Business Cycles and Financial Intermediation in Emerging Economies[*]

Christoph Große Steffen[†]

DIW Berlin

Free University Berlin

December 2011

- PRELIMINARY VERSION -

Abstract

This paper explores the quantitative role of financial market frictions on capital flows and the business cycle in emerging markets. A financial sector in analogy to Gertler and Karadi (2011) is embedded in an otherwise standard neoclassical model of a small open economy. An agency problem between international investors and domestic banks gives rise to an endogenously determined leverage ratio. Along with a traditional productivity shock, international investors appetite for emerging market assets is introduced as an exogenous disturbance. I find that the amount of attractable external funds that the financial sector can extend to the domestic economy depends on bank capital and investment behavior of foreigners. Domestic banks amplify the external funding squeeze to the real economy which leads to higher output volatility in case of financial openness. A calibrated version of the model fits key Mexican real and financial sector business cycle moments.

Keywords: open-economy business cycles; financial intermediation; emerging markets; capital flows.

JEL classification: F32; F42; F44.

1 Introduction

Financial integration has spurred capital flows to emerging markets at an increasing scale over the past decade. While the empirical literature on the overall effect of financial openness is inconclusive, there is sustained evidence that net capital flows to emerging markets are pro-cyclical and highly volatile, thereby increasing aggregate output volatility and financial instability. A recent example is the cut-back of foreign external finance for banks in emerging market regions during the turmoil caused by the global financial crisis. Bank intermediated capital inflows throughout the expansionary period in the run-up to the crisis fueled domestic credit expansion and GDP growth. When the crisis hit, investors in developed markets responded with a *flight to quality* which affected confidence in emerging market assets although not necessarily related to weaker fundamentals. The result was increasing pressures in external financing conditions in emerging economies which led to a contraction in domestic credit supply and output losses. The boom-bust cycle in foreign external financing was particularly pronounced in emerging Europe, Brazil, Chile, Korea and South Africa (Mihaljek, 2010). However, given the scale of economic vulnerability in emerging market regions, it was surprising that a systemic banking crisis did not materialize (Berglöf et al., 2009). Now, capital flows are back at pre-crisis levels and policy makers are actively debating their effect on financial stability and economic growth (Ostry et al., 2011).

This paper expands on the pro-cyclical relationship between capital flows and emerging market business cycles in regular times and discusses their effects on financial stability. Specifically, the paper asks two questions. First, are financial market frictions quantitatively relevant for the propagation of shocks to a capital importing small open emerging economy? Second, how does a temporary limited appetite for emerging market assets which is unrelated to market fundamentals and can be observed at business cycle frequencies affect the real side of the economy?

To this end, a standard model of a small open economy is augmented by a financial sector which is modeled in analogy to Gertler and Karadi (2011, henceforth GK) and adapted to the open economy dimension. In this set-up, pro-cyclicality of capital flows emerges from an agency problem between foreign investors and domestic financial intermediaries, which gives rise to a market determined leverage ratio that fluctuates over the cycle. As a consequence, the amount of attractable external funds that the financial sector can extend to the domestic economy depends on endogenous bank capital. In the presence of adverse real shocks, reductions in bank capital induce a self-enforcing financial accelerator mechanism. Banks sharply reduce their

domestic credit supply in order to restore acceptable bank capital levels, thereby driving asset prices down further.

Limited access to international financial markets is introduced as an exogenous shock on the agency problem between foreign investors and domestic financial intermediaries. Following Fostel and Geanakoplos (2008), in an *anxious* state of the global economy, investors reign in demand for emerging market assets in times of global insecurity although emerging market fundamentals do not necessarily have worsened. The implicit assumption of this modeling strategy is that the agency problem between foreign investors is time variant and uncorrelated to domestic fundamentals. A way to rationalize this assumption is to think of an investor who seeks to reduce monitoring effort in times of global distress due to limited monitoring capacities.

The main findings of the study are threefold. First, a model calibrated to Mexican data succeeds in reproducing key business cycle moments from the real and financial side of the economy. Bank leverage and bank net worth turn out to be more volatile than output and highly persistent. A main finding of the quantitative excercise is that the inclusion of a financial sector amplifies endogenous shocks which leads to higher output volatility in the case of financial openness. Second, reduced demand for emerging market assets affects the domestic real sector via a bank capital channel. Since banks need to restore balance sheets, they lower asset demand in the initial period. This shock is endogenously propagated to the real sector by lower investment activities. Third, the intuitive conjecture that financial sectors with lower leverage ratios are better vested to buffer external shocks is confirmed by the model.

The remainder of this paper is organized as follows. The next section discusses the related literature. Section 3 documents stylized facts which elicit the pro-cyclical nature of gross capital flows and presents key Mexican business cycle moments from the real and financial sector. Section 4 describes the model and section 5 presents and discusses the main findings. Section 6 concludes.

2   Relation with the literature

The fundamental discourse this paper is related to is the question whether domestic developments or global factors drive the business cycle of emerging economies. Calvo et al. (1996), among others, have argued in favour of external factors as the dominant source of aggregate volatility, alluding to the experience of volatile international capital flows during the 1990s. While

there is vast empirical literature on sudden stops of capital inflows during systemic crisis episodes (Calvo et al., 2008; Reinhart and Reinhart, 2009, among many others), there is only limited research on the patterns of capital flows to emerging markets during regular times. Broner et al. (2010) document the cyclical behavior of gross capital flows for different country-samples over the last 40 years. They show that gross capital inflows from foreign investors to middle- and low-income countries are more pro-cyclical than in high-income countries. This observation is confirmed by Meller (2011). She finds that the cyclicality of capital flows depends on threshold values in countries' financial risk position. Those countries which are perceived by international investors as financially more risky exhibit pro-cyclical capital flows, whereas developed economies with low financial risk benefit from counter-cyclical capital flows. Meller (2011) concludes that financial openness increases output volatility for emerging market countries.

By putting the focus on the agency problem between foreign investors and domestic financial intermediaries, this paper connects several recent strands of the theoretical literature. First, the paper borrows heavily from the literature on the financial accelerator as described in Kiyotaki and Moore (1997) and Bernanke et al. (1999). Caballero and Krishnamurthy (2001) and Gertler et al. (2007) extend the idea of credit frictions due to limited collateral to the international dimension in order to analyse emerging market crises. Related to this approach are quantitative models as developed by Mendoza (2010) and a policy oriented literature which investigates the question of excessive borrowing from abroad as in Jeanne and Korinek (2010), Bianchi (2010) and Benigno et al. (2010). More precisely, this paper uses the results from a recent branch of the literature which ascribes a prominent role in the transmission of shocks to bank capital. Meh and Moran (2010) find that bank capital reduces a moral hazard problem between depositors and banks in the optimal financial contract. This leads to a bank capital channel which amplifies technology and monetary shocks to the real economy. Gertler and Kiyotaki (2010) and Gertler and Karadi (2011) also attribute an important role to bank capital in the propagation of shocks to the real sector. However, their ultimate interest lies in the analysis of an optimal reaction of the monetary authority and not on the business cycle implications. The model described in this paper can be understood as an extension of the financial accelerator in the banking sector to an open economy setting.

The idea of a stochastic shock within the agency problem between foreign investors and domestic banks emerges from a strand of literature which investigates the relationship of global market liquidity and investors' appetite for emerging market assets. Fostel and Geanakoplos (2008) show in a model of a

global *anxious economy* that international investors retrieve asymmetrically heavily from emerging market assets when bad news on the global economy are revealed to the public. In a setup with heterogenous agents, this leads to a temporary flight to collateral which explains the volatile access of emerging economies to international financial markets at business cycle frequency. Brunnermeier and Pedersen (2009) relate asset market liquidity to funding liquidity of banks. In their model, margins are optimally set by investors in each period. In times of low asset liquidity, investors raise margin requirements since they cannot distinguish between fundamental and liquidity shocks. This leads to a further dry up of asset markets, hence margins have a destabilizing role.

The results of the paper are most closely related to a literature which is concerned with the explanation of a set of stylized emerging market business cycle facts. These are (i) higher volatility in output and investment than in developed small open economies, (ii) excess volatility in consumption and (iii) a strongly counter-cyclical trade balance-to-output ratio. Broadly, two leading approaches can be distinguished in this field. To begin with, Neumeyer and Perri (2005) and Uribe and Yue (2006) focus on the counter-cyclical relationship between international interest rates and output. They introduce a working capital requirement on the side of entrepreneurs in combination with negatively correlated technology and interest rate shocks as central frictions into the neoclassical small open economy framework. This renders labor input sensitive to the international interest rate which leads to a counter-cyclical relationship. An alternative approach is the introduction of a stochastic productivity trend, as shown by Aguiar and Gopinath (2007) and Boz et al. (2008). If a permanent growth shock occurs, agents adjust consumption immediately to the expected infinite higher growth path of the economy which leads to a higher initial reaction in consumption compared to output. Empirical evidence points into the direction of the financial frictions hypothesis as the main driving forces for emerging market business cycle data, as was documented by García-Cicco et al. (2010) and Chang and Fernández (2010).

However, financial frictions originating in the financial sector as explanation of long-run emerging market business cycles facts have not been considered in the literature.[1] The existing literature on the financial sector in emerging markets relates to the concentration of currency crises during the

---

[1] One notable exception is Oviedo (2005), who introduces costly financial intermediation into the setup with shocks on the international interest rate. However, Oviedo (2005) does not put the financial sector at the center stage of emerging market business cycles. In fact, the financial sector with costly intermediation reduces aggregate volatility, whereas the here presented model with an agency problem enforces the cycle.

second half of the 1990s, which often have been coupled with banking crises (Kaminsky and Reinhart, 1999). This phenomen has spurred research in the form of so-called *third generation* crisis models which focus on the liability side of banks. Specifically, Chang and Velasco (2000, 2001) concentrate on the maturity mismatch problem which can cause bank runs by foreign creditors and domestic depositors alike. Burnside et al. (2001, 2004) elicit the role of government guarantees in excessive unheged foreign currency borrowing by banks which can lead to self-fulfilling speculative attacs.

3 Stylized facts

This section documents the cyclical pattern of gross capital inflows. Besides, business cycle statistics from the Mexican real and financial sector are presented.

3.1 Cyclicality of gross capital inflows

For the extraction of cyclical information of gross capital inflows, I construct a panel of 33 countries of which there are 21 classified as emerging market economies and 12 as developed small open economies. I follow Aguiar and Gopinath (2007) in the classification where applicable and group European Union new member countries as emerging market economies. The longest series in the unbalanced panel range from 1980q1 to 2011q1, the shortest from 1997q1 to 2011q1. Comprehensive details on the list of countries included in the panel and the series length can be obtained in Table 4 in the appendix.

In the construction of gross capital inflows (GCI) I follow Broner et al. (2010). Capital inflows by foreign investors are defined as the sum of three positions of the financial accounts: foreign direct investment in the country, portfolio investment liabilites, and other investment liabilities. Data on financial derivatives is left out due to their relatively small amount and their limited availability across countries. Since flows in reserve assets are operated via monetary authorities, they are also not considered here. GCI are reported in US dollars, deflated by the US deflator and detrended using the HP-filter for quarterly series. The data comes from the IMF's Balance of Payments statistics.

Output data is taken either from the IMF's International Financial Statistics or the OECD's Quarterly National Accounts when available over the entire sample length. Output was de-saisonalized and deflated when necessary. I obtain the cyclical component of logged GDP by extracting the trend

with the HP-filter for quarterly series. The data is plotted for each country in Figure 1.

Figure 2 depicts the lead-lag structure of the cross-correlations of GDP with gross capital inflows. Gross capital inflows into emerging markets are pro-cyclical and lead the cycle by one quarter, as shown in panel (a). The average coefficient of correlation between output and lagged gross capital inflows is relatively high with 0.44. This pro-cyclicality is less pronounced in developed economies. Panel (b) shows a flat curve for developed economies which translate into lower cross-correlations and peak on average two periods before the cycle with a correlation coefficient of 0.35. The pro-cyclical pattern of gross capital inflows gets more distinct if one devides the emerging market economies in a low risk sample and a high risk sample. For this purpose, I evaluated over the period 2001q1 to 2010q4 the average OECD's Historical Country Risk Classification which measures a country's credit risk on a scale between 0 (lowest risk) and 7 (highest risk). The resulting high risk group includes Argentina, Brazil, Bulgaria, Indonesia, Latvia, Peru, Romania, Russia, South Africa and Turkey and exhibits an average rating of 4.6. The low risk group has an average rating of 2.1 and covers Chile, Czech Republic, Estonia, Hungary, Israel, Korea, Mexico, Poland, Slovak Republic and Thailand. This information is summarized in panel (c). A country's credit risk increases significantly the pro-cyclical pattern of gross capital inflows. High risk countries have a coefficient of correlation of 0.54 versus 0.35 for the low risk group. This result corresponds with the empirical findings of Meller (2011). However, a counter-cyclical correlation cannot be observed. A final observation on the evolution of the pro-cyclical pattern of gross capital inflows over time is presented in panel (d). The lead lag strucure for the longest available series are confronted with the recent period of financial globalisation, i.e. the years 2000 to 2010. For both emerging and developed economies, the pro-cyclical pattern has increased over time. The stylized facts presented in Figure 2 lead me to the hypothesis that pro-cyclical capital inflows may drive the business cycle in financially more risky emerging market economies, and that the recent period of financial globalisation may have assisted this channel. The next section provides an explanation for the pro-cyclical nature of gross capital inflows in the form of a theoretical model.

3.2 Mexican business cycle statistics

Next, standard business cycle statistics for the Mexican economy are briefly presented in order to be able to evaluate the model quantitatively. The novelty here is that the co-movement of financial sector variables is included.

Data on output, private consumption, investment and the trade balance comes from the IMF International Financial Statistics and ranges from 1981q1 to 2011q1. The quartely levels series is deflated and de-saisonalized by the Census X12 procedure. The logged data is detrended using the HP-filter. Balance sheet information for the Mexican financial sector comes from the national banking and securities commission, CNBV. It provides historical monthly balance sheet data on all banks belonging to the universal banking scheme, including foreign owned subsidiaries. These commercial banks control more than 50 percent of Mexico's financial system (Banco de México, 2010). From this data I construct quarterly series from 2001q1 to 2010q4 for bank equity, assets and liabilities. Financial data is logged and detrended by the appropriate HP-filter. Table 1 summarizes the results.

In the real sector, Mexico exhibits typical emerging market business cycle facts. These are a relative volatility of consumption over output greater than one, denoted as excess volatility in consumption, high investment volatility with a standard deviation of 7.16, and a strongly counter-cyclical current account. On the financial side, I document bank equity[2] n_t and bank leverage ratio ϑ_t as the ratio of intermediated assets over bank capital. Both bank equity and the leverage ratio are more volatile than output. Besides, the leverage ratio seems a-cyclical or only mildly counter-cyclical, whereas bank equity is moderately pro-cyclical. There is strong empirical persistence in financial sector variables with an autocorrelation coefficient close to 0.7.

4 The Model

The core framework is a neoclassical model of a small-open economy (SOE) where the net foreign asset position is made stationary through portfolio adjustment costs, as discussed in Schmitt-Grohé and Uribe (2003). I augment this model with a financial sector based on GK, which is therefore adapted to the open economy setting. These changes to the otherwise standard SOE model are needed to account for a certain type of financial friction related to emerging market economies (EME). There are four types of agents in the model economy: households, financial intermediaries[3], non-financial firms, and capital producers. Capital producers are needed to introduce capital adjustment costs. Financial intermediaries are owned by domestic households and mainly invest international capital in shares of non-financial

---

[2]Bank equity, bank net worth and bank capital are used interchangeably throughout this paper.

[3]In the following, I will use 'financial intermediaries' and 'banks' interchangeably, both meaning the same, i.e. the financial sector of the model economy.

domestic firms. An agency problem between financial intermediaries and foreign lenders produces an endogenous borrowing constraint on the leverage ratio in the financial sector and induces a financial accelerator mechanism as in Bernanke et al. (1999). Since the real side of the economy depends through the issuance of shares on bank finance for the purchase of physical capital, the international borrowing constraint effectively limits domestic production. As the discussion of the quantitative results will show, this set-up changes the transmission channel of different shocks which have been considered in the literature.

4.1 Households

There is a measure one continuum of identical households in the economy. Households engage in consumption, borrowing and labor supply. In period t, the representative household borrows the amount d_{t+1}^H at international financial markets for consumption smoothing purposes at the international non-contingent gross real interest rate R_t. This interest rate is a stochastic country specific rate and represents the actual effective interest rate which domestic agents face if they intend to borrow at international capital markets.

In each household, there is a fraction $1 - f$ of workers and a fraction f of bankers. Workers supply labor to the non-financial sector and receive the wage rate w_t in return. Bankers own the financial intermediaries and contribute to the household's income by transferring any profits from intermediation back to the household. Within each household, there is perfect consumption insurance. Bankers face a finite horizon in order to prevent that they can finance their entire activities from equity capital. Specifically, bankers have a non-contingent probability to exit the financial sector of $1 - \theta$, which entails an average survival time in the financial sector of $1/(1 - \theta)$ and leads to the amount $f(1 - \theta)$ of bankers leaving their sector each period. In order to keep a constant ratio of workers and bankers in the model economy, the same amount of workers switches to the financial sector. Bankers who exit give their accumulated earnings to the household. New bankers will be provided with start up funds from the household which will be specified later.

Households have GHH-prefereces (Greenwood et al., 1988) and choose their level of consumtion (c_t), labor supply (l_t) and next period's debt level (d_{t+1}^H) to maximize expected utility

$$\max_{\{c_t, l_t, d_{t+1}^H\}} \sum_{i=0}^{\infty} \beta^i \left[\frac{(c_t - \omega^{-1} l_t^\omega)^{1-\gamma} - 1}{1 - \gamma} \right], \tag{1}$$

subject to a flow budget constraint

$$d^H_{t+1} + w_t l_t + \Pi_t = R_t d^H_t + c_t + \Psi(d^H_{t+1} - \bar{d}^H), \qquad (2)$$

with $\beta \in (0,1)$ denoting the subjective discount factor and Π_t the sum of profits from financial intermediaries net of start up funds, which are transfered in a lump sum to the household at the end of each period.

International borrowing is subject to frictions in the form of portfolio adjustment costs, $\Psi(d^H_{t+1} - \bar{d}^H)$. These costs are convex in deviations from the steady state net foreign asset position. The household's corresponding optimality conditions for labor supply and saving are given by

$$l_t^{\omega-1} = w_t, \qquad (3)$$
$$\beta E_t\left[\Lambda_{t,t+1}(R_{t+1})\right] = 1 - \Psi'(d^H_{t+1} - \bar{d}^H), \qquad (4)$$
$$\text{with} \quad \Lambda_{t,t+1} \equiv \frac{(c_{t+1} - \omega^{-1} l_{t+1}^\omega)^{-\gamma}}{(c_t - \omega^{-1} l_t^\omega)^{-\gamma}}.$$

The first equation sets the marginal rate between consumption and leisure equal to the wage rate. The second condition is the Euler equation for consumption adjusted for portfolio adjustment costs.

4.2   Financial Intermediaries

Financial intermediaries are owned by domestic households. Banks' equity stock equals the amount of net worth n_{jt} that a bank j holds at the end of period t. Banks obtain in period t non-contingent debt from international financial markets d^B_{jt+1} and use this for domestic investment activities. To understand their role in the model economy, one might think of specialists who provide their informational advantage over domestic non-financial firms to foreign investors.[4] Banks extend foreign funds to the real sector of the model economy by acquiring financial claims, i.e. shares, from non-financial firm j, denoted by s_{jt}, at the price q_t. Hence, they effectively own the non-financial sector. The emerging contract is a state-contingent equity aggreement which yields in the subsequent period the gross rate R^k_{t+1}. Thus, bank $j's$ balance sheet at the end of period t is given by

$$q_t s_{jt} = n_{jt} + d^B_{jt}, \qquad (5)$$

where bank assets can be found on the left hand-side whereas equity and liabilities are to be found on the right hand-side of the balance sheet identity.

---

[4]According to Diamond (1984), it is optimal to delegate monitoring activities to local financial intermediaries if they have a comparative advantage of seeking information about domestic investment projects.

Bank $j's$ payoffs in the following period determine the law of motion of its net worth position which yields in combination with the definition of the bank's balance sheet (5)

$$n_{jt+1} = (R_{t+1}^k - R_{t+1})q_t s_{jt} + R_{t+1}n_{jt}. \tag{6}$$

Growth in net worth beyond the riskless rate can only materialize over increasing quantities of assets, $q_t s_{jt}$, or in the interest rate premium, $R_{t+1}^k - R_{t+1}$. When the bank receives payments on its shares, it repays international investors. In order to set an incentive for the bank to engage in financial intermediation, the discounted risk adjusted interest rate premium should be positive at all times:

$$E_{t+i}\beta^i \Lambda_{t,t+1+i}(R_{t+1+i}^k - R_{t+1+i}) \geq 0 \qquad \vee\, i \geq 0. \tag{7}$$

Note that the intermediary uses the household's discount factor, since it is owned by the latter. This motivates the banks' objective to maximize terminal wealth which can be carried over to the household at the end of its lifetime. Formally, bankers maximize end of lifetime net worth over the choice of shareholding:

$$V_{jt} = \max_{\{s_{jt}\}} E_t \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i} n_{jt+1+i} \tag{8}$$

$$\text{with} \quad n_{jt+1+i} = (R_{t+1+i}^k - R_{t+1+i})q_{t+i}s_{jt+i} + R_{t+1+i}n_{jt+i} \tag{9}$$

Given a positive premium, financial intermediaries have an incentive to borrow an infinite amount internationally in order to finance asset purchases. To limit this possibility for arbitrage, I follow GK and adopt a moral hazard problem between international investors and domestic banks. Accordingly, each period bankers have the possibility to divert the time-dependent fraction λ_t of assets and take it home to the household of which the banker is a member. In this case, the international investor has the imminent threat to force the financial intermediary into bankruptcy and to recover the share $1 - \lambda_t$ of the bank's assets.[5]

---

[5]This is a short-cut to implement the idea of a costly state verification setting due to asymmetric information as shown by Townsend (1979) in a macro model. Holmström and Tirole (1997) show in a model with uninformed investors, capital constrained financial intermediaries and firms how bank monitoring helps firms to pledge a higher share of project returns to potential investors, establishing that monitoring and collateral are partial substitutes. Since intermediaries themselves have a moral hazard problem due to costly monitoring on their side, uninformed investors enforce market-determined leverage ratios. Hence, the amount of uninformed capital that an intermediary can attract depends on banks' capital.

A major departure from GK is to allow for a financial shock on the incentive compatibility constraint. This introduces a new source of risk into the economy, namely the unexpected need for the financial sector to restructure its balance sheet. This is ment to be a short cut for the refinancing risk of banks at international capital markets. Formally,

$$\lambda_t = \bar{\lambda} \varrho_t, \tag{10}$$

with $\bar{\lambda}$ denoting the steady state value of the incentive constraint. The financial shock ϱ_t is orthogonal to bank net worth and represents an exogenous disturbance to bank refinancing.[6] It's law of motion will be specified below. To motivate the idea of an additional refinancing restriction for EME at international capital markets, one might think of an anxious international investor in the sense of FG who looses appetite for emerging market assets in times of global insecurity.[7] The opposite case is also conceivable. During times of capital inflow surges, international investors are over optimistic and accept higher leverage ratios in the financial sector of a country so that they can participate in the boom. In both cases, in order to assure that financial intermediation takes place, the following incentive compatibility constraint must hold at all times:

$$V_{jt} \geq \lambda_t q_t s_{jt} \tag{11}$$

Only if the continuation value for the banker on the left-hand side is higher than the value to divert funds on the right-hand side, the international lender can be sure that she is not going to be defrauded and, thus, allows capital to flow into the country. If the lending premium for the financial intermediary is positive, it is clear that this equation holds with equality at all times, since the bank will expand its activities up to the point the incentive compatibility constraint is binding. Resuming the banks optimization problem, optimal share holding is fully pinned down by period t net worth.

Proposition 1. *The solution to the bank's maximization problem can be expressed as*

$$V_{jt}^* = \upsilon_t q_t s_{jt} + \eta_t n_{jt}, \tag{12}$$

with

$$\upsilon_t = E_t \left[(1-\theta)\beta\Lambda_{t,t+1}(R_{t+1}^k - R_{t+1}) + \beta\Lambda_{t,t+1}\theta\chi_{t,t+1}\upsilon_{t+1} \right], \tag{13}$$

$$\eta_t = E_t \left[(1-\theta)\beta\Lambda_{t,t+1}(R_{t+1}) + \beta\Lambda_{t,t+1}\theta Z_{t,t+1}\eta_{t+1} \right] \tag{14}$$

---

[6]Jermann and Quadrini (ming) analyze a similar financial shock to borrowing capacities of firms in a closed economy.

[7]A further possible microfoundation could be that an anxious investor perceives a deterioration of her monitoring capability in times of global distress and requires in response higher bank capital levels for monitoring intense activities.

where $\chi_{t,t+1}$ and $Z_{t,t+1}$ denote bank $j's$ growth rate of asset holding and its net worth respectively, thus $\chi_{t,t+1} = q_{t+1}s_{jt+1}/q_t s_{jt}$ and $Z_{t,t+1} = n_{jt+1}/n_{jt}$.

Proof. See appendix. ‖

The variable v_t can be interpreted as the expected discounted marginal gain to the banker of additional shareholding $q_t s_{jt}$, by receiving one more unit of international capital and holding net worth n_{jt} constant. In turn, η_t describes the expected discounted marginal return of having one additional unit of n_{jt}, holding s_{jt} constant. The value of v_t is related to the positive premium requirement in (7). While in frictionless competitive capital markets this premium would vanish, thus v_t would equal zero, the here adapted agency problem limits the volume of financial intermediation such that the premium stays positive in equilibrium.

It can be shown that shareholding in the financial sector in equilibrium is determined by banks' net worth. First, note from equations (11) and (12) that the incentive compatibility constraint can be rewritten as

$$v_t q_t s_{jt} + \eta_t n_{jt} \geq \lambda_t q_t s_{jt}.$$

Given that the constraint binds in equilibrium, asset holding by financial intermediaries can be expressed in terms of the bank's net worth position:

$$q_t s_{jt} = n_{jt}\frac{\eta_t}{\lambda_t - v_t} \tag{15}$$

This relation balances the banker's incentives to defraud on international investors by equating the banker's expected gains and losses from doing so. Holding n_{jt} constant and increasing s_{jt} would break this balance and create an incentive for the banker to divert funds. Substituting in twice the balance sheet definition into the equation above yields bank j's leverage ratio as the relation of intermediated assets over equity:

$$\frac{q_t s_{jt}}{n_{jt}} = \frac{\eta_t}{\lambda_t - v_t} \tag{16}$$

As can be seen from this equation, the leverage ratio on the LHS is defined by non firm-specific components on the RHS. This allows us to obtain aggregate demand for assets and the aggregate net worth position of the financial sector by summing over all individuals

$$q_s s_t = \frac{\eta_t}{\lambda_t - v_t}n_t = \vartheta_t n_t \tag{17}$$

with ϑ_t denoting aggregate leverage ratio in the financial sector in period t.

Next, turning to the aggregate law of motion of the financial sector's net worth, remember that aggregate net worth n_t is a composite of existing financial intermediaries n_t^e and newly entering banks n_t^n:

$$n_{t+1} = n_{t+1}^e + n_{t+1}^n \tag{18}$$

Since the survival probability of existing bankers is known, the aggregate net worth position of existing bankers n_t^e is given from the transition equation for net worth (6)

$$n_t^e = \theta \left[(R_{t+1}^k - R_{t+1}) \frac{\eta_t}{\lambda_t - v_t} + R_{t+1} \right] n_t. \tag{19}$$

As it was mentioned already in the discussion of the household's problem, newly entering bankers obtain startup transfers from the household. Similar to GK, these transfers amount to the time invariant fraction $\nu/(1-\theta)$ of the value of assets that exiting bankers had in their final operating period on their balance sheet

$$n_t^n = (1-\theta)\frac{\nu}{(1-\theta)} q_t s_t = \nu q_t s_t. \tag{20}$$

Following (18), (19) and (20), the aggregate net worth position of the financial sector evolves according to:

$$n_{t+1} = \theta \left[(R_{t+1}^k - R_{t+1}) \frac{\eta_t}{\lambda_t - v_t} + R_{t+1} \right] n_t + \nu q_t s_t \tag{21}$$

4.3   Non-Financial Firms

There is a competitive non-financial sector in the model economy. Firms engage in the production of a single tradable retail good which serves as numeraire. Production takes place according to a standard Cobb-Douglas production technology

$$y_t = z_t k_t^\alpha h_t^{1-\alpha}, \tag{22}$$

where k_t denotes the capital stock, h_t labor input and z_t is an standard transitory shock on aggregate productivity.

When output is available to the firms at the end of the period, the wage bill $w_t h_t$ are paid to the households. Depreciated capital $(1-\delta)k_t$ is sold to capital producers at the unitary price of q_t and the new capital stock k_{t+1} is purchased for production purposes in the subsequent period. New capital

is financed by issuing shares which are bought by financial intermediaries according to the following pricing equation:

$$q_t s_{jt} = q_t k_{t+1} \tag{23}$$

This condition equates the price of a unit of capital to the price of a financial claim. The arising equity contract between the bank and the non-financial firm yields the state-contingent real gross interest rate R_t^k. Thus, firms' payments to their shareholders amount to $R_t^k(q_t s_{jt-1})$ which implies zero profits in the non-financial sector. The underlying assumption is that this funding relationship contains no frictions. Specifically, since the security offered by non-financial firms is perfectly state-contingent, there are no frictions that hinder firms to obtain funds from financial intermediaries. However, since banks suffer from the agency problem on international financial markets, physical capital purchases are indirectly affected through this constraint. Firms maximize profits according to

$$
\begin{aligned}
\max_{\{k_{t+1+i}, h_{t+i}\}} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} &\left[z_{t+i} k_{t+i}^\alpha h_{t+i}^{1-\alpha} - w_{t+i} h_{t+i} \right. \\
&\left. -(R_{t+i} - 1)\kappa_{t-1} - R_{t+i}^k q_{t+i} s_{t-1+i} + (1 - \delta) k_{t+i} q_{t+i} \right]
\end{aligned} \tag{24}
$$

subject to the pricing equation (23). Note that firms use the household's discount factor, as they are indirectly owned by the latter. The firm's maximization problem yields the following first order conditions for factor demand:

$$
\begin{aligned}
(1 - \alpha) z_t k_t^\alpha h_t^{-\alpha} &= w_t \tag{25} \\
E_t \left(\alpha z_{t+1} k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} \right) &= E_t \left(R_{t+1}^k q_t - q_{t+1}(1 - \delta) \right) \tag{26}
\end{aligned}
$$

The labor demand equation (25) sets the marginal product of labor equal to the wage rate. Capital demand equates the marginal product of capital to the rental rate of capital net of depreciation. From (26) follows the law of motion for return on capital:

$$
R_{t+1}^k = \frac{\alpha \frac{y_{t+1}}{k_{t+1}} + q_{t+1}(1 - \delta)}{q_t} \tag{27}
$$

4.4 Capital Producers

The form of capital producers are adopted from Bernanke et al. (1999) in order to account for sufficient variation in the endogenous price of capital.

14

Furthermore, capital adjustment costs are typically needed in small open-economy models to reduce investment volatility (Mendoza, 1991).

There is a competitive sector of identical capital producing firms which is owned by households. Capital producers buy at the end of each period the depreciated capital stock $q_t(1-\delta)k_t$ from non-financial firms and invest the amount i_t which yields the gross newly built capital $\Phi\left(\frac{i_t}{k_t}\right)k_t$. Only net investment is subject to quadratic adjustment costs, which are governed by the function $\Phi\left(\frac{i_t}{k_t}\right)$, which satisfy $\Phi(\delta) = \delta$ and $\Phi'(\delta) = 1$. Hence, adjustment costs are zero in the deterministic steady state. Capital producers sell the newly produced capital stock k_{t+1} at the competitive price q_t to non-financial firms. Thus, there are zero profits in the market for capital goods. The related profit maximization problem takes the form

$$\max_{\{i_{t+i}\}} E_t \sum_{i=0}^{\infty} \beta^i \Lambda_{t,t+i} \left[q_t k_{t+1} - q_t(1-\delta)k_t - i_t\right], \tag{28}$$

subject to the law of motion of the capital stock

$$k_{t+1} = (1-\delta)k_t + \Phi\left(\frac{i_t}{k_t}\right)k_t, \tag{29}$$

$$\text{with} \quad \Phi\left(\frac{i_t}{k_t}\right) = \left[\frac{i_t}{k_t} - \frac{\phi}{2}\left(\frac{i_t}{k_t} - \delta\right)^2\right]. \tag{30}$$

This maximization problem yields the traditional q-relation for investment in physical capital:

$$q_t = \left[1 - \phi\left(\frac{i_t}{k_t} - \delta\right)\right]^{-1} \tag{31}$$

4.5 Closing the model

Finally, the exogenous processes for $[z_t, \varrho_t]_{t=0}^{\infty}$ and the trade balance need to be specified.

Total factor productivity z_t is a standard independent and identically distributed shock which is described by the following process:

$$ln(z_t) = \rho_z ln(z_{t-1}) + \varepsilon_t^z, \quad \text{with} \quad \varepsilon_t^z \sim \mathcal{N}(0, \sigma_z^2) \tag{32}$$

The financial shock ϱ_t is also modelled as an *i.i.d.* financial shock to the investor's risk perception:

$$ln(\varrho_t) = \rho_\varrho ln(\varrho_{t-1}) + \varepsilon_t^\varrho, \quad \text{with} \quad \varepsilon_t^\varrho \sim \mathcal{N}(0, \sigma_\varrho^2)$$

This approach allows for the analysis of an isolated shock on the capability of banks to refinance their activities at international financial markets which is orthogonal to financial sector variables or domestic fundamental changes.

The trade balance-to-output ratio in this model amounts to aggregate production, less domestic absobtion and transaction costs due to investment and portfolio adjustments, divided by output:

$$tby_t \;\; = \;\; 1 - \frac{c_t + i_t + \Psi(\cdot) + \Phi(\cdot)}{y_t} \tag{33}$$

Given the previous model description, the decentralized equilibrium is defined as a stochastic sequence of allocations $\big[c_t, l_t, d_{t+1}^H, s_t, n_t, \eta_t, \upsilon_t, \vartheta_t, d_{t+1}^B,$ $h_t, k_{t+1}, i_t, y_t, tby_t\big]_{t=0}^\infty$ and prices $\big[q_t, w_t, r_t^k\big]_{t=0}^\infty$ that, given the initial capital stock k_0, the initial debt positions of households and banks, d_0^H and d_0^B, and the exogenous processes $[z_t, \varrho_t]_{t=0}^\infty$, satisfies i) the optimality conditions of all agents in the model and ii) market clearing on all markets.

5 Model analysis

5.1 Calibration

The model's parameters are listed in Table 2. Baseline parameter values are chosen to fit Mexican long-run data moments. For better comparability, I adopt the calibration of Uribe and Yue (2006, henceforth UY) if possible, who themselves calibrate their model to Mexican data and refer to Mendoza (1991) for standard values. From the latter I retain the values for the capital share of output, the coefficient of risk aversion, the wage elasticity of labor supply and the capital adjustment cost parameter, which are $\alpha = 0.32$, $\gamma = 2$, $\omega = 1.455$, and $\phi = 0.028$ respectively. The depreciation rate of the capital stock $\delta = 0.058$ is chosen to match the empirical ratio of investment to GDP of 19.5 percent. The steady state level of household debt is calibrated to yield a ratio of household debt to GDP of 10 percent. I use the estimate of UY for the adjustment cost coefficient of household debt $\psi = 0.00042$ which is very close to the value used by Schmitt-Grohé and Uribe (2003) and limits the role of debt adjustment costs to render the net foreign asset position stationary. UY calibrate the gross real interest rate R according to historical EMBI spreads for a sample of seven emerging market economies. The resulting average quarterly rate of 2.77 percent is consistent with an annualized rate of about 11 percent which split up into an average spread of 7 percent and a world interest rate of 4 percent.

Turning next to the financial sector variables, I proceed according to the calibration strategy of GK. The steady state divertable fraction of bank assets $\bar{\lambda} = 0.08$ is chosen to yield a long-run leverage ratio of 11.6 which is taken from Mexican financial sector data. Although the average Mexican leverage ratio in the financial sector shows a downward trend[8] (see Figure 3), taking the mean over the available sample period is a reasonable approximation to the data. The parameter which governs the fraction of the exiting banks' net worth which turns into start-up funds for new bankers $\nu = 0.00016$ yields an average spread of 95 basispoints. This corresponds to the average empirical spread between the international interest rate R and the domestic lending rate. The survival probability of bankers $\theta = 0.877$ yields an average survival time of 2 years for bankers.

The shock processes are also empirically disciplined. In the baseline specification with both shocks, the standard deviation of the shocks and the autocorrelation parameters are chosen to match the volatility and persistence of output fluctuations and the leverage ratio. This yields a value of $\sigma_z = 1.0467$ percent and persistence $\rho_z = 0.3925$, which is quite close to what Mendoza (2010) finds empirically (0.0134 and 0.537). The financial shock parameters on ϱ_t take a standard deviation of $\sigma_\varrho = 0.7944$ percent and persistence $\rho_\varrho = 0.9367$. In the specification with only technology shocks, the moments of the output variable serve as the only target, which yiels $\sigma_z = 1.0549$ percent and $\rho_z = 0.4014$. Finally, in the specification with only financial shocks and only the moments of the leverage ratio serving as calibration targets, one obtains $\sigma_\varrho = 2.1523$ percent and $\rho_\varrho = 0.7669$.

5.2 Transmission of shocks

Figure 4 plots the impulse responses for a one standard deviation productivity shock of the specification with technology shocks only. I contrast the financial sector model (FSM) with a standard model of a small open economy with portfolio adjustment costs (SOE) as in Schmitt-Grohé and Uribe (2003) and the same calibration of preferences and the production side as reported in Table 2. The severe drop of asset prices in the FSM is due to the endogenous financial accelerator mechanism. Given the lower productivity in the initial period, the return on capital R_t^k that bankers earn on shares currently on their balance sheets drops and lowers the spread which

---

[8]A stronger capitalization of the Mexican banking sector is due to increased foreign ownership since liberalizing the financial sector in 1997 (Hernández-Murillo, 2007) and enhanced cooperation with the Basel Committee on Banking Supervision in regulatory issues (Banco de México, 2010).

constitues the marginal gain of bankers to hold assets. Hence, the purchase of shares is less attractive for banks and reduced demand lowers asset prices. Furthermore, the immediate decline of asset prices reduces bank net worth, thereby limiting the possibility of banks to attract foreign external finance. This explains a strongly pro-cyclical bank net worth position, as reported in Table 3, column (III.1). In order to restore their balance sheets and to fulfill the incentive compatibility constraint inherent to the agency problem, banks sell assets which puts further downward pressure on prices. Opposite to that, the leverage ratio increases, indicating a strong counter-cyclical re-action. This is due to a faster decrease of asset prices relative to bank net worth.

The implications on the real side of the model economy are highly visible on the investment side. Capital producers can sell less capital to non-financial firms, since they are themselves indirectly credit constrained through their issuance of shares to domestic banks. Hence, capital producers curtail invest-ment. This reaction is by far more severe in the FSM and has implications on aggregate output which returns more slowly to its steady state. The strongly counter-cyclical reaction of the trade balance-to-output ratio is primarily due to the heavy reaction of investment, which declines relatively more than out-put. Finally, bank borrowing abroad declines, which is a direct consequence of the interational bank lending channel. The external funding squeeze corresponds to pro-cyclical gross capital inflows.

Turning to the shock on ϱ_t, Figure 5 plots the impulse resonses for a fi-nancial shock as in specification (IV) of Tabel 3. Remember that a shock on the ability of bankers to divert a fraction of bank assets is a disturbance which originates in the agency problem between foreign investors and do-mestic banks. It constitutes therefore a stylized way to model limitations of domestic financial intermediaries to obtain foreign external funding due to the anxiousness of international investors to buy emerging market assets.

The impulse responses show that there is modest endogenous propagation of the shock. All variables have returned after fifteen quarters to their steady state values. If the ability of a banker to divert a fraction of bank assets increases, the international investor forces the financial intermediary to sell assets in the initial period in order to restore the incentive compatibility con-straint. The effect is an initial drop in asset demand, which puts downward pressure on asste prices and induces a direct stall in investment, since banks stop purchasing shares of non-financial firms. Output declines and banks cut back foreign borrowing, leading to pro-cyclical capital inflows. However, cap-ital is still highly productive so that return on capital increases. Asset prices recover fast and exhibit a strong overshooting effect in the first quarter after

the shock occured. Banks' net worth is lifted over steady state and, in turn, banks' leverage ratio drops. As asset prices return to their steady state value over time, the leverage ratio increases while bank net worth decreases. The normalization to steady state values renders the leverage ratio pro-cyclical whereas net worth is counter-cyclical, see Table 3, column (IV).

5.3 Quantitative results

Next, I compare the empirical business cycle statistics in column (I) of Table 3 to the theoretical moments of the model generated in its baseline specification as reported in column (II), using a standard first-order approximation of the log-linearized model. Given that only four moments serve as calibration targets for the shock processes, the overall performance of the financial sector model in the baseline specification is quite satisfying.

Starting with the relative volatility, all variables in the model except consumption are more volatile than output. Therefore, excess volatility of consumption is not a feature detected in the baseline specification. Investment and bank equity are more volatile in the model whereas consumption and the trade balance-to-output ratio are less volatile compared to the data.

Turning to the cyclical pattern of the series shows that all model signs correspond to the signs in the data. In particular, the trade balance-to-output is strongly countercyclical and with a value of -.34 very close to the data. Also consumption and investment are both highly pro-cyclical. On the financial side of the model, the leverage ratio is highly counter-cyclical and bank equity pro-cyclical. However, correlations in the data are much weaker than in the model.

Finally, the serial correlations of model variables come very close to those in the data. All empirical moments exhibit high persistence, which can be reproduced by the model in its baseline calibration. Only the serial correlation of investment is with .10 substantially lower in the model.

5.4 Sensitivity analyis

What are the implications of a substantially lower or higher leverage ratio? To answer this question, I calibrate the model to a steady state leverage ratio of $\vartheta = 6$ and $\vartheta = 15$, respectively, and evaluate the two stochastic shocks in their baseline specification.

Beginning with a transitory adverse shock on productivity, Figure 6 shows that a higher leverage ratio leads to a stronger decline in asset prices. As discussed before, lower capital productivity lowers return on capital and de-

19

creases demand for assets. Since net worth drops slower than asset prices, highly leveraged banks have to shorten their balance sheets more severely than banks with a lower leverage ratio. This leads to a more pronounced financial accelerator in the model economy with higher aggregate leverage ratio. On the real side of the economy mostly investment is affected; implications for output and consumption are very limited. The second moments of real sector variables increase only slightly, as shown in columns V.1 and V.2 of Table 3[9]. A lower leverage ratio reduces the counter-cyclical pattern of the trade balance-to-output ratio due to a less significant reaction of investment.

Also a shock on ϱ_t is amplified in a model economy with a higher leverage ratio, as can be seen in Figure 7. An adjustment of the banker's ability to divert a fraction of bank assets leads to a stronger fire sale of assets in the case of higher leverage ratios, since by construction there are more assets on the balance sheet to divert compared to the bank with a lower leverage ratio. Therefore, the initial decline in asset prices is much more distinct, leading to stronger reactions in the subsequent periods.

6   Conclusion

This paper presents a model of a small open economy with a capital importing financial sector modeled in close analogy to GK. I calibrate the model to Mexican data from the real and financial sector.

The main contribution of the model is that it moves the source of financial frictions for the explanation of stylized emerging market business cycle facts from the corporate to the financial sector of the economy. This allows for the analysis of aggregate financial sector behavior in response to a external funding squeeze at international financial markets, a global shock which can be observed at business cycle frequency for emerging market economies. In particular, the model is based on the strongly pro-cyclical relationship of gross capital inflows. These are assumed to be channeled through domestic financial intermediaries and having an expansionary effect on credit growth and output. If domestic banks have difficulties in accessing international financial markets to fund domestic credit growth, domestic non-financial firms are indirectly credit constrained which reduces aggregate production. This approach is consistent with episodes of *sudden stops* of capital inflows (Calvo et al., 2008), but also with less devastating episodes of a global *anxious economy* (Fostel and Geanakoplos, 2008).

---

[9]Calibration of shocks in the quantitative evaluation of different leverage ratios as in the baseline specification.

The model succeeds relatively well in reproducing key business cycle moments from the real and financial side of the Mexican economy. Bank leverage and bank net worth are more volatile than output and highly persistent. One shortcoming of the setup is that the pro-cyclical behavior of bank net worth and the a-cyclical or mildly counter-cyclical evolution of bank leverage are exaggerated by the model. A main finding of the quantitative excercise is that the inclusion of a financial sector amplifies exogenous shocks which leads to higher output volatility in the case of financial openness. Second, reduced demand for emerging market assets affects the domestic real sector via an international bank capital channel. Since banks need to restore balance sheets, they lower asset demand in the initial period. This shock is endogenously propagated to the real sector by lower investment activities. Third, the intuitive conjecture that financial sectors with lower leverage ratios are better vested to buffer external shocks is confirmed by the model.

Given that capital inflows surges and sudden reversals pose a major challenge to policy makers in emerging market economies, the role of the financial sector in the intermediation of capital flows is still relatively unexplored. The here presented model is a first step to understand the role of a capital importing financial sector for the explanation of domestic aggregate volatility and financial stability in a quantitative framework. Other important questions are left for future research. For example, the inclusion of a domestically funded banking system might help to explain the substitution effects in case of adverse global financial shocks. For the analysis of exchange rate behaviour and the response of a monetary authority in response to changes in international gross capital flows it will be necessary to analyse the international bank capital channel in a New Keynesian environment.

7 References

Aguiar, M. and G. Gopinath (2007). Emerging market business cycles: The cycle is the trend. *Journal of Political Economy 115*(1), 69–102.

Banco de México (2010). Financial system report june 2010.

Benigno, G., H. Chen, C. Otrok, A. Rebucci, and E. Young (2010). Revisiting overborrowing and its policy implications. *CEPR Discussion Paper* (7872).

Berglöf, E., Y. Korniyenko, A. Plekhanov, and J. Zettelmeyer (2009). Understanding the crisis in emerging europe. *EBRD Working Paper* (109).

Bernanke, B., M. Gertler, and S. Gilchrist (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor and M. Woodford (Eds.), *Handbook of macroeconomics Vol.1*, pp. 1341–1393. North-Holland: Elsevier.

Bianchi, J. (2010). Credit externalities: Macroeconomic effects and policy implications. *American Economic Review: Papers & Proceedings 100*, 398–402.

Boz, E., C. Daude, and C. B. Durdu (2008). Emerging market business cycles revisited: Learning about the trend. *International Finance Discussion Papers* (927).

Broner, F. A., T. Didier, A. Erce, and S. L. Schmukler (2010). Gross capital flows: Dynamics and crises. *Banco de Espana Working Paper* (1039).

Brunnermeier, M. K. and L. H. Pedersen (2009). Market liquidity and funding liquidity. *Review of Financial Studies 22*(6), 2201–2238.

Burnside, C., M. Eichenbaum, and S. Rebelo (2001). Prospective deficits and the asian currency crisis. *Journal of Political Economy 109*, 1155–1197.

Burnside, C., M. Eichenbaum, and S. Rebelo (2004). Government guarantees and self-fulfilling speculative attacks. *Journal of Economic Theory 119*(1), 31–63.

Caballero, R. J. and A. Krishnamurthy (2001). International and domestic collateral constraints in a model of emerging market crises. *Journal of Monetary Economics 48*(3), 513–595.

Calvo, G. A., A. Izquierdo, and L.-F. Mijía (2008). Systemic sudden stops: The relevance of balance-sheet effects and financial integration. *NBER Working Paper* (14026).

Calvo, G. A., L. Leiderman, and C. M. Reinhart (1996). Inflows of capital to developing countries in the 1990s. *Journal of Economic Perspectives 10*(2), 123–139.

Chang, R. and A. Fernández (2010). On the sources of aggregate fluctuations in emerging economies. *NBER Working Paper* (15938).

Chang, R. and A. Velasco (2000). Financial fragility and the exchange rate regime. *Journal of Economic Theory 92*, 1–34.

Chang, R. and A. Velasco (2001). A model of financial crises in emerging markets. *Quarterly Journal of Economics 116*(2), 489–517.

Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *Review of Economic Studies 51*, 393–414.

Fostel, A. and J. Geanakoplos (2008). Leverage cycles and the anxious economy. *American Economic Review 98*(4), 1211–1244.

García-Cicco, J., R. Pancrazi, and M. Uribe (2010). Real business cycles in emerging countries? *American Economic Review 100*(2510-2531).

Gertler, M., S. Gilchrist, and F. M. Natalucci (2007). External constraints on monetary policy and the financial accelerator. *Journal of Money, Credit and Banking 39*(2/3), 295–330.

Gertler, M. and P. Karadi (2011). A model of unconventional monetary policy. *Journal of Monetary Economics 58*, 17–34.

Gertler, M. and N. Kiyotaki (2010). Financial intermediaries and credit policy in business cycle analysis. In B. Friedman and M. Woodford (Eds.), *Handbook of Monetary Economics 3A*. North-Holland: Elsevier.

Greenwood, J., Z. Hercowitz, and G. W. Huffman (1988). Investment, capital utilization, and the real business cycle. *American Economic Review 78*(3), 402–417.

Hernández-Murillo, R. (2007). Experiments in financial liberalization: The mexican banking sector. *Federal Reserve Bank of St. Louis Review 89*(5), 415–432.

Holmström, B. and J. Tirole (1997). Financial intermediation, loanable funds, and the real sector. *Quarterly Journal of Economics 112*(3), 663–691.

Jeanne, O. and A. Korinek (2010). Excessive volatility in capital flows: A pigouvian taxation approach. *American Economic Review: Papers & Proceedings 100*, 403–407.

Jermann, U. and V. Quadrini (forthcoming). Macroeconomic effects of financial shocks. *American Economic Review*.

Kaminsky, G. L. and C. M. Reinhart (1999). The twin crises: The causes of banking and balance-of-payments problems. *American Economic Review 89*(3), 473–500.

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

Meh, C. A. and K. Moran (2010). The role of bank capital in the propagation of shocks. *Journal of Economic Dynamics and Control 34*(3), 555–576.

Meller, B. (2011). The two-sided efect of financial globalization on output volatility. *Deutsche Bundesbank Discussion Paper* (7).

Mendoza, E. M. (1991). Real business cycles in a small open economy. *American Economic Review 81*(4), 797–818.

Mendoza, E. M. (2010). Sudden stops, financial crises and leverage. *American Economic Review 100*(5), 1941–1966.

Mihaljek, D. (2010). Domestic bank intermediation in emerging market economies during the crisis: Locall owned versus foreign-owned banks. *BIS Papers* (54), 31–48.

Neumeyer, P. A. and F. Perri (2005). Business cycles in emerging economies: The role of interest rates. *Journal of Monetary Economics 52*(2), 345–380.

Ostry, J. D., A. R. Ghosh, K. Habermeier, L. Laeven, M. Chamon, M. S. Qureshi, and A. Kokenyne (2011). Managing capital inflows: What tools to use? *IMF Staff Position Note*.

Oviedo, M. P. (2005). World interest rate, business cycles, and financial intermediation in small open economies. *Working Paper, Iowa State University* (05018).

Reinhart, C. M. and V. R. Reinhart (2009). Capital flow bonanzas: An encompassing view of the past and present. In J. A. Frankel and C. A. Pissarides (Eds.), *NBER International Seminar on Macroeconomics 2008*, pp. 9–62. Chicago: Univ. of Chicago Press.

Schmitt-Grohé, S. and M. Uribe (2003). Closing small open economy models. *Journal of International Economics 61*, 163–185.

Schmitt-Grohé, S. and M. Uribe (2004). Solving dynamic general equilibrium models using a second-order approximation to the policy function. *Journal of Economic Dynamics and Control 28*(4), 755–775.

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

Uribe, M. and V. Z. Yue (2006). Country spreads and emerging countries: Who drives whom? *Journal of International Economics 69*, 6–36.

A Tables and Figures

Table 1: Mexican empirical business cycle moments

std. deviation		relative volatility		cross-correlation		autocorrelation	
$\sigma(y)$	2.64	$\sigma(c)/\sigma(y)$	1.34	$\rho(c,y)$	.80	$\rho(y_t, y_{t-1})$	.66
$\sigma(c)$	3.55	$\sigma(i)/\sigma(y)$	2.71	$\rho(i,y)$	.76	$\rho(c_t, c_{t-1})$	.64
$\sigma(i)$	7.16	$\sigma(tb)/\sigma(y)$	3.36	$\rho(tby,y)$	-.31	$\rho(i_t, i_{t-1})$	.77
$\sigma(\vartheta)$	4.21	$\sigma(\vartheta)/\sigma(y)$	1.59	$\rho(\vartheta,y)$	-.05	$\rho(\vartheta_t, \vartheta_{t-1})$	.67
$\sigma(n)$	3.07	$\sigma(n)/\sigma(y)$	1.16	$\rho(n,y)$	.29	$\rho(n_t, n_{t-1})$	.68

Source: Mexican national accounts data from IMF IFS, data for the financial sector from national sources (CNBV). See data appendix for details.

Table 2: Baseline calibration

	Parameter	Value
Preferences and production		
Capital share of output	α	0.32
Depreciation rate of capital	δ	0.058
Risk aversion	γ	2
Wage elasticity of labor supply	ω	1.455
Household's discount factor	β	0.973
Interest rate	R	1.0277
Steady state level of household debt to GDP	$\bar{d}^H/\bar{y}$	0.1
Capital adjustment cost coefficient	ϕ	0.028
Portfolio adjustment cost coefficient	ψ	0.00042
Financial sector		
Survival probability of bankers	θ	0.877
Divertable fraction of bank assets in steady state	$\bar{\lambda}$	0.08
Start-up capital of banks	ν	0.00016

Notes: The model is calibrated for quarterly data.

Table 3: Quantitative evaluation of the model

	(I)	(II)	(III.1)	(III.2)	(IV)	(V.1)	(V.2)
	Data	Baseline	TFP Shock		Financial Shock	Sensitivity	
	Mex		FSM	SOE	FSM	$\vartheta = 6$	$\vartheta = 15$
Standard deviations							
$\sigma(y)$	2.64	2.64*	2.64*	2.28	0.95	2.56	2.66
$\sigma(c)$	3.55	2.11	2.12	1.71	0.63	2.05	2.12
$\sigma(i)$	7.16	14.74	13.85	3.91	18.60	11.85	15.95
$\sigma(\vartheta)$	4.21	4.21*	3.45	-	4.21*	3.00	5.07
$\sigma(n)$	3.07	5.44	5.16	-	3.99	3.79	6.41
Relative volatility							
$\sigma(c)/\sigma(y)$	1.34	0.80	0.80	0.75	0.66	0.80	0.80
$\sigma(i)/\sigma(y)$	2.71	5.58	5.25	1.71	19.58	4.63	6.00
$\sigma(tb)/\sigma(y)$	3.36	2.35	2.10	0.63	3.76	1.88	2.59
$\sigma(\vartheta)/\sigma(y)$	1.59	1.59*	1.31	-	4.43	1.17	1.91
$\sigma(n)/\sigma(y)$	1.16	2.06	1.95	-	4.20	1.48	2.41
Cross-correlation							
$\rho(c, y)$	.80	.92	.91	.92	1.00	.92	.92
$\rho(i, y)$	.76	.63	.70	.89	-.28	.62	.62
$\rho(tby, y)$	-.31	-.34	-.41	.45	.38	-.23	-.75
$\rho(\vartheta, y)$	-.05	-.69	-.98	-	.89	-.39	-.35
$\rho(n, y)$	.29	.85	.99	-	-.66	.70	.88
Serial correlation							
$\rho(y_t, y_{t-1})$	.66	.66*	.66*	.49	.75	.62	.67
$\rho(c_t, c_{t-1})$	.64	.75	.75	.65	.76	.73	.75
$\rho(i_t, i_{t-1})$	.77	.10	.11	.24	-.01	.15	.08
$\rho(\vartheta_t, \vartheta_{t-1})$	.67	.67*	.54	-	.67*	.91	.54
$\rho(n_t, n_{t-1})$	.68	.67	.66	-	.39	.86	.57

Notes: Data marked with an asterisk denote calibration targets. Calibration of shocks: Baseline specification (II):$\sigma_z = 0.010467$, $\rho_z = 0.3925$,$\sigma_\varrho = 0.007944$, $\rho_\varrho = 0.9367$. Specification (III.):$\sigma_z = 0.010549$, $\rho(z) = 0.4014$, and $\sigma_\varrho = \rho_\varrho = 0$. Specification (IV.):$\sigma_\varrho = 0.021523$, $\rho_\varrho = 0.7669$, and $\sigma_z = \rho_z = 0$. Specification(V.): as in baseline.
Source: Mexican national accounts data from IMF IFS, data for the financial sector from national sources (CNBV). See data appendix for details.

Table 4: Country sample

Country	Period	Classification	Source
Argentina	1993q1 - 2010q4	Emerging	IMF
Australia	1980q1 - 2011q1	Developed	IMF, OECD
Austria	1988q1 - 2011q1	Developed	IMF
Brazil	1995q1 - 2011q1	Emerging	IMF
Bulgaria	1994q4 - 2011q1	Emerging	IMF
Canada	1980q1 - 2011q1	Developed	IMF, OECD
Chile	1996q1 - 2011q1	Emerging	IMF
Czech Republic	1994q1 - 2011q1	Emerging	IMF
Denmark	1981q1 - 2011q1	Developed	IMF
Estonia	1993q1 - 2010q1	Emerging	IMF
Finland	1980q2 - 2011q1	Developed	IMF
Hungary	1995q1 - 2011q1	Emerging	IMF, OECD
Indonesia	1997q1 - 2011q1	Emerging	IMF
Ireland	1997q1 - 2011q1	Developed	IMF
Israel	1980q3 - 2011q1	Emerging	IMF
Korea	1980q1 - 2011q1	Emerging	IMF, OECD
Latvia	1996q1 - 2011q1	Emerging	IMF
Mexico	1981q1 - 2011q1	Emerging	IMF
Netherlands	1980q1 - 2011q1	Developed	IMF
New Zealand	1987q2 - 2010q4	Developed	IMF, OECD
Norway	1994q1 - 2011q1	Developed	IMF, OECD
Peru	1991q1 - 2010q4	Emerging	IMF
Philippines	1981q1 - 2010q4	Emerging	IMF
Poland	2000q1 - 2011q1	Emerging	IMF, OECD
Portugal	1980q1 - 2011q1	Developed	IMF
Romania	1998q1 - 2011q1	Emerging	IMF
Russia	1994q1 - 2011q1	Emerging	IMF
Slovac Republic	1997q1 - 2010q4	Emerging	IMF
South Africa	1985q1 - 2011q1	Emerging	IMF
Spain	1980q1 - 2011q1	Developed	IMF
Sweden	1980q1 - 2011q1	Developed	IMF
Thailand	1993q1 - 2011q1	Emerging	IMF
Turkey	1989q1 - 2011q1	Emerging	IMF

Notes: Data comes from IMF's International Financial Statistics and OECD's Quarterly National Accounts. Classification of countries evolves according to Aguiar and Gopinath (2007) where applicable. European New Member States are grouped as emerging countries.

Figure 1: Correlations of gross capital inflows with the business cycle.

(a) Emerging market economies

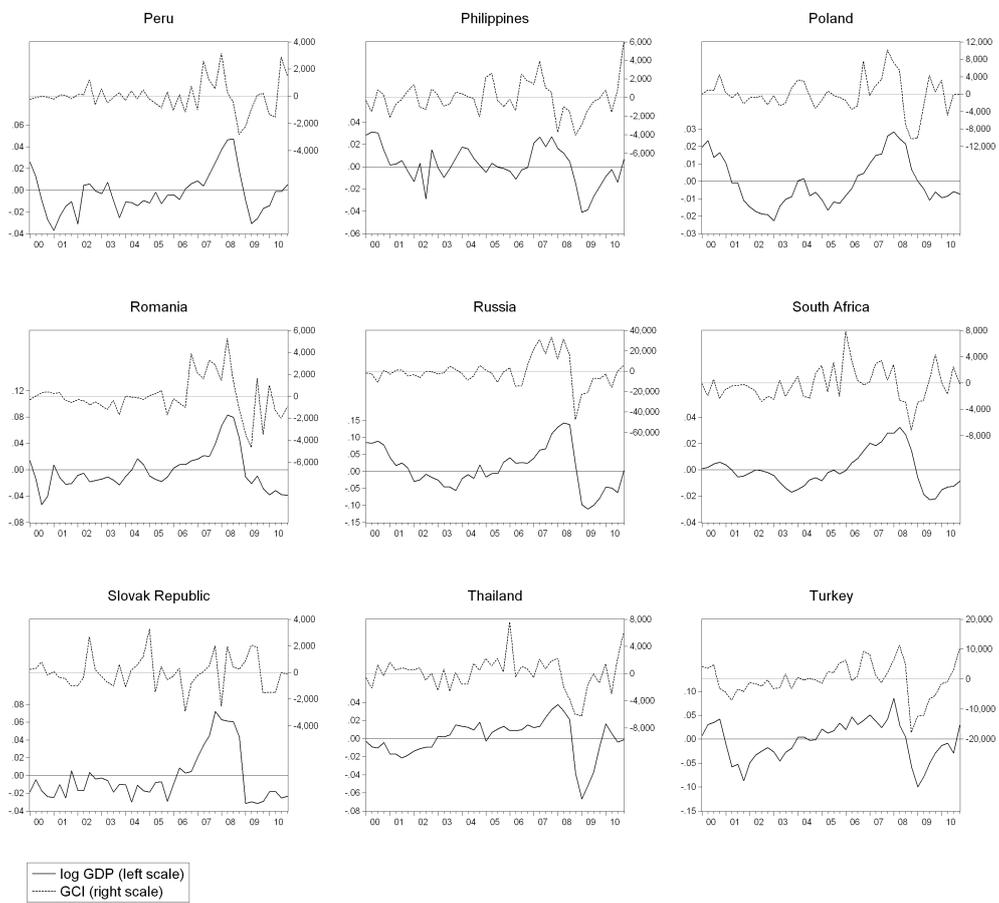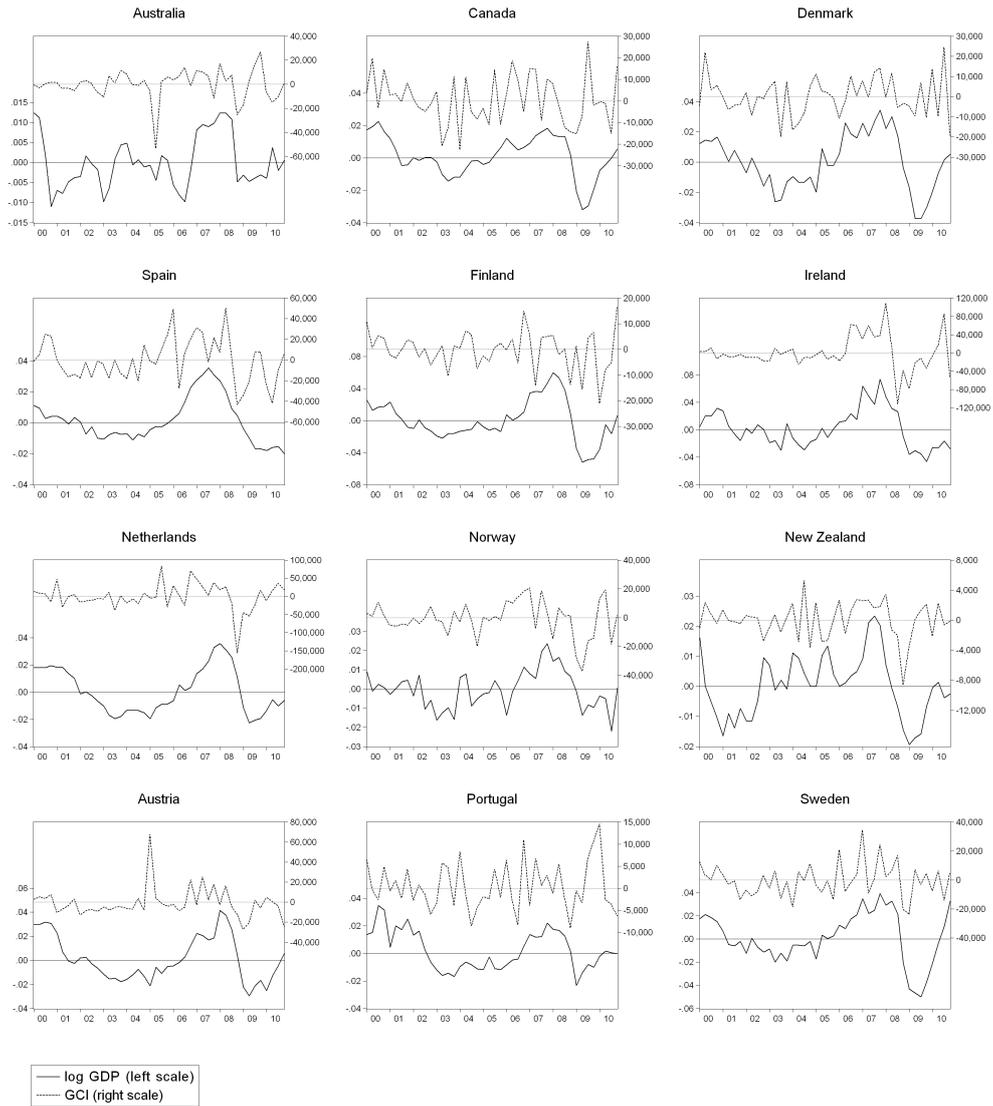Figure 1: [continued]
(a) Emerging market economies (ii)

Peru   Philippines   Poland

Romania   Russia   South Africa

Slovak Republic   Thailand   Turkey

log GDP (left scale)
GCI (right scale)

Figure 1: [continued]

(b) Developed economies

Notes: GDP in percentage deviations from HP-trend, GCI are in deviations from HP-trend.
Source: See data appendix.

Figure 2: Lead-lag structure of cross-correlations.

(a) Emerging market economies

(b) Developed economies

(c) Risk classification

(d) Evolution over time
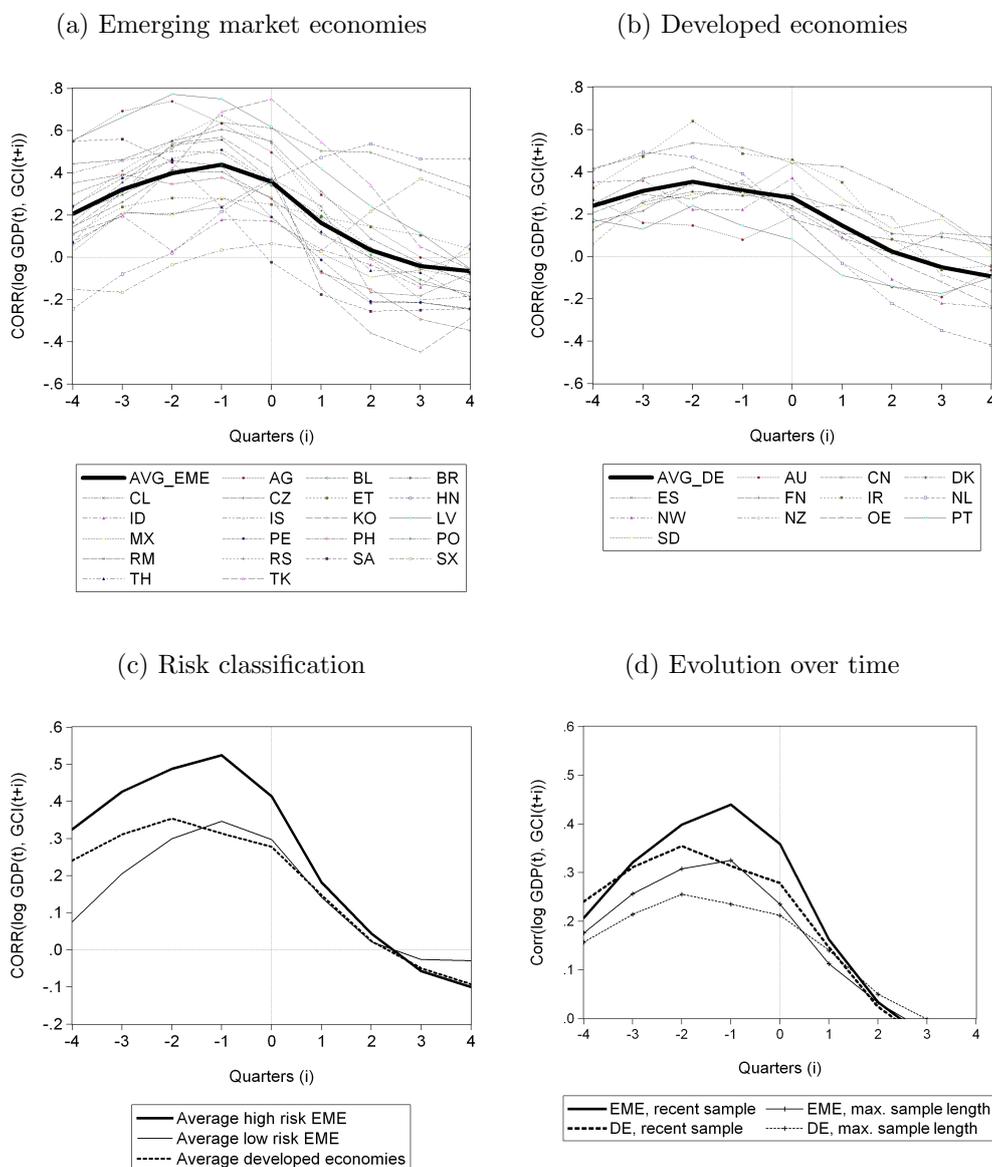
Notes: GDP in percentage deviations from HP-trend, GCI are in deviations from HP-trend.
Panel (a) and (b): Cross-correlations for the period 2000q1-2010q4.
Panel (c): 'High risk' sub-sample: Argentina, Brazil, Bulgaria, Indonesia, Latvia, Peru, Romania, Russia, South Africa, Turkey. 'Low risk' sub-sample: Chile, Czech Republic, Estonia, Hungary, Israel, Korea, Mexico, Poland, Slovak Republic, Thailand. Sample 2000q1 - 2010q4
Panels (d): The 'recent sample' covers 2000q1 - 2010q4. The 'maximum sample length' varies across countries due to data availability, see Table 4 for details.

Country codes: AG=Argentina, AU=Australia, OE=Austria, BR=Brazil, BL=Bulgaria, CN=Canada, CL=Chile, CZ=Czech Republic, DK= Denmark, ET=Estonia, FN=Finland, HN=Hungary, ID=Indonesia, IR=Ireland, IS=Israel, KO=Korea, LV=Latvia, MX=Mexico, NL=Netherlands, NZ=New Zealand, NW=Norway, PE=Peru, PH=Philippines, PO=Poland, PT=Portugal, RM=Romania, RS=Russia, SX=Slovak Republic, SA=South Africa, ES=Spain, SD=Sweden, TH=Thailand, TK=Turkey.
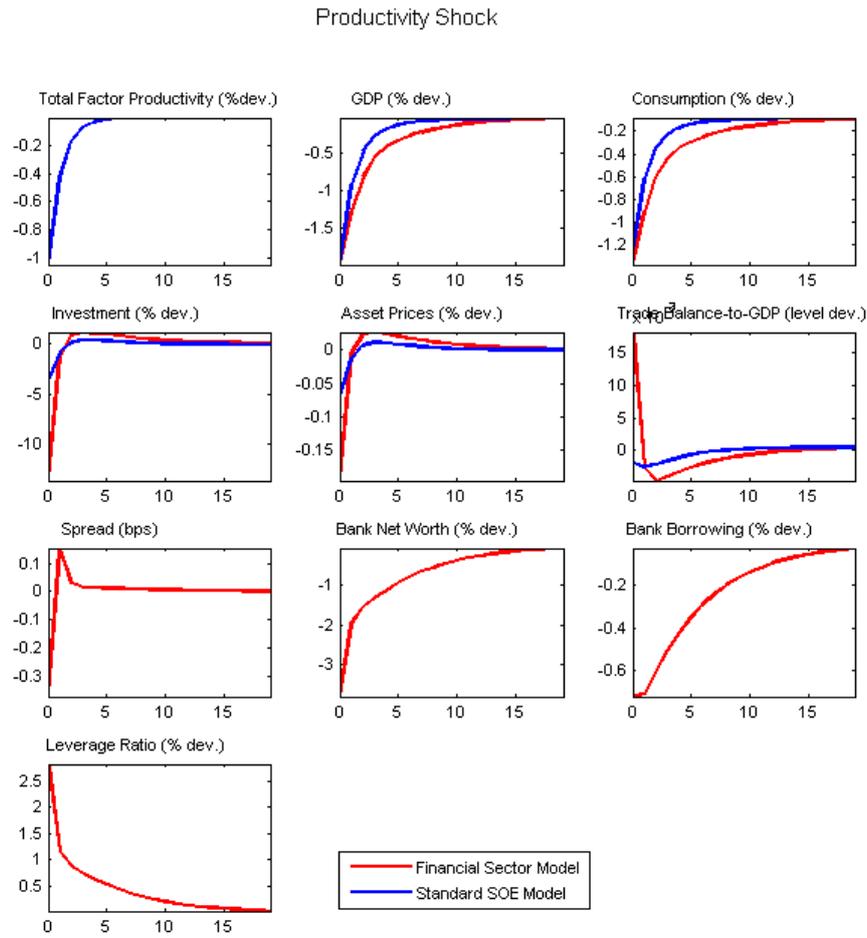
Source: Risk classification according to OECD's Historical Country Risk Classification. See data appendix.

32

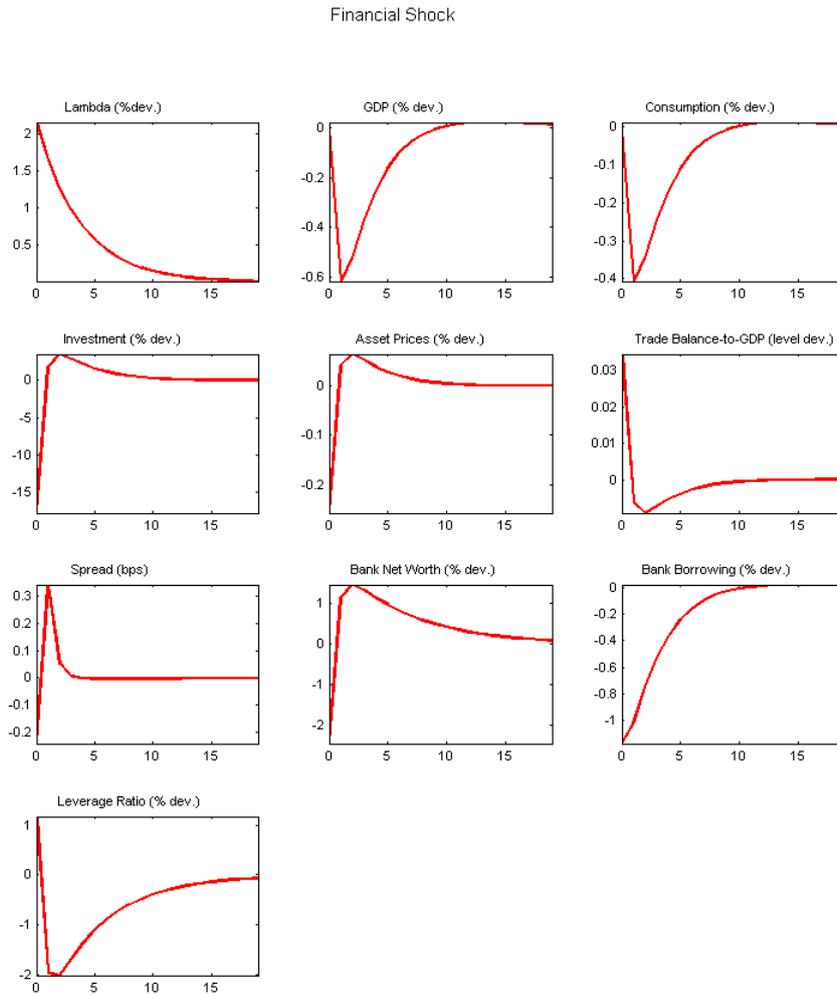Figure 3: Mexican leverage ratio, 2001q1 - 2010q4
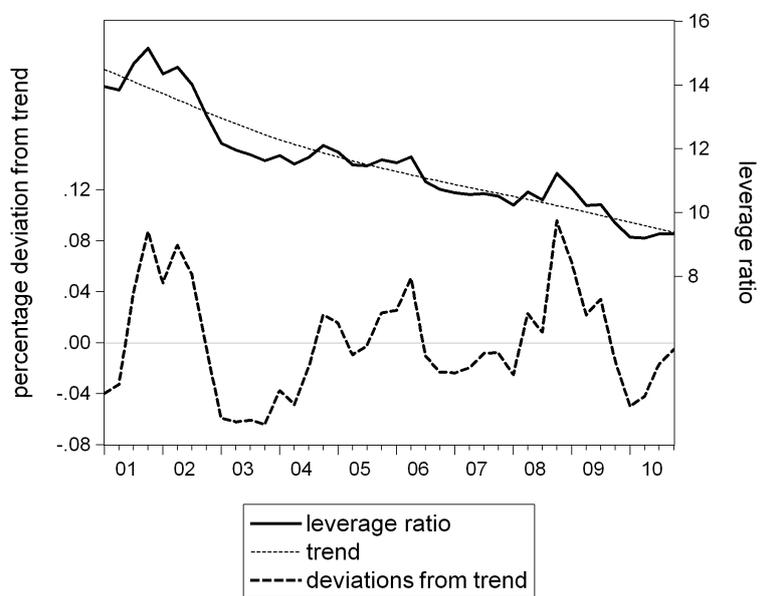
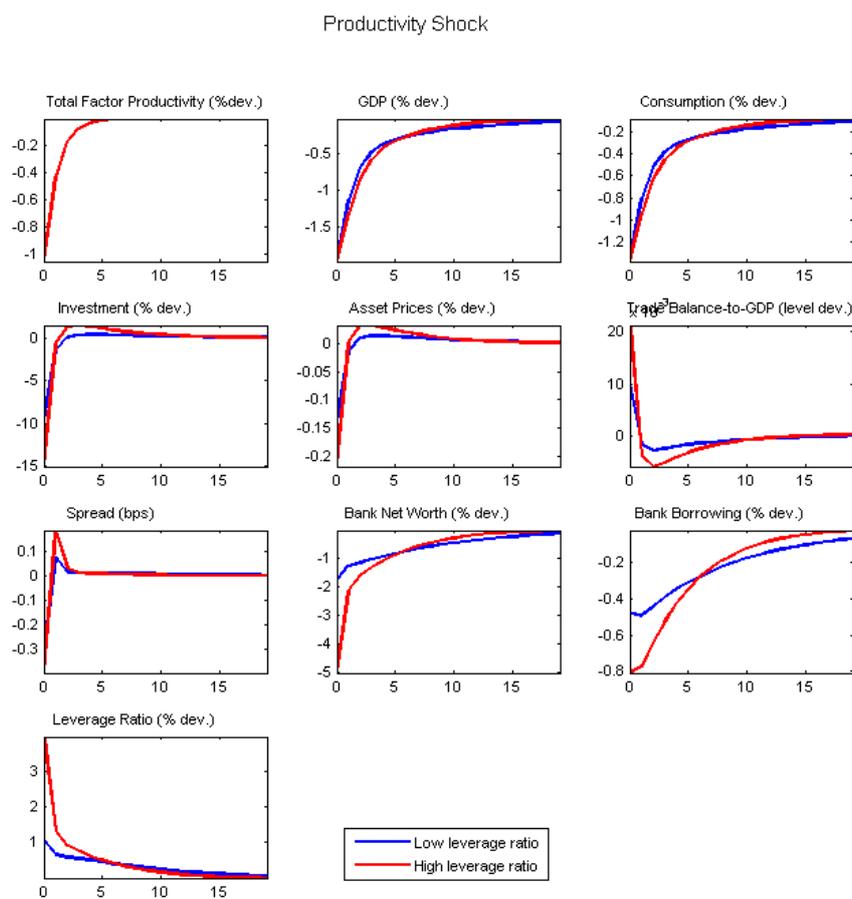# Figure 4: IRFs to a productivity shock

Productivity Shock

Notes: Impulse responses in percentage deviations from steady state. Shock calibrated as in specification (III) of Table 3, i.e. $\sigma_z = 0.010549$, $\rho_z = 0.4014$.

Figure 5: IRFs to a financial shock

Financial Shock

Figure 6: Sensitivity 1: IRFs to a productivity shock with different leverage ratios.

Productivity Shock

Notes: Impulse responses in percentage deviations from steady state. IRF to a productivity shock as in specification (III), i.e. $\sigma_z = 0.010549$, $\rho_z = 0.4014$.

Figure 7: Sensitivity 2: IRFs to a financial shock with different leverage ratios.

Financial Shock
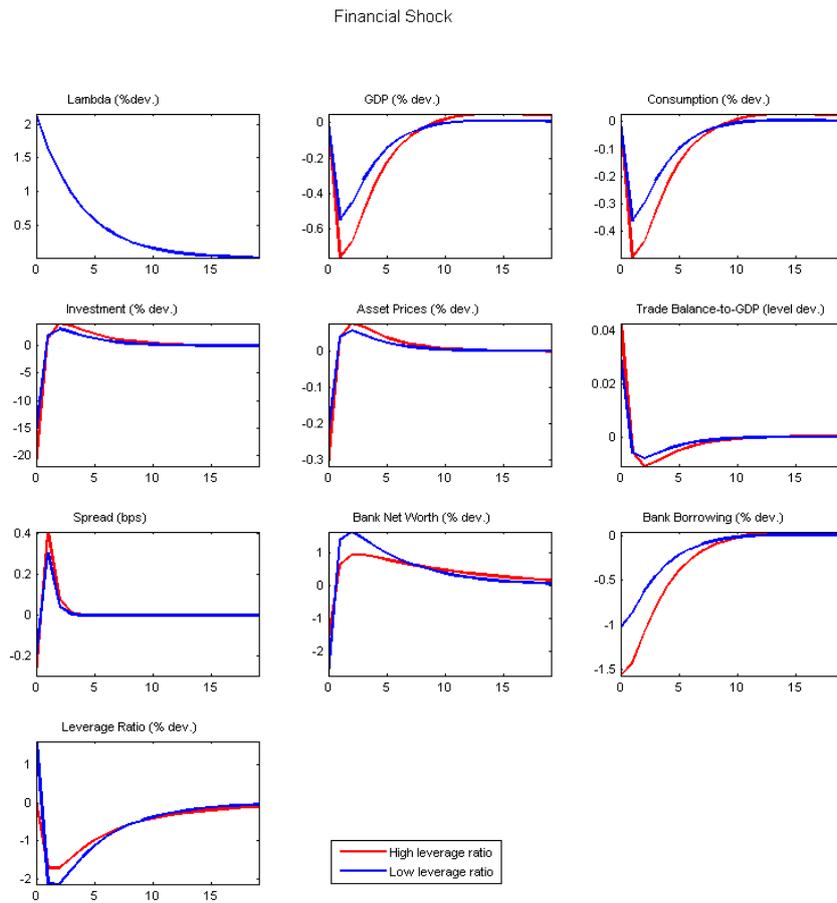
Notes: Impulse responses in percentage deviations from steady state. Shock modeled as in specification (IV) of Table 3, i.e. $\sigma_\varrho = 0.021523$, $\rho_\varrho = 0.7669$.

B   Model Appendix

B.1   Baseline model with capital importing banks

B.1.1   Households

$$\max_{\{c_t, l_t, d_{t+1}^H\}} E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{(c_t - \omega^{-1} l_t^\omega)^{1-\gamma} - 1}{1-\gamma} \right] \tag{B.1}$$

s.t.

$$d_{t+1}^H = (1 + r_t) d_t^H + c_t - w_t l_t + \Psi(d_{t+1}^H) - \Pi_t \tag{B.2}$$

$$\text{with} \quad \Psi(d_{t+1}^H) = \frac{\psi}{2}(d_{t+1}^H - \bar{d}^H)^2 \tag{B.3}$$

FOCs:

$$c_t: \quad (c_t - \omega^{-1} h_t^\omega)^{-\gamma} = \lambda_t \tag{B.4}$$

$$l_t: \quad (c_t - \omega^{-1} h_t^\omega)^{-\gamma}(-l^{\omega-1}) = \lambda_t w_t \tag{B.5}$$

$$d_{t+1}^H: \quad \beta E_t \left[\frac{\lambda_{t+1}}{\lambda_t}(1 + r_{t+1}) \right] = 1 - \psi(d_{t+1}^H - \bar{d}^H) \tag{B.6}$$

B.1.2   Financial Intermediaries

Balance sheet (at the end of period t)

$$q_t s_{jt} = n_{jt} + d_{jt}^B \tag{B.7}$$

Law of motion for bank j's net worth position at the beginning of period $t + 1$, shortly before exit and entry into financial sector takes place and new lending activities start:

$$n_{jt+1} = q_t s_{jt} R_{t+1}^k - R_{t+1} d_{jt}^B$$

using (B.7) yields

$$
\begin{aligned}
n_{jt+1} &= R_{t+1}^k q_t s_{jt} - R_{t+1}[q_t s_{jt} - n_{jt}] \\
&= (R_{t+1}^k - R_{t+1}) q_t s_{jt} + R_{t+1} n_{jt}
\end{aligned}
\tag{B.8}
$$

Positive premium requirement

$$E_{t+i}\beta^i \Lambda_{t,t+1+i}(R_{kt+1+i} - R_{t+1+i}) \geq 0 \qquad \vee \, i \geq 0 \tag{B.9}$$

Banks' profit maximization

$$V_{jt} = \max_{\{s_{jt}\}} E_t \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i} \left\{ \left[(R^k_{t+1+i} - R_{t+1+i})q_{t+i}s_{jt+i} \right] + R_{t+1+i}n_{jt+i} \right\}$$

(B.10)

s.t.

$$V_{jt} \geq \lambda_t q_t s_{jt} \tag{B.11}$$

The FIs' problem yields the following FOCs:

$$s_{jt}: \qquad (1-\theta)\Lambda_{t,t+1}(R^k_{t+1} - R_{t+1})q_t - \mu_t \lambda q_t = 0 \qquad \text{(B.12)}$$

$$\mu_t: \qquad V_{jt} - \lambda q_t s_{jt} \qquad = 0 \qquad \text{(B.13)}$$

with μ_t denoting the Lagrange multiplier on the incentive compatibility constraint from the agency problem, and λ_t being a parameter in the latter.

Proof of Proposition 1. The proof follows an expansion around the definition of V_{jt} in (B.10) and a straight forward notation in recursive form. It is devided in two steps, for each auxiliary variable υ_t and η_t separatly, and leaves out expectation signs to simplify the notation:

Step 1:

$$
\begin{aligned}
\upsilon_t q_t s_{jt} &= \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i}(R^k_{t+1+i} - R_{t+1+i})q_{t+i}s_{jt+i} \\
\Leftrightarrow \upsilon_t &= \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i}(R^k_{t+1+i} - R_{t+1+i})\chi_{t,t+i} \qquad\qquad \text{(B.14)} \\
&= (1-\theta)\beta\Lambda_{t,t+1}(R^k_{t+1} - R_{t+1}) + \sum_{i=1}^{\infty} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i}(R_{kt+1+i} - R_{t+i})\chi_{t,t+i} \\
&= (1-\theta)\beta\Lambda_{t,t+1}(R^k_{t+1} - R_{t+1}) + \beta\Lambda_{t,t+1}\theta\chi_{t,t+1}\sum_{i=1}^{\infty}(1-\theta)\theta^{i-1}\beta^{i-1} \\
&\qquad \Lambda_{t+1,t+i}(R^k_{t+1+i} - R_{t+1+i})\chi_{t+1,t+i} \qquad\qquad\qquad\qquad \text{(B.15)}
\end{aligned}
$$

Now, scrolling equation (B.14) one period ahead yields:

$$
\begin{aligned}
\upsilon_{t+1} &= \sum_{i=0}^{\infty} (1-\theta)\theta^i \beta^{i-1}\Lambda_{t+1,t+i}(R^k_{t+1+i} - R_{t+1+i})\chi_{t+1,t+i} \\
&= \sum_{i=1}^{\infty} (1-\theta)\theta^{i-1}\beta^i \Lambda_{t+1,t+i}(R^k_{t+1+i} - R_{t+1+i})\chi_{t+1,t+i}
\end{aligned}
$$

(B.17)

Combine (B.15) and (B.16) to get

$$v_t = E_t \left[(1-\theta)\beta\Lambda_{t,t+1}(R^k_{t+1} - R_{t+1}) + \beta\Lambda_{t,t+1}\theta\chi_{t,t+1}v_{t+1} \right]. \qquad \text{(B.18)}$$

Step 2:

$$\eta_t n_{jt} = \sum_{i=0} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i} R_{t+1+i} n_{jt+i}$$

$$\Leftrightarrow \eta_t = \sum_{i=0} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i} R_{t+1+i} Z_{t,t+i} \qquad \text{(B.19)}$$

$$= (1-\theta)\beta\Lambda_{t,t+1+i} R_{t+1} + \sum_{i=1} (1-\theta)\theta^i \beta^i \Lambda_{t,t+1+i} R_{t+1+i} Z_{t,t+i}$$

$$= (1-\theta)\beta\Lambda_{t,t+1+i} R_{t+1} + \beta\Lambda_{t,t+1}\theta Z_{t,t+1} \sum_{i=1} (1-\theta)\theta^{i-1}\beta^{i-1}\Lambda_{t+1,t+i} R_{t+(\text{B.20})} {}_{t,t+i}$$

Scrolling equation (B.19) one period ahead

$$\eta_{t+1} = \sum_{i=0} (1-\theta)\theta^i \beta^i \Lambda_{t+1,t+i} R_{t+1+i} Z_{t+1,t+i}$$

$$= \sum_{i=1} (1-\theta)\theta^{i-1}\beta^{i-1}\Lambda_{t+1,t+i} R_{t+1+i} Z_{t+1,t+i} \qquad \text{(B.21)}$$

Combine (B.20) and (B.21) in order to obtain

$$\eta_t = E_t \left[(1-\theta)\beta\Lambda_{t,t+1+i} R_{t+1} + \beta\Lambda_{t,t+1}\theta Z_{t,t+1}\eta_{t+1} \right] \qquad \text{(B.22)}$$

||

In order to arrive at the law of motion of the leverage ratio of the bank, replace V_{jt} in the incentive compativility constraint (B.11) through proposition 1. Note that if the positive premium requirement (B.9) holds, then the incentive constraint (B.11) holds with equality in equilibrium, hence

$$v_t q_t s_{jt} + \eta_t n_{jt} = \lambda_t q_t s_{jt}$$

$$\Leftrightarrow q_t s_{jt} = n_{jt} \frac{\eta_t}{\lambda_t - v_t} \qquad \text{(B.23)}$$

Using the banks' balance sheet (B.7) twice,

$$n_{jt} + d^B_{jt} = n_{jt} \frac{\eta_t}{\lambda_t - v_t}$$

$$\Leftrightarrow \frac{q_t s_{jt}}{n_{jt}} = \frac{\eta_t}{\lambda - v_t} \qquad \text{(B.24)}$$

On the left hand-side of the above equation, there is the leverage ratio defined as intermediated assets over bank equity. Therefore, define the law of motion for the aggregate leverage ratio, or capital-asset ratio, as

$$\frac{q_t s_t}{n_t} = \frac{\eta_t}{\lambda_t - \upsilon_t} = \vartheta_t \tag{B.25}$$

Law of motion of the aggregate net worth position
Using (B.23) to rewrite (B.8) one obtains

$$n_{jt} = \left[(R^k_{t+1} - R_{t+1}) \frac{\eta_t}{\lambda_t - \upsilon_t} + R_{t+1} \right] n_{jt} \tag{B.26}$$

Note from the derivation of the law of motion of the aggregate bank leverage that banks have identical leverage ratios. Hence, the subscript indicating individual financial institutions can be erased and (B.23) rewritten in the form:

$$q_t s_t = n_t \frac{\eta_t}{\lambda_t - \upsilon_t} \tag{B.27}$$

The aggregate net worth:

$$n_{t+1} = n^e_{t+1} + n^n_{t+1} \tag{B.28}$$

with n^n_t denoting period t newly entering FIs and n^e_t remaining FIs from previous periods. Then, it follows from (B.26) in conjunction with (B.28) and survival probability θ:

$$n^e_t = \theta \left[(R^k_{t+1} - R_{t+1}) \frac{\eta_t}{\lambda_t - \upsilon_t} + R_{t+1} \right] n_t \tag{B.29}$$

$$n^n_t = (1 - \theta) \frac{\nu}{(1 - \theta)} q_t s_t = \nu q_t s_t \tag{B.30}$$

with ν denoting a parameter which governs the fraction of the total final periods bank assets transferred to each newly entering banker according to $\nu/(1 - \theta)$. Combining the last two equations (B.29) and (B.30) yields the aggregate law of motion of FIs' net worth:

$$n_{t+1} = \theta \left[(R^k_{t+1} - R_{t+1}) \frac{\eta_t}{\lambda_t - \upsilon_t} + R_{t+1} \right] n_t + \nu q_t s_t \tag{B.31}$$

B.1.3 Non-Financial Firms

$$Y_t = z_t k_t^\alpha h_t^{1-\alpha} \tag{B.32}$$

$$q_t s_{jt} = q_t k_{t+1} \tag{B.33}$$

$$\max_{\{k_{t+1}, h_t\}} E_t \sum_{t=0}^\infty \beta^t \Pi_t^F \tag{B.34}$$

with

$$\Pi_t^F = y_t - w_t h_t - R_t^k q_t s_{jt-1} + q_t(1-\delta)k_t - q_t k_{t+1} + q_t s_{jt}$$

Substituting in (B.32) to (**??**) yields

$$\Pi_t^F = z_t k_t^\alpha h_t^{1-\alpha} - (R_t - 1)(w_t h_t) - R_t^k q_t k_t + q_t(1-\delta)k_t \tag{B.35}$$

define

$$(1 + r_t) \equiv R_t \tag{B.36}$$

$$(1 + r_t^k) \equiv R_t^k \tag{B.37}$$

FOCs:

$$h_t: \quad z_t(1-\alpha)k_t^\alpha h_t^{-\alpha} = w_t \tag{B.38}$$

$$k_{t+1}: \quad z_{t+1}\alpha k_{t+1}^{\alpha-1} h_{t+1}^{1-\alpha} = R_{t+1}^k q_t - q_{t+1}(1-\delta) \tag{B.39}$$

Rewrite (B.39) to obtain the law of motion for the return on capital:

$$R_{t+1}^k = \frac{\alpha \frac{y_{t+1}}{k_{t+1}} + q_{t+1}(1-\delta)}{q_t} \tag{B.40}$$

B.1.4 Capital Producer

$$\max_{\{i_t\}} q_t k_{t+1} - q_t(1-\delta)k_t - i_t \tag{B.41}$$

s.t.

$$k_{t+1} = (1-\delta)k_t + \Phi\left(\frac{i_t}{k_t}\right)k_t \tag{B.42}$$

$$\text{with} \quad \Phi\left(\frac{i_t}{k_t}\right) = \frac{i_t}{k_t} - \frac{\phi}{2}\left(\frac{i_t}{k_t} - \delta\right)^2 \tag{B.43}$$

FOC:

$$q_t = \left[1 - \phi\left(\frac{i_t}{k_t} - \delta\right)\right]^{-1} \tag{B.44}$$

B.1.5 Aggregate Resource Constraint and Flow Variables

Summing over all agents' flow budget constraints:

$$
\begin{aligned}
0 = \ & y_t - R_t^k q_{t-1} s_{t-1} - w_t h_t - (R_t - 1) w_t h_t + q_t (1 - \delta) k_t + q_t s_t - q_t k_{t+1} \\
& + (1 - \theta) q_t s_{t-1} - \nu q_t s_t + w_t h_t - c_t - d_t^H R_t + d_{t+1}^H - \Psi(\cdot) \\
& + d_{t+1}^B + \nu q_t s_t - (1 - \theta) q_t s_{t-1} + R_t^k q_{t-1} s_{t-1} - q_t s_t - R_t d_t^B \\
& + q_t k_{t+1} - q_t (1 - \delta) k_t - i_t - -\frac{\phi}{2} \left(\frac{i_t}{k_t} - \delta \right)^2
\end{aligned}
\tag{B.45}
$$

This yields the aggregate resource constraint as:

$$
y_t = c_t + i_t + \Psi(\cdot) + -\frac{\phi}{2} \left(\frac{i_t}{k_t} - \delta \right)^2 + R_t d_t^H - d_{t+1}^H + R_t d_t^B - d_{t+1}^B
\tag{B.46}
$$

Definition The trade balance is the net amount of output the economy transfers to foreigners each period, hence

$$
tb_t = y_t - c_t - i_t - \Psi(\cdot) - \Phi(\cdot)
\tag{B.47}
$$

and, accordingly, the trade-balance-to-GDP-ratio:

$$
tby_t = 1 - \frac{c_t + i_t + \Psi(\cdot) + \Phi(\cdot)}{y_t}
\tag{B.48}
$$

B.1.6 Decentralized Equilibrium

Given the previous model description, the decentralized equilibrium is defined as a stochastic sequence of allocations $\left[c_t, l_t, d_{t+1}^H, s_t, n_t, \eta_t, \upsilon_t, \vartheta_t, d_{t+1}^B, h_t, k_{t+1}, i_t, y_t, tby_t \right]_{t=0}^{\infty}$ and prices $\left[q_t, w_t, r_t^k \right]_{t=0}^{\infty}$ that, given the initial capital stock k_0, the initial debt positions of households and banks, d_0^H and d_0^B, and the exogenous processes $[z_t, \varrho_t]_{t=0}^{\infty}$, satisfies i) the optimality conditions of all agents in the model and ii) market clearing on all markets.

B.1.7 Steady state of the model

This subsection describes the long-run steady state of the model which is the state around a log-linear approximation to the solution of the non-linear system of dynamic equations will be based on. To start with, note that in theministic detesteady state all shocks are turned off, hence $\bar{z} = \bar{\varrho} = 1$ and $R_t = \bar{R}$. Besides, $\bar{q} = \Lambda_{t,t+i} = 1$. Then, combining labor supply (B.4), (B.5) and labor demand (B.38) yields

$$
\bar{h} = \left[(1 - \alpha) \left(\frac{\bar{k}}{\bar{h}} \right)^{\alpha} \right]^{\frac{1}{\omega - 1}}.
\tag{B.49}
$$

From firms first order condition for the capital stock (B.39) follows the capital to labor ratio

$$\frac{\bar{k}}{\bar{h}} = \left[\frac{\bar{R}^k - 1 + \delta}{\alpha} \right]^{\frac{1}{\alpha - 1}}. \tag{B.50}$$

Combining both equations yields the steady state labor equation

$$\bar{h} = \left[(1 - \alpha) \left[\frac{\bar{R}^k - 1 + \delta}{\alpha} \right]^{\frac{\alpha}{\alpha - 1}} \right]^{\frac{1}{\omega - 1}}. \tag{B.51}$$

Next, we need to find a steady state expression of the endogenous variable R^k in order to solve for the steady state value of labor. I begin with substituting $\bar{q}\bar{s}$ in the law of motion for aggregate net worth of banks (B.31) with (B.28) and obtain

$$\bar{n} = \theta \left[(\bar{R}^k - \bar{R}) \left(\frac{\bar{\eta}}{\bar{\lambda} - \bar{v}} \right) + \bar{R} \right] \bar{n} + \nu \frac{\bar{\eta}}{\bar{\lambda} - \bar{v}} \bar{n}. \tag{B.52}$$

Note that v_t (B.18) and η_t (B.22) can be rewritten in steady state as

$$\bar{v} = x(\bar{R}^k - \bar{R}), \tag{B.53}$$
$$\bar{\eta} = x\bar{R}, \tag{B.54}$$
$$\text{with parameter} \quad x \equiv \frac{\beta(1 - \theta)}{(1 - \beta\theta)}. \tag{B.55}$$

I arrive at the steady state expression for R^k by plugging the steady state expressions $\bar{v}$ and $\bar{\eta}$ into the steady state expression for banks aggregate net worth (B.52). Rearranging terms yields:

$$\bar{R}^k = \frac{\bar{R}x + \lambda - \bar{R}\theta\lambda - \bar{R}x\nu}{x} \tag{B.56}$$

Plugging the steady state definition of R^k from (B.56) into the steady state labor equation (B.51) completes the derivation of steady state labor input. Multiplying the capital-to-labot ratio (B.50) by the labor input reveals the steady state capital input. All other steady state variables evolve subse-

quently according to the following set of equations:

$$\bar{y} = \bar{k}^\alpha \bar{h}^{1-\alpha} \tag{B.57}$$

$$\bar{w} = \bar{h}^{\omega-1} \tag{B.58}$$

$$\bar{i} = \delta \bar{k} \tag{B.59}$$

$$\bar{s} = \bar{k} \tag{B.60}$$

$$\bar{v} = (\bar{R}^k - \bar{R})x \tag{B.61}$$

$$\bar{\eta} = \bar{R}x \tag{B.62}$$

$$\bar{n} = \bar{k}\frac{\bar{\lambda} - \bar{v}}{\bar{\eta}} \tag{B.63}$$

$$\bar{d}^B = \bar{k} + \bar{h}\bar{w}\tau - \bar{n} \tag{B.64}$$

$$\bar{\vartheta} = \frac{\bar{\eta}}{\bar{\lambda} - \bar{v}} - 1 \tag{B.65}$$

$$\bar{c} = \bar{y} - \bar{i} - (\bar{R} - 1)\bar{d}^H - (\bar{R} - 1)\bar{d}^B \tag{B.66}$$

$$t\bar{b}y = 1 - \frac{\bar{c} + \bar{i}}{\bar{y}} \tag{B.67}$$

B.1.8 Stochastic solution to the model

On the characterization of the stochastic solution to the baseline model economy I follow closely the notation of Schmitt-Grohé and Uribe (2004). Given the laws of motion for the exogenous processes and the dynamic equilibrium equations, the corresponding system of non-linear equations can be written in the form:

$$E_t f(y_{t+1}^*, y_t^*, x_{t+1}, x_t) = 0 \tag{B.68}$$

The vector of control variables y_t^* is in the baseline model of dimension 13×1 and comprises the variables $y_t^* = (c_t; l_t; s_t; n_t; \lambda_t; \eta_t; v_t; \vartheta_t; d_t^B; h_t; i_t; y_t; tby_t)'$. The 5×1 vector of state variables $x_t = (x_t^1; x_t^2)'$ contains the two endogenous states $x_t^1 = (k_{t+1}; d_{t+1}^H)'$, as well as the three exogenous states $x_t^2 = (z_t; R_t; \varrho_t)'$. I conjecture that there exist two functions g and h such that a general solution to the model in (B.68) can be characterized as

$$y_t^* = g(x_t, \sigma),$$
$$x_{t+1} = h(x_t, \sigma) + \eta\sigma\epsilon_{t+1}.$$

In the next step, the two unknown policy functions g and h are approximated using a first-order Taylor series expansion at the deterministic steady state

of the model, where a upper bar denotes steady state values. Since in steady state $(x_t, \sigma) = (\bar{x}, 0)$, this yields

$$g(x_t, \sigma) = g(\bar{x}, 0) + g_x(\bar{x}, 0)(x_t - \bar{x}) + g_\sigma(\bar{x}, 0)\sigma,$$
$$h(x, \sigma) = h(\bar{x}, 0) + h_x(\bar{x}, 0)(x_t - \bar{x}) + h_\sigma(\bar{x}, 0)\sigma.$$

Schmitt-Grohé and Uribe (2004) show that for the existence of a unique solution it must hold that

$$g_\sigma = h_\sigma = 0.$$

I obtain the coefficients of matrices g_x and h_x by using the perturbation algorithm of a first-order approximation at the steady state which is implemented in the software package Dynare.

B.2 The benchmark model without banks

As a natural benchmark to the model with capital importing bank developed above, the here described model is a neoclassical small open economy model with capital adjustment costs and portfolio adjustment costs as in Schmitt-Grohé and Uribe (2003), model 3. Besides, it nests a working capital requirement as in NP or UY which can be switched off by setting the parameter τ equal to zero.

B.2.1 Households

The infinitely lived household chooses consumption, labor supply, its level of debt and the physical capital stock subject to a budget constraint and a no-Ponzi game condition.

$$\mathcal{L} \max_{\{c_t, l_t, d_{t+1}, k_{t+1}\}} E_t \sum_{t=0}^{\infty} \beta^t \left\{ \left[\frac{(c_t - \omega^{-1} l_t^\omega)^{1-\gamma} - 1}{1 - \gamma} \right] \right.$$

$$\left. + \lambda_t \left[d_{t+1} + w_t l_t + r_t^k k_t + \Phi_t - c_t - i_t - R_t d_t - \frac{\psi}{2}(d_{t+1} - \bar{d})^2 \right] \right\} \quad \text{(B.69)}$$

$$\text{with} \quad i_t = [k_{t+1} - k_t(1 - \delta)] + \frac{\phi}{2}(k_{t+1} - k_t)^2 \quad \text{(B.70)}$$

FOCs:

$$c_t : \qquad\qquad [c_t - \omega^{-1} l_t^\omega]^{-\gamma} = \lambda_t \qquad\qquad \text{(B.71)}$$

$$l_t : \qquad\qquad [c_t - \omega^{-1} l_t^\omega]^{-\gamma} l_t^{\omega-1} = \lambda_t w_t \qquad\qquad \text{(B.72)}$$

$$d_{t+1} : \qquad \lambda_t \left[1 - \psi(d_{t+1} - \bar{d}) \right] = \beta E_t(\lambda_{t+1} R_{t+1}) \qquad \text{(B.73)}$$

$$k_{t+1} : \quad \lambda_t \left[1 + \phi(k_{t+1} - k_t) \right] = \beta E_t \left\{ \lambda_{t+1} \left[r_{t+1}^k + 1 - \delta + \phi(k_{t+2} - k_{t+1}) \right] \right\}$$
$$\text{(B.74)}$$

B.2.2 Firms

Profit maximizing firms rent labor and physical capital from households for production purpose in each period:

$$\max_{\{h_t, k_{t+1}\}} \Lambda_{t,t+1} E_t \sum_{t=0}^{\infty} z_t k_t^\alpha h_t^{1-\alpha} - w_t h_t - r_t^k k_t \tag{B.75}$$

FOCs:

$$h_t: \quad (1-\alpha) z_t k_t^\alpha h_t^{-\alpha} = w_t \tag{B.76}$$

$$k_{t+1}: \quad r_t^k = \alpha z_t k_t^{\alpha-1} h_t^{1-\alpha} \tag{B.77}$$

q-relation for investment

$$q = 1 + \phi(i - \delta k_t) \tag{B.78}$$

B.2.3 Closing the model

Aggregate resource constraint

$$
\begin{aligned}
0 = \quad & d_{t+1} + w_t l_t + r_t^k k_t + \Psi_t - c_t - (1 + r_t) d_t - \frac{\psi}{2}(d_{t+1} - \bar{d})^2 \\
& - k_{t+1} + k_t(1 - \delta) - \frac{\phi}{2}(k_{t+1} - k_{t+1})^2 \\
& + z_t k_t^\alpha h_t^{1-\alpha} - w_t h_t - r_t^k k_t - \Psi_t \\
\Leftrightarrow \quad y_t + d_{t+1} = \quad & c_t + i_t + (1 + r_t) d_t + \frac{\psi}{2}(d_{t+1} - \bar{d})^2 + \frac{\phi}{2}(k_{t+1} - k_t)^2
\end{aligned}
\tag{B.79}
$$

Trade balance

$$
\begin{aligned}
TB_t &= y_t - c_t - i_t - \frac{\psi}{2}(d_{t+1} - \bar{d})^2 - \frac{\phi}{2}(k_{t+1} - k_t)^2 \\
tby_t &= 1 - \left(\frac{c_t + i_t + \frac{\psi}{2}(d_{t+1} - \bar{d})^2 + \frac{\phi}{2}(k_{t+1} - k_t)^2}{y_t} \right)
\end{aligned}
\tag{B.80}
$$

B.2.4 Steady state of the benchmark model

From the household's first order condition for physical capital obtain:

$$
\begin{aligned}
1 &= \beta \left[\bar{r}^k + 1 - \delta \right] \\
\text{with} \quad \tfrac{1}{\beta} &= \bar{R} \\
\Rightarrow \quad \bar{r}^k &= \bar{R} - 1 + \delta \\
\Leftrightarrow \quad \bar{r}^k &= \bar{r} + \delta
\end{aligned}
\tag{B.81}
$$

From the firm's first-order condition for physical capital get:

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

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

$$\frac{\bar{k}}{\bar{h}} = \left(\frac{\bar{r} + \delta}{\alpha} \right)^{\frac{1}{\alpha - 1}} \tag{B.82}$$

From the firm's first-order condition for labor input:

$$(1 - \alpha) \left(\frac{\bar{k}}{\bar{h}} \right)^{\alpha} = \bar{w} \tag{B.83}$$

and using household's labor supply condition and (B.82), after rearranging

$$\bar{h} = \left[(1 - \alpha) \left(\frac{\bar{r} + \delta}{\alpha} \right)^{\frac{\alpha}{\alpha - 1}} \right]^{\frac{1}{\omega - 1}}. \tag{B.84}$$

Multiplying the capital to labor ratio (B.82) with the steady state value for labor (B.84) yields the steady state capital stock $\bar{k}$. All other steady state values evolve according to:

$$\bar{y} = \bar{k}^{\alpha} \bar{h}^{1 - \alpha} \tag{B.85}$$

$$\bar{w} = \bar{h}^{\omega - 1} \tag{B.86}$$

$$\bar{l} = \bar{h} \tag{B.87}$$

$$\bar{i} = \delta \bar{k} \tag{B.88}$$

$$\bar{TB} = \bar{r} \bar{d} \tag{B.89}$$

$$\bar{tby} = 1 - \left(\frac{\bar{c} + \bar{i}}{\bar{y}} \right) \tag{B.90}$$

C   Data Appendix

C.1   Gross capital flows

Gross capital flows for the panel of 33 countries are constructed as the sum over three positions of the IMF Balance of Payment (BOP) database, namely foreign direct investment in the country, portfolio investment liabilities, and other investment liabilities. All data is obtained via datastream (codes %%I78BEDA,%%I78BGDA, and %%I78BIDA). Gross capital flows are in quarterly frequency and reported in millions of US dollars. Hence, I deflate all series with the US deflator.

I obtain output data and relevant GDP deflators for the country panel mainly from the IMF International Financial Statistics database. Data for output was deflated and de-saisonalized if necessary. If the series was not available for the sample length of gross capital inflows, I took output data in real terms from the OECD Quarterly National Accounts (see Table 4 for details).

I extract the cyclical component of gross capital inflows and from the logs of output by applying the HP-filter with smoothing parameter $\lambda = 1600$.

The OECD's Risk Classification are reported on quarterly basis and available online[10]. For the sample of 33 countries, I construct an average country specific risk classification as a simple average over the period 2001q1 to 2010q4.

C.2   Mexican business cycle statistics

Data for output, consumption, investment and the trade balance are all from the IMF International Financial Statistics and obtained via datastream. Consumption is "private consumption" and investment "gross fixed capital formation". The trade balance is constructed as "exports" net of "imports of goods and services". All data is deflated and saisonally adjusted if necessary.

I obtain data for the Mexican financial system from the website of the Mexican banking and securities commission (CNBV).[11] Data is chosen from the universal banking category. Bank capital is taken directly from the balance sheet (capital contable). Assets are the sum of all assets under the chosen banking category. It is therefore a measure for the overall size of the banking sector. Liabilities are constructed as the difference between assets

---

[10]http://www.oecd.org/document/49/0,3746,en_2649_34169_1901105_1_1_1_1,00.html

[11]http://sidif.cnbv.gob.mx/Documentacion/BM_Series_Historicas/BM_Series_Hist%C3%B3ricas.xlsm

minus bank capital. All series are converted to quarterly series by taking averages, and deflated using the deflator for the Mexican Peso from the IMF International Financial Statistics. Finally, leverage is defined as total assets over bank equity.

The cyclical component of real and financial variables are extracted by using the HP-filter with $\lambda = 1600$.