\phi_2^F AK_2}{R^F} \right) \quad (3.5)$$

Plugging it into equation (4) gives an expression of L_1 in terms of R^F .

$$L_1 = \frac{(1 - \lambda)(F^J + D) + \frac{\phi_2^F AK_2}{R^F}}{2} \quad (3.6)$$

The analytical derivative of L_1 with respect to R^F is given by:

$$\frac{dL_1}{dR^F} = -\frac{\phi_2^F AK_2}{(R^F)^2} < 0$$

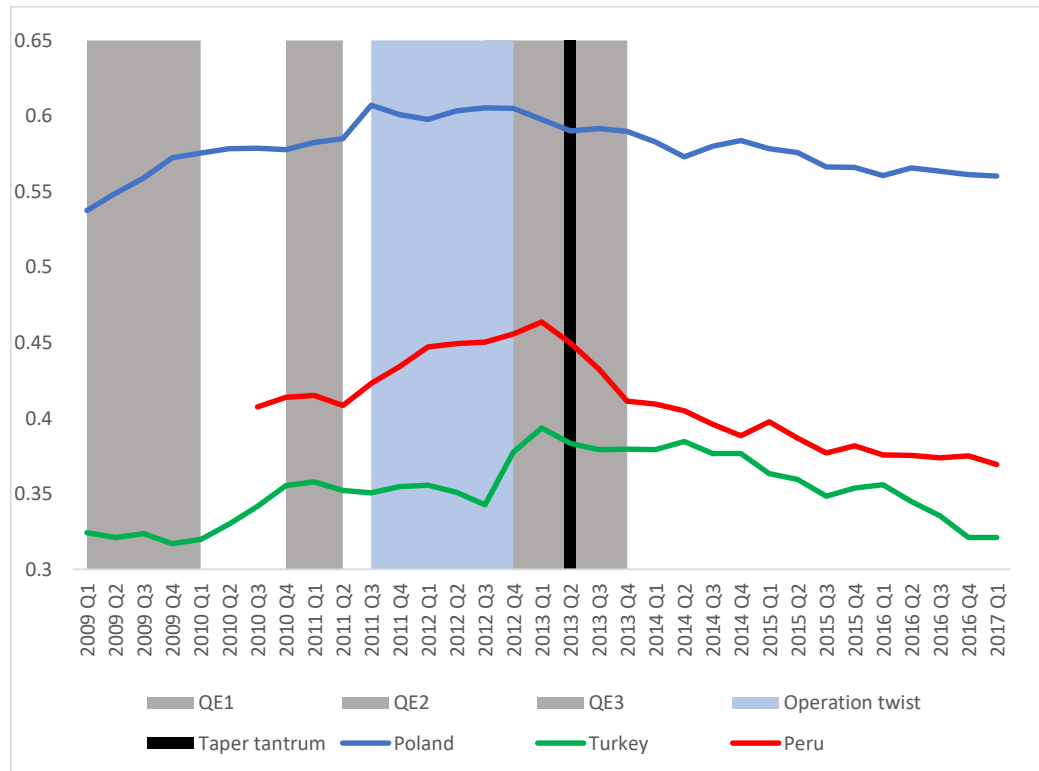
The negative derivative highlights the implications of changes in R^F on small firms through the domestic financial market. A hike in R^F makes large firms finance a lower share of their investment from international financial markets. This in turn translates into higher domestic interest rates as large firms now demand more loans from domestic banks. Elevated domestic interest rates make bank loans less attractive for small firms. In other words, small firms get crowded out as higher loan demand by large firms leads to a more domestic bank credit available for small firms.

3.4 Empirical investigation

Figure 3.2 shows the quarterly ratio of Small and Medium Enterprise (SME) bank credit to total bank credit for Peru, Poland, and Turkey, from 2009Q1 to 2017Q1. We proxy the bank credit allocated to SMEs with smaller sized loans¹. Gray shaded areas highlight periods of Quantitative Easing (QE) executed by the FED. There are three of them and they represent QE1, QE2, and QE3, in a chronological order. The blue shaded area depicts *operation twist*—another Fed unconventional monetary policy tool.

¹We used 0.5M or 1M as the threshold, depending on the availability of data for Peru, Poland, and Turkey. Therefore loans with an amount lower than the threshold is considered as SME credit.

Figure 3.2: Ratio of SME bank credit to total bank credit



Finally, the black vertical line pins down the first Fed announcement signaling the gradual termination of unconventional expansionary policies, also known as *taper tantrum*. QEs are Large Scale Asset Purchase (LSAP) programs aimed to boost the economy in an environment where short-term interest rates are already near zero. Letting long-term treasury bonds be the main target (especially for QE2 and QE3) of LSAPs allowed the Fed to exert downward pressure on long-term interest rates. *Operation twist* had a similar goal as it consisted of funding long-term treasury notes purchases by selling short-term treasury bills. The global importance

of US financial markets and the large scale of the Fed balance sheet expansion have pushed investors from low yield safe treasury bonds to corporate bonds or emerging market bonds with high risk and return. As a result, the period from the start of QE1 ending with the taper tantrum is marked with low long-term interest rates in international financial markets.

Figure 3.2 associates this period of low R^F with an upward trend of the share allocated to SMEs in total bank credit for Peru, Poland, and Turkey. This is consistent with the model which predicts a greater access of type 2 (small) firms to domestic bank credit as type 1 (large) firms prefer borrowing directly from international financial markets. The most prominent observation in figure 3.2 is the break of this trend around *taper tantrum* for all three of countries. Post taper tantrum is characterized by the end of LSAP programs and by announcements signaling future balance sheet reduction heading in the direction of policy normalization. The downward trend of the SME bank credit share is once again consistent with the model's prediction that SMEs are getting crowded out.

3.5 Conclusion

This paper provides a theoretical framework that links post GFC trends in international markets — historically low long-term bond yields, the emerging corporate bond boom in foreign markets, and the stagnation of emerging market banks cross-border liabilities — to unconventional monetary policies in advanced economies. The main contribution of the model is to show that domestic bank credit access of small firms is vulnerable to US unconventional monetary policy. This is a relevant topic since the FED is expected to normalize its balance

sheet size in the coming years. Our finding implies that there is a risk of credit rationing for SMEs if there is a significant hike in the term premium of long-term corporate bond yields. To ensure financial stability against this threat, emerging market policy makers should implement policies that ease financing for SMEs when these external events occur. Possible remedies are a tax break for SMEs or incentives to domestic banks to promote credit expansion to SMEs.

Future research should focus on improving the identification of the crowding out effect. For instance, if firm-level bank loan data were available, taking into account firm characteristics would certainly help. It would also be interesting to investigate the implications of this phenomenon on real economic decisions. Some examples are; does “not having access to bank credit” deter investments for SMEs? Is it worse for SMEs that are already credit-constrained? Furthermore, it is known that exporters need more external financing since these firms incur additional fixed costs for exports. How does variations in access to bank credit affect SMEs exports?

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Appendix A

Evidence on the balance sheet effect of emerging market firms

A.1 Derivation of $\varphi(\alpha, \rho, \varepsilon^s)$ in Equation (1) (Regional bank VaR rule)

$$\omega(y_j) = \Phi\left(\frac{\sqrt{\rho}y_j - \Phi^{-1}(\varepsilon^s)}{\sqrt{1-\rho}}\right) = z$$

where z denotes the value of the loan portfolio with face value of 1 dollar. Rearranging the equation above, we get

$$y_j = \omega^{-1}(z) = \frac{\sqrt{1-\rho}\Phi^{-1}(z) + \Phi^{-1}(\varepsilon^s)}{\sqrt{\rho}}$$

The cdf of z then is

$$F(\omega(y_j) < z) = F(y_j < \omega^{-1}(z)) = \Phi\left(\frac{\sqrt{1-\rho}\Phi^{-1}(z) + \Phi^{-1}(\varepsilon^s)}{\sqrt{\rho}}\right)$$

VaR rule consists of keeping the leverage so that the probability of default on its liabilities does not exceed a fixed probability, α . φ is the leverage implied by the VaR rule where the probability of default to the creditors is equal to α ;

$$F(\omega(y_j) < \varphi) = \Phi\left(\frac{\sqrt{1-\rho}\Phi^{-1}(\varphi) + \Phi^{-1}(\varepsilon^s)}{\sqrt{\rho}}\right) = \alpha$$

We then rearrange the equation to solve for φ

$$\varphi = \Phi^{-1}\left(\frac{\sqrt{\rho}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon^s)}{\sqrt{1-\rho}}\right)$$

A.2 Derivation of $\psi(\alpha, \rho, \beta, \varepsilon^b, \alpha_g)$ in Equation (2) (Global bank VaR rule)

$$\omega_g(G) = \lambda \Phi \left(\frac{\sqrt{\beta}G - \Phi^{-1}(\alpha)}{\sqrt{1-\beta}} \right) + (1-\lambda) \Phi \left(\frac{\sqrt{\rho}\sqrt{\beta}G - \Phi^{-1}(\varepsilon^b)}{\sqrt{1-\rho\beta}} \right) = z_g$$

where z_g denotes the value of the loan portfolio with face value of 1 dollar. The cdf of z_g is

$$F(\omega_g(G) < z_g) = F(G < \omega_g^{-1}(z_g)) = \Phi(\omega_g^{-1}(z_g))$$

VaR rule consists of keeping the leverage so that the probability of default on its liabilities does not exceed a fixed probability, α_g . ψ is the leverage implied by the VaR rule where the probability of default to the creditors is equal to α_g :

$$F(\omega_g(G) < \psi) = F(G < \omega_g^{-1}(\psi)) = \Phi(\omega_g^{-1}(\psi)) = \alpha_g$$

We then rearrange the equation to solve for ψ

$$\omega_g^{-1}(\psi) = \Phi^{-1}(\alpha_g)$$

$$\psi = \omega_g(\Phi^{-1}(\alpha_g))$$

$$\psi = \lambda \Phi \left(\frac{\sqrt{\beta}\Phi^{-1}(\alpha_g) - \Phi^{-1}(\alpha)}{\sqrt{1-\beta}} \right) + (1-\lambda) \Phi \left(\frac{\sqrt{\rho}\sqrt{\beta}\Phi^{-1}(\alpha_g) - \Phi^{-1}(\varepsilon^b)}{\sqrt{1-\rho\beta}} \right)$$

For the special case where $\alpha = \alpha_g$

$$\psi = \lambda \Phi \left(\frac{(\sqrt{\beta}-1)\Phi^{-1}(\alpha)}{\sqrt{1-\beta}} \right) + (1-\lambda) \Phi \left(\frac{\sqrt{\rho}\sqrt{\beta}\Phi^{-1}(\alpha) - \Phi^{-1}(\varepsilon^b)}{\sqrt{1-\rho\beta}} \right)$$

A.3 Regressions for international claims (cross-border claims + local claims in foreign currency)

Table A.1: 2SLS results for international claims vis-a-vis domestic banks

<i>Dependent variable: Annual growth rate of International claims vis-a-vis domestic banks ($\Delta IC_{j,t}^{b-b}$)</i>		
	OLS	2SLS
$\Delta M2_{j,t}$	0.7** (0.276)	0.827** (0.326)
$\Delta PublicDebt / GDP_{j,t}$	0.292 (0.626)	0.873 (0.564)
$\Delta GDP_{j,t}$	2.038*** (0.587)	0.917 (1.289)
$\Delta Interest\ spread_{j,t}$	1.577 (1.438)	-0.012 (1.848)
$\Delta local\ leverage_{j,t}$	-3.386 (2.12)	-3.333 (2.448)
$\Delta local\ bank\ equity_{j,t}$	6.208*** (2.027)	5.679*** (1.877)
$\Delta global\ bank\ equity_t$	-0.544*** (0.275)	-0.751** (0.377)
$\Delta GB\ Claims_t$	0.384* (0.203)	0.258 (0.242)
$\Delta RER_{j,t}^w$	-0.406** (0.168)	-1.417* (0.769)
<i>Constant</i>	-11.807 (4.424)	-6.903 (6.877)
<i>N</i>	847	847
<i>R</i> ²	0.2331	0.1420

Standard errors are clustered within countries.
Standard errors in parentheses. Two-tailed test.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: 2SLS results for international claims vis-a-vis non-financial sector

<i>Dependent variable: Annual growth rate of International claims vis-a-vis non-financial sector ($\Delta IC_{j,t}^{b-nb}$)</i>		
	OLS	2SLS
$\Delta M2_{j,t}$	0.583*** (0.165)	0.583*** (0.173)
$\Delta PublicDebt/GDP_{j,t}$	0.174 (0.633)	0.176 (0.611)
$\Delta GDP_{j,t}$	0.76 (0.451)	0.758 (0.631)
$\Delta Interest\ spread_{j,t}$	-1.319 (1.183)	-1.323 (1.442)
$\Delta local\ leverage_{j,t}$	-0.73 (1.091)	-0.73 (1.051)
$\Delta local\ bank\ equity_{j,t}$	0.987 (2.255)	0.986 (2.241)
$\Delta global\ bank\ equity_t$	-0.658*** (0.196)	-0.659*** (0.191)
$\Delta GB\ Claims_t$	0.538*** (0.16)	0.538*** (0.143)
$\Delta RER_{j,t}^w$	-0.252** (0.089)	-0.254 (0.397)
<i>Constant</i>	2.16 (2.998)	2.172 (3.427)
<i>N</i>	847	847
<i>R</i> ²	0.2331	0.2441

Standard errors are clustered within countries.

Standard errors in parentheses. Two-tailed test.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Appendix B

Amplification of global financial shocks in EMEs: the role of moral hazard

B.1 Data

The data set includes quarterly data for Argentina, Brazil, Mexico, South Africa and Turkey. The sample periods vary cross countries. They are: Argentina 1994Q1-2001Q3, Brazil 1996Q1-2011Q4, Mexico 1994Q1-2013Q4, South Africa 1994Q1-2013Q4, and Turkey 1999Q3-2014Q1. In total, the data set contains approximately 300 observations. Our choice of countries and sample period is guided mainly by data availability. The countries I consider belong to the set of countries included in J.P. Morgan's EMBI+ data set for emerging country spreads. In the EMBI+ database, time series for country spreads begin in 1994Q1 or later.

Quarterly series for GDP, investment and net exports are from IMF's International Financial Statistics. All of these variables are deflated using the GDP deflator. The country spread is measured using data on spreads from J.P. Morgan's Emerging Markets Bond Index Plus (EMBI+). The U.S. real interest rate is measured by the interest rate on three-month U.S. Treasury bill minus a measure of U.S. expected inflation. EMBI+ is a composite index of different U.S. dollar-denominated bonds on four markets: Brady bonds, Eurobonds, U.S. dollar local markets and loans. The spreads are computed as an arithmetic, market-capitalization-weighted average of bonds spreads over U.S. Treasury bonds of comparable duration. The banking sector borrowing-lending spread in emerging economies is the difference between the domestic lending rate by banks and the deposit rate, as reported by International Financial Statistics. The data from Turkey is from Central Bank of the Republic of Turkey. The U.S. BAA corporate spread is calculated as the difference between U.S. BAA corporate rate and U.S. 20 year government bond yields. The U.S. real interest rate is measured as the 3-month gross U.S. Treasury Bill rate deflated using a measure of the expected U.S. Inflation. The expected U.S. $E_t \frac{1}{1 + \pi_{t+1}}$ is taken to equal the fitted component of a regression of $\frac{1}{1 + \pi_{t+1}}$ onto a constant and two lags. This regression uses quarterly data on the growth rate of the U.S. CPI index from 1994 Q1 to 2014 Q2. The results are robust to using higher lags of inflation for the calculation of U.S. real interest rates. The method for measuring the expected inflation rate is taken from

Scmitt et al (2011). Sovereign spreads (EMBI+) are taken from Global Financial Data. The 3-month U.S. Treasury Bill rate, the U.S. CPI, the U.S. BAA corporate bond rate and the 20 year government bond yield are obtained from the St. Louis Fed. FRED Database.

B.2 Equilibrium Conditions

Equilibrium conditions (3),(4),(5) and (6) are derived from the first order conditions originating from representative agent's utility maximization problem.

$$d_t = (1 + r_{t-1})d_{t-1} + c_t + k_{t+1} - (1 - \delta)k_t + \Phi(k_{t+1} - k_t) - y_t \quad (\text{B.1})$$

$$U_c(c_t, h_t) = \beta(\tilde{c}_t, \tilde{h}_t)(1 + r_t)U_c(c_{t+1}, h_{t+1}) \quad (\text{B.2})$$

$$(1 + \Phi'(k_{t+1} - k_t))U_c(c_t, h_t) = \beta(\tilde{c}_t, \tilde{h}_t) \left(1 - \delta + A_t F_k(k_{t+1}, h_{t+1}) + \Phi'(k_{t+2} - k_{t+1}) \right) U_c(c_{t+1}, h_{t+1}) \quad (\text{B.3})$$

$$-\frac{U_h(c_t, h_t)}{U_c(c_t, h_t)} = A_t F_h(h_t, k_t) \quad (\text{B.4})$$

Equation (7) stems from FI's balance sheet where its assets are equal to its liabilities.

$$d_t = b_t \quad (\text{B.5})$$

Equation (8) represents the first order condition from FI's profit maximization problem.

$$\gamma b_t = r_t - r_t^* \quad (\text{B.6})$$

Conditions (9),(10) and (11) describe the exogenous stationary stochastic processes for productivity A_t , world interest rate r_t^* , and bank friction coefficient γ_t , respectively.

$$\ln(A_{t+1}) = \rho \ln(A_t) + \eta \varepsilon_{t+1} \quad (\text{B.7})$$

$$r_{t+1}^* - r^* = \rho_r (r_t^* - r^*) + \eta^r \varepsilon_{t+1}^r \quad (\text{B.8})$$

$$\ln\left(\frac{\gamma_{t+1}}{\bar{\gamma}}\right) = \rho_\gamma \ln\left(\frac{\gamma_t}{\bar{\gamma}}\right) + \eta^\gamma \varepsilon_{t+1}^\gamma \quad (\text{B.9})$$

Inequality (12) is by assumption and holds to ensure positive profit for the FI so that financial intermediation takes place.

$$r_t > r^* \text{ for } t \geq 0 \quad (\text{B.10})$$

B.3 Deterministic Steady State and calibration of the parameters

Table B.1: Parameter Values

	σ	δ	r^*	\bar{r}	α	ω	ϕ	ζ
Parameter Value	2	0.1	0.04	0.06	0.32	1.455	0.028	1.35
	ψ	ρ	η	ρ^γ	η^γ	ρ^r	η^r	$\bar{\gamma}$
	0.11	0.42	0.0129	0.4	0.001	0.4	0.001	0.0179

Based on parameter values widely used in related business-cycle literature, we set the values of σ, δ, r^* . The wage elasticity of labor supply, ω , the magnitude of adjustment capital adjustment, ϕ , the persistence coefficients of the shocks, $\rho, \rho_r, \rho_\gamma$, and the standard deviations of the shocks, $\eta, \eta_r, \eta_\gamma$ are calibrated to match second moments (volatility and serial correlation) of hours worked, investment, output in business cycles. α is set to match the labor income to output ratio consistent with data.

Let us now focus on the equilibrium conditions at the steady state.

Note that steady state variables are denoted with a bar on top.

Setting $\bar{A} = 1$, equilibrium condition (5) at the steady state gives

$$1 = \frac{1}{1 + \bar{r}} \left(1 - \delta + \alpha \left(\frac{\bar{k}}{\bar{h}} \right)^{\alpha-1} \right)$$

This delivers the steady state capital-labor ratio in terms of the known parameters and \bar{r} .

$$\kappa(\bar{r}) \equiv \frac{\bar{k}}{\bar{h}} = \left[\frac{(1 + \bar{r}) - 1 + \delta}{\alpha} \right]^{\frac{1}{\alpha-1}}$$

The following condition is obtained from (6) at the steady state and delivers steady state labor and capital in terms of the parameters and \bar{r} .

$$\bar{h}(\bar{r}) = ((1 - \alpha)\kappa(\bar{r})^\alpha)^{\frac{1}{\omega-1}}$$

$$\bar{k}(\bar{r}) = \kappa(\bar{r})\bar{h}(\bar{r})$$

We next use the steady state Euler equation.

$$\beta(\bar{c}, h(\bar{r}))(1 + \bar{r}) = 1$$

Thus, for given parameters ζ and ψ , we can express c in terms of \bar{r} .

We can equally express the steady state household debt \bar{d} as a function of \bar{r} since all the other variables in the budget constraint below are also a function of \bar{r} .

$$\bar{c}(\bar{r}) = -\bar{r}\bar{d} - \delta\bar{k}(\bar{r}) + \kappa^\alpha\bar{h}(\bar{r})$$

We next turn our attention to the credit supply side. Equilibrium condition (8) at the steady state allows us to express b in terms of \bar{r} and steady state bank friction coefficient $\bar{\gamma}$.

$$\bar{b} = \frac{\bar{r} - r^*}{\bar{\gamma}}$$

Finally, the asset clearing condition (7) at the steady state is as follows

$$\bar{d}(\bar{r}) = \bar{b}(\bar{r}, \bar{\gamma})$$

This is one equation with two unknowns. We can either set a value for $\bar{\gamma}$ and determine \bar{r} that clears the asset market. Alternatively, we can set a desired value for \bar{r} and determine $\bar{\gamma}$ that clears the asset market. In addition to the set $(\bar{r}, \bar{\gamma})$, the calibration of parameters ζ and ψ also influences \bar{c} and \bar{d} . In the selection of $(\bar{r}, \bar{\gamma}, \zeta, \psi)$, we consider the following criteria:

- We set \bar{r} to a value consistent with the data for emerging countries, and far enough from r^* so that $r_t > r^*$ holds even in the presence of shocks.

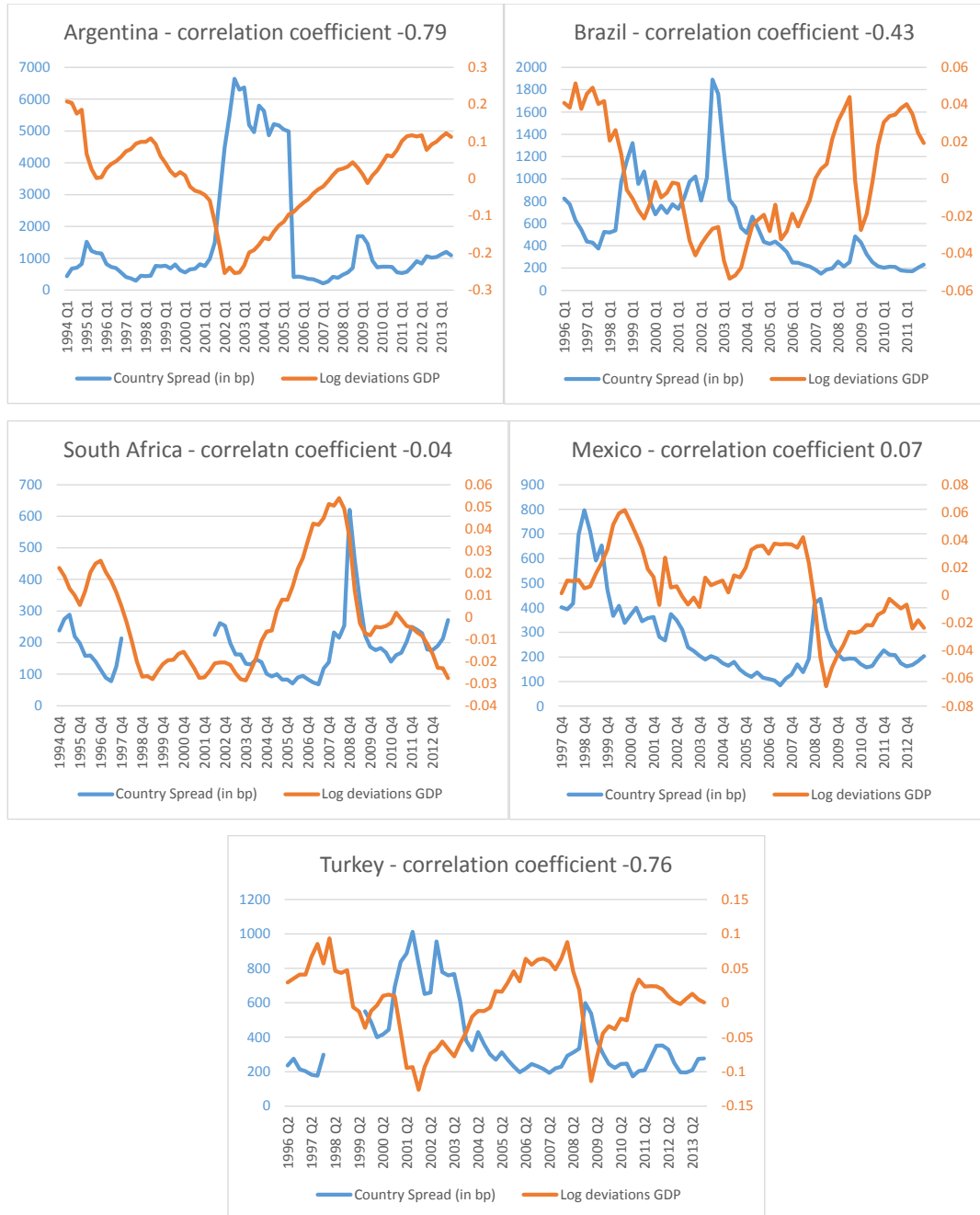
- Later in the quantitative section, the size of $\bar{\gamma}$ becomes important for percent shocks to bank friction coefficient γ_t . If $\bar{\gamma}$ is too low, then the magnitude of the responses is too small. Therefore, we set $\bar{\gamma}$ as high as possible without compromising on other criteria.

- ζ and ψ are located in the Euler equation at the steady state. We choose a low value for ψ as to minimize its effect on the business cycle fluctuations during shocks. Once h_t is determined in terms of the parameters and \bar{r} , we can calibrate ζ to aim a value for \bar{d} . This works as

ζ gives a value for \bar{c} , which in turn implies a value for \bar{d} from the steady state household budget constraint. We should insure that \bar{d} stays positive in the steady state, even in the presence of shocks. Otherwise the FI has no one to lend to. In addition, we can aim a value for \bar{d} resulting in a trade balance to output ratio consistent with emerging country data.

Taking into account this criteria, the calibration of parameters as well as the implied values for $\bar{r}, \bar{\gamma}$ are summarized in Table B.1.

Figure B.1: Country spreads and business cycles



Notes: Output is seasonally adjusted and detrended using a log-linear trend. EMBI+ is an index of country interest rates which are real yields on dollar-denominated bonds of emerging countries issued in international financial markets. Output is taken from IFS. EMBI+ is taken from Global Financial Data