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Abstract*

Corporate sectors in emerging market economies have noticeably increased their reliance on foreign financing, presumably reflecting low global interest rates. This trend has largely reflected increased bond issuance by emerging economies firms, in contrast to the bank loans that dominated capital flows in the past. To shed light on these developments, we develop a stochastic dynamic model of an open economy in which the levels of direct versus intermediated finance are determined endogenously. The model embeds the static, partial equilibrium model of Holmström and Tirole (1997) into a dynamic general equilibrium setting. It generates an increase in both bonds and loans following an exogenous drop in world interest rates; also, the ratio of bonds to loans increases because bank credit becomes relatively more expensive, reflecting the scarcity of bank equity. These implications are in line with empirical observations and highlight the role of equity in the adjustment process. More generally, the model is suitable for studying the interaction between modes of finance and the macroeconomy, and is of independent interest.

JEL classifications: E22, E44, E47

Keywords: Bond issuance, Bank loans, Dynamic model, Global interest rates, General equilibrium, Open economy

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1 Introduction

In recent years, the corporate sector in emerging market economies has increased its reliance on foreign financing considerably. This trend became more marked during the period of low global interest rates following the global financial crisis, and has generated a lively debate regarding its interpretation and policy implications. An optimistic view is that the increase in corporate liabilities is a natural response to favorable interest rates and relatively favorable investment prospects in emerging countries. A less sanguine view is that larger foreign liabilities are dangerous and place emerging economies in a precarious position.

Understanding this phenomenon has been complicated by the observation that it has largely reflected increased bond issuance by emerging economies' firms, in contrast to the bank loans which dominated capital flows in the past.¹ To illustrate, Figure 1² reproduces a chart from IADB (2014), describing the evolution of foreign corporate liabilities in Brazil, Chile, Colombia, Mexico, and Peru, as well as an average (LAC-5). The figure shows a clear acceleration in the amount of both bonds and loans owed by Latin American firms. It also shows that the relative importance of bonds has increased since the start of the century and, more emphatically, since the global crisis. For the typical country in the figure, the share of bonds in the stock of international corporate debt increased from 22% in 2000 to 43% in 2013. This process has taken place while, simultaneously, debt-to-output ratios have increased in emerging economies. In 2005 debt-to-GDP for LAC-5 was about 30%, while by the end of 2013 it had almost doubled, just below 60%.³

Figure 2 shows that the surge of external borrowing has been accompanied by a drop in the interest rates faced by emerging economies. This drop was partly related to the low global interest rates since the onset of the crisis, here measured by real U.S. T-bill rates. However, since the early 2000s it was also accompanied by the low spreads that these countries are charged

¹Note also that these developments have been dominated by corporate debt rather than sovereign debt, which was prevalent in earlier periods.

²Figures and tables are gathered at the end of the paper.

³The Online Appendix reproduces Figure 1 by scaling the amount of debt by GDP

on top of the riskless rate.⁴ Low spreads continued despite the short-lasting jump following the panic of 2008.

This paper sheds light on the interpretation and implications of these events by developing a stochastic dynamic equilibrium model of an open economy in which the quantities of direct versus intermediated finance are determined endogenously. Our model embeds the static, partial equilibrium model of Holmström and Tirole (1997, henceforth HT) into an otherwise standard dynamic setting. As in HT, the production of capital goods requires finance from outside investors. Due to moral hazard problems, a fraction of this production can be financed directly from the outsiders, while another portion can be financed only with the participation of monitors or "banks". In each period, therefore, the amounts of bank loans and direct finance are endogenous and depend on variables such as the price of capital goods and the equity capital of investment producing firms and banks. The latter are determined in a dynamic general equilibrium, in contrast to HT. Hence our model allows for a study of the interaction between modes of finance and the macroeconomy, and is of independent interest.

As a main finding, the model yields an intuitive economic explanation of the joint dynamics of bonds, bank loans, and interest rates summarized by Figures 1 and 2. In the model, an exogenous drop in world interest rates leads to an increase in the demand for capital goods and a corresponding increase in their relative price. The latter raises the profitability of investment goods production; given existing corporate equity, this raises pledgeable value and allows for increases in both corporate bonds and bank loans. At the same time, however, the return to the equity of the banking sector goes up, reflecting that such equity is scarce and slow to adjust. Hence bank finance becomes relatively more costly than direct finance and, accordingly, the ratio of corporate bonds to bank loans goes up. These implications are all in line with the empirical observations mentioned above, and reflect the crucial roles of corporate equity and bank equity in the adjustment process.

The model also generates rich and realistic dynamics that express the interplay between

⁴These favorable borrowing conditions have been enjoyed not only by sovereign borrowers (EMBIG spread) but also by non-financial corporations (CEMBI spread).

investment supply and demand, financial frictions, and the evolution of equity. In particular, the responses of corporate bonds and bank loans to lower interest rates reflect the adjustment of investment as well as of the returns to bank equity and corporate equity. The latter, in turn, are determined by the dynamics of the price of capital goods and the rates of accumulation of both kinds of equity. We study these features of the model in a calibrated version.

The model is suitable to tackle several related questions. In particular, it has been conjectured that the observed increase in direct finance relative to indirect finance in emerging countries may reflect changes in the underlying technology of finance which, at the same time, may have made those countries more vulnerable to external shocks. Our model provides a less pessimistic perspective: as we show, permanent changes in moral hazard parameters or monitoring costs can indeed result in an increase in the ratio of commercial bonds to loans, but also imply smoother responses to interest rate shocks. This is intuitive, reflecting that the mode of finance provides an additional margin of adjustment, and suggests that the recent increase in corporate liabilities is a natural response to low interest rates and relatively favorable investment prospects in emerging countries.⁵

Finally, we extend the model to allow for an exports commodity sector, and analyze the impact of shocks to world commodity prices. This is of interest because many emerging economies, including the ones featured in Figures 1 and 2, rely heavily on commodity exports whose prices have experienced large fluctuations since the millennium. In the extended model, a favorable shock to the prices of export commodities causes an increase in the demand for capital goods, raising their price. This, in turn, leads to increased production of capital goods, larger quantities of both direct and indirect finance, and an increase in the bonds to loans ratio, just as in the baseline model and because of the same reasons. The extended model thus confirms that insights of the baseline model as to the mechanism by which external shocks may explain the dynamics of bonds and loans. It also indicates that, in reality, favorable commodity

⁵In contrast, Shin (2013) and others have argued that larger foreign liabilities are dangerous and place emerging economies in a precarious position. Shin (2013) has emphasized that the increase in commercial debt can be problematic because of the possibility of exacerbating currency mismatch problems, which we do not address in this paper.

prices may have acted in conjunction with lower interest rates in generating such dynamics.

Our work is related to several strands of literature. One is a set of empirical studies that have documented recent international trends in corporate debt issuance and analyzed the determinants of corporate debt choice. Shin (2013) and Turner (2014) report the considerable increase in foreign currency borrowing in international bond markets by emerging market corporations, part of which has been done by their offshore affiliates and most of it in dollars. IADB (2014) carefully documents this phenomenon for Latin American economies while Caballero et.al. (2015) shows evidence for emerging economies in Asia and Eastern Europe. Our model can be seen as a theoretical explanation of these empirical findings.

In developing our model, we build upon HT and other basic contributions that have provided microfoundations for the choice between bank and market finance under moral hazard.⁶ Our work extends this line of research by endogenizing the choice between bank finance and market finance embedding HT's dual moral hazard problem within a dynamic, general equilibrium context of a small open economy.

Our approach emphasizes the role of corporate equity and bank equity as determinants of the demand for credit, like HT. We go beyond HT, however, in exploring dynamics as well as macroeconomic implications. Chen (2001), Aikman and Paustian (2006), and Meh and Moran (2010) have also embedded HT into dynamic equilibrium settings. A crucial difference with our paper, however, is that none of these forerunners modeled the endogenous determination of direct finance versus intermediated finance, which is the central concern of our paper.

Perhaps the closest antecedent of our study is the recent paper by De Fiore and Uhlig (2015)⁷. They develop a model in which firms choose to finance productive projects either directly or with the help of financial intermediaries; the latter can draw a signal about the probability of project success, which helps avoiding bankruptcy. De Fiore and Uhlig (2015)

⁶Repullo and Suarez (2000) also endogenize the choice between bank finance and market finance within an environment where firms are heterogeneous in the amount of available net worth. See also Diamond, 1991; Rajan, 1992; Besanko and Kanatas, 1993; and Bolton and Scharfstein, 1996

⁷De Fiore and Uhlig (2011) first develops the model in De Fiore and Uhlig (2015), providing steady state analysis and focusing on long run differences between the US and the Euro area.

then argue that their model can account for a simultaneous fall in bank loans to and increase in bond issuance by US firms during the Great Recession; this is the case if firm-level uncertainty and intermediation costs of banks happen to increase at the same time. Our paper coincides with De Fiore and Uhlig's in modeling the endogenous determination of direct finance versus bank finance in dynamic macro models, but it is very different otherwise. We start from different facts: in emerging economies, the amounts of bonds and bank loans have moved in the same direction; in contrast, De Fiore and Uhlig's objective was to explain the observed fall in loans and increase in bonds in the US. More notably, our theoretical framework is quite different from theirs: ours emphasizes the key role of corporate and bank equity, which allows us to provide an economic explanation of the links between observable changes in world interest rates and commodity prices and the dynamic behavior of bonds and loans. Finally, De Fiore and Uhlig's model is a closed economy one, while we model an open economy in order to understand the international phenomena described above.

The plan of the paper is as follows. Section 2 presents the basic model, outlines its solution, and discusses its theoretical implications. Section 3 describes a baseline calibration. Section 4 examines dynamic implications of the calibrated model. Section 5 extends the model to allow for a commodity exports sector and discusses the implications. Final remarks are given in Section 6. Some technical issues are delayed to an Appendix.

2 The Model

2.1 Households and Final Goods Production

Our specification of the household sector and of the production of final goods is standard, so it will be brief. This is because, for our purposes, the main aspect of this part of the model to generate a dynamic demand for capital goods. Accordingly, we assume that producing final goods requires capital, which is owned by domestic households, and that the relative price of capital is time varying.

Time is discrete and indexed by $t = 0, 1, \dots$. We focus on a small open economy. There is a freely traded final good that will serve as numeraire. Competitive domestic firms produce final goods with capital and labor via a Cobb-Douglas function:

$$Y_t = A_t K_t^\alpha H_t^{1-\alpha} \quad (1)$$

with Y_t denoting output of final goods, K_t capital input, H_t labor input, A_t total factor productivity (assumed to be exogenous), and $0 < \alpha < 1$

Competitive factor markets yield the usual marginal conditions

$$\alpha Y_t = r_t^K K_t \quad (2)$$

$$(1 - \alpha) Y_t = w_t H_t \quad (3)$$

where r_t^K and w_t denote the rental rate of capital and the wage rate.

Households are the owners of productive factors, including capital. They can also borrow or lend in world markets at a gross interest rate $\Psi_{t+1} R_{t+1}^*$, where R_{t+1}^* is the safe world interest rate between periods and Ψ_{t+1} is a country specific spread.

The household's budget constraint in period t is, then,

$$C_t + Q_t X_t + \Psi_t R_t^* D_t = w_t H_t + r_t^K K_t + D_{t+1} + (1 - \phi^f) \Pi_t \quad (4)$$

where C_t denotes consumption of the final good, X_t purchases of new capital, Q_t the price of new capital, and D_{t+1} the amount borrowed abroad. Finally, $(1 - \phi^f) \Pi_t$ denotes dividends from investment producing firms, which are transferred to the household, as described below.

The spread Ψ_t is exogenous to the household but, as discussed by Schmitt-Grohé and Uribe (2003), it depends on \bar{D}_t , the aggregate value of D_t :

$$\Psi_t = \bar{\Psi} + \tilde{\Psi}(e^{\bar{D}_t - \bar{D}} - 1) \quad (5)$$

The representative household maximizes the expected present discounted utility of consumption and labor effort. We assume GHH preferences (Greenwood, Hercowitz, and Huffman 1988) for which the marginal utility of consumption is

$$\lambda_t^c = \left(C_t - \kappa \frac{H_t^\tau}{\tau} \right)^{-\sigma} \quad (6)$$

where κ, τ , and σ are parameters. Optimal labor supply is then given by:

$$w_t = \kappa H_t^{\tau-1} \quad (7)$$

The optimal foreign borrowing-lending policy is given by

$$1 = \beta^h E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} \Psi_{t+1} R_{t+1}^* \quad (8)$$

where $\beta^h \in (0, 1)$ is the household's discount factor and $E_t(\cdot)$ is the conditional expectation operator.

Finally, capital accumulation is subject to adjustment costs:

$$K_{t+1} = (1 - \delta)K_t + X_t - \frac{\varphi}{2} K_t \left(\frac{K_{t+1}}{K_t} - 1 \right)^2 \quad (9)$$

where $0 < \delta < 1$ is the depreciation rate and $\varphi > 0$ is a parameter giving the degree of adjustment costs. Then optimal investment is given by the dynamic equation:

$$\begin{aligned} & Q_t \left[1 + \varphi \left(\frac{K_{t+1}}{K_t} - 1 \right) \right] \\ &= \beta^h E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} \left[r_{t+1}^K + Q_{t+1} (1 - \delta) + \varphi \left(\frac{K_{t+2}}{K_{t+1}} - 1 \right) \frac{K_{t+2}}{K_{t+1}} - \frac{\varphi}{2} \left(\frac{K_{t+2}}{K_{t+1}} - 1 \right)^2 \right] \end{aligned} \quad (10)$$

where β^h is the household's discount factor. This equation, as well as the previous ones, have

standard interpretations.

For a given process for the price of capital Q_t , and given a process for Π_t , the preceding two equations determine the demand for investment. It is often assumed that domestic output can be split between consumption goods and new capital goods at no cost, so that $Q_t = 1$ always, and that investment production yields no profits so that $\Pi_t = 0$. In that case, (1)-(10) is a system of ten equations that suffices to determine the rest of the variables so far.

2.2 Finance and Production of New Capital Goods

To depart from the usual approach, we assume that new capital goods X_t are produced via a process subject to financial frictions. In equilibrium Q_t will be variable and investment will reflect the dynamic supply of investment as well as demand. More importantly, those dynamic forces will interact with the behavior of alternative modes of corporate finance.

New capital goods are produced by "holdings", each of which manages a continuum of productive units ("branches" for short) indexed by $i \in [0, 1]$. The representative holding arrives to period t with some amount of equity K_t^f , inherited from the previous period. At the beginning of the period, each branch i is charged with financing and executing a project of the same size, which takes I_t units of tradables as input, and returns a random amount of new capital goods at the end of the period, as we will describe. The size of the investment project, I_t , is chosen by the manager of the holding to maximize end of period profits.

Also at the beginning of the period, the holding's equity is split randomly between its branches (this may reflect some idiosyncrasies in startup costs, for example). A branch i is given equity $A_t^i = Z_t^i K_t^f$, where Z_t^i is a random variable with mean one, distributed i.i.d. across periods and time. The cdf of $z_t^i = \log(Z_t^i)$ will be denoted by $\Phi(z)$, and the corresponding density function by $\phi(z)$.

This setting might correspond to a situation in which there are nationwide corporations (holdings) that own units (branches) in different locations. The holding chooses a project design that has to be implemented by all branches. Each branch is given the same initial

amount of equity money, but idiosyncratic shocks to equity imply that branches effectively start projects with an equity distribution implied by K_t^f and the distribution of Z_t^i .

2.2.1 Individual Projects

Consider the problem of a branch which starts period t with equity A_t^i . As mentioned, the branch manager takes the project size I_t as given. Assuming that $I_t > A_t^i$, she will need to seek external finance in order to implement the investment project. To allow for both direct and intermediated finance, here we borrow the assumptions of HT.

Specifically, investment projects are subject to moral hazard. If the branch manager has secured at least an amount I_t of funds at the beginning of the period, she can invest them into a "good" project that yields RI_t units of new capital with probability p_H and zero with probability $1 - p_H$. The manager can, alternatively, invest I_t in a "bad" project, which reduces the probability of the successful outcome to $p_L < p_H$ but gives the manager a private benefit of size BI_t . Here R, B, p_H and p_L are some given constants.

Branch managers can seek funds from outside investors. Because contracts are settled within a period, and the rest of the world is included in the set of outside investors, it is appropriate to assume that outside investors are risk neutral and have a zero opportunity cost for funds. However, assuming that the good project has positive expected value but the bad project does not, outside investors will agree to lend only under a contract that provides enough incentives to the branch manager not to undertake the bad project. Denoting by $R_t^{f,i}$ the payoff to the branch manager in case of project success, the necessary incentive compatibility constraint can be written as

$$p_H R_t^{f,i} \geq p_L R_t^{f,i} + BI_t$$

or

$$R_t^{f,i} \geq \frac{BI_t}{\Delta}$$

with $\Delta = p_H - p_L$

Also, for the branch manager to be able to finance the project entirely by borrowing from the outside lenders, the amount borrowed must be $I_t - A_t^i$. Then, the expected payoff to the lenders must be at least as large, that is,

$$p_H(Q_t R I_t - R_t^{f,i}) \geq I_t - A_t^i$$

Combining the last two inequalities, it follows that the branch manager will be able to finance its project directly from outside lenders only if it has enough equity: $A_t^i \geq \bar{A}_t$, where

$$\bar{A}_t = I_t \left[1 - p_H(R Q_t - \frac{B}{\Delta}) \right] \quad (11)$$

Given I_t , \bar{A}_t depends naturally on investment parameters such as R , as noted by HT. In our setting, \bar{A}_t also depends on the price of capital: it falls if Q_t increases. This will imply that the supply of capital will increase with Q_t , which is intuitive.

What if $A_t^i < \bar{A}_t$? As in HT, we assume the existence of financial intermediaries or "banks". Banks start each period with some equity of their own that can be used for funding projects. More importantly, they also own a monitoring technology that allows them to reduce the branch manager's private benefit of the bad project from B to $b < B$. However, using the monitoring technology entails a private cost cI_t to a bank.

This implies that, for a branch j to secure external funding with the participation of a bank, the bank's payoff if the project is successful, denoted by $R_t^{m,j}$, has to provide enough incentives for the bank to monitor:

$$p_H R_t^{m,j} - cI_t \geq p_L R_t^{m,j}$$

or

$$R_t^{m,j} \geq \frac{cI_t}{\Delta} \equiv R_t^m$$

Also, for a branch j to convince a bank to participate in the project, it must offer the bank a return on its funds at least as large as what the banker would obtain elsewhere. Denoting

the latter by β_t , and the bank's contribution to the project by $I_t^{m,j}$, the condition is that $p_H R_t^{m,j} \geq \beta_t I_t^{m,j}$. As we will see, although the contract is within a period, β_t will be, in general, greater than the market return (of one). This means that banks will not be paid more than strictly necessary, so that the condition must hold with equality, which combined with the previous relation gives

$$I_t^{m,j} = \frac{p_H R_t^m}{\beta_t} \equiv I_t^m$$

In this case, the participation of outside investors implies the incentive compatibility constraint $p_H R_t^{f,j} \geq p_L R_t^{f,j} + bI_t$, that is,

$$R_t^{f,j} \geq \frac{bI_t}{\Delta}$$

where $R_t^{f,j}$ denotes the payoff to the branch manager in case of project success.

Finally, for outside investors to recover the opportunity cost of their funds, their expected payoff must be at least as large as the amount they lend to the project. This can be written as:

$$p_H(Q_t R I_t - R_t^{f,j} - R_t^{m,j}) \geq I_t - I_t^{m,j} - A_t^i$$

As in the case of direct finance, one can show now that a branch j will be able to finance its project via monitored finance if it has enough equity: $A_t^j \geq \underline{A}_t$, where

$$\underline{A}_t = I_t \left[1 - \frac{cp_H}{\beta_t \Delta} - p_H \left(R Q_t - \frac{b+c}{\Delta} \right) \right] \quad (12)$$

Additional comment on the determination of the rate of return to bank equity, β_t , may be useful for the analysis later. In this setting, as in HT, the return to a banker for participating in a project must be large enough to induce monitoring. This requires that the payoff to the banker, $R_t^m = cI_t/\Delta$, exceed the opportunity cost of the monitoring cost, which is just cI_t (since $\Delta < 1$ and the alternative rate of return is the intraperiod return of zero). Therefore, bankers earn an excess return for participating in investment projects. The assumption in HT, which we borrow here, is that bankers compete for such excess returns by providing equity I_t^m

to the projects. The rate of return β_t then adjusts so as to equate the aggregate amount of bank equity thus provided to the available stock at the beginning of the period, which will be denoted by K_t^m . In our formulation, K_t^m is predetermined, so the rate of return on equity β_t adjusts to reflect the scarcity of bank capital.

2.2.2 The Choice of Project Size

To proceed, let $G_t(A_t^i)$ denote the distribution of equity in period t . This is a time dependent function derived from $A_t^i = Z_t^i K_t^f$ and our assumptions about the distribution of Z_t^i .⁸ One can show that the profits of a typical holding in period t can then be written as:

$$\begin{aligned} \Pi_t^f &= p_H Q_t R I_t (1 - G_t(\underline{A}_t)) + \int_0^{\underline{A}_t} A_t^i dG_t(A_t^i) \\ &\quad - \int_{\underline{A}_t}^{\infty} (I_t - A_t^i) dG_t(A_t^i) - p_H \frac{c I_t}{\beta_t \Delta} (G_t(\bar{A}_t) - G_t(\underline{A}_t)) (\beta_t - 1) \end{aligned} \quad (13)$$

The first line expresses the holding's end of period revenue, the sum of expected payoff from investment projects plus the (zero) return from funds from branches that will not be able to finance project. The first term in the second line summarizes the market cost of external finance. Noting that $p_H c I_t / \beta_t \Delta = I_t^m$, the last term captures the excess return to bank equity.

The holding chooses investment size I_t to maximize profits subject to (11) and (12), taking Q_t and β_t as given. After some manipulation, the first order optimality condition can be written as:

$$\begin{aligned} &(p_H R Q_t - 1)(1 - G_t(\underline{A}_t)) - \left[\frac{c p_H}{\Delta} \left(1 - \frac{1}{\beta_t}\right) \right] (G_t(\bar{A}_t) - G_t(\underline{A}_t)) \\ &= \underline{A}_t g_t(\underline{A}_t) [p_H R Q_t - 1] + [\bar{A}_t g_t(\bar{A}_t) - \underline{A}_t g_t(\underline{A}_t)] \frac{p_H c}{\Delta} \left(1 - \frac{1}{\beta_t}\right) \end{aligned} \quad (14)$$

where $g_t(A)$ is the density function associated with $G_t(\cdot)$.⁹

The preceding equation together with (11) and (12) now determine I_t , \underline{A}_t , and \bar{A}_t . The

⁸ $G_t(A) = \Pr \{A_t^i \leq A\} = \Pr \{\log A_t^i \leq \log A\} = \Pr \{\log Z_t^i \leq \log A - \log K_t^f\} = \Phi(\log A - \log K_t^f)$

⁹ $g_t(A) = \frac{\partial}{\partial A} G_t(A) = \frac{1}{A} \phi(\log A - \log K_t^f)$

interpretation of this condition is illuminating. The LHS can be seen as the expected increase in the surplus to the holding from a marginal increase in project size I_t . Each additional unit of initial investment has expected return $p_H R Q_t - 1$, and is undertaken by $1 - G_t(\underline{A}_t)$ branches. Part of that gain, however, is appropriated by the banks because the return on bank equity exceeds the market return (that is, if $\beta_t > 1$): this is the second term in the LHS. The RHS collects terms associated with the impact of an increase in I_t on the distribution of branches. A larger I_t implies an increase in \underline{A}_t and, hence, a reduction of approximately $\underline{A}_t g_t(\underline{A}_t)$ producing units, implying a corresponding reduction in the holding's revenue of $p_H R Q_t - 1$ per lost unit. Finally, \bar{A}_t also increases, which means that approximately $\bar{A}_t g_t(\bar{A}_t)$ branches move from direct finance to bank finance. Since $\underline{A}_t g_t(\underline{A}_t)$ drop out from production, the number of branches resorting to bank finance increases by $[\bar{A}_t g_t(\bar{A}_t) - \underline{A}_t g_t(\underline{A}_t)]$, with each of them shifting profit towards banks by $(p_H c / \Delta)(1 - 1/\beta_t)$.

2.3 Market Clearing and Dynamic Equilibrium

As discussed, the return on the bankers' equity, β_t , adjusts so that the bankers' participation in investment projects adds up to bank equity, denoted by K_t^m . This requires:

$$K_t^m = I_t^m [G_t(\bar{A}_t) - G_t(\underline{A}_t)] = \frac{p_H c I_t}{\beta_t \Delta} [G_t(\bar{A}_t) - G_t(\underline{A}_t)] \quad (15)$$

In turn, the equilibrium price of new capital goods, Q_t , must adjust to equate the demand for new capital goods to their supply:

$$X_t = p_H R I_t [1 - G_t(\underline{A}_t)] \quad (16)$$

To finish specifying dynamics, we need to describe the laws of motion of the equity variables K_t^m and K_t^f . As a first approximation, we simply assume here that banks and holding company branches have fixed dividend rates $1 - \theta^m$ and $1 - \theta^f$ respectively.

Hence the law of motion of K_t^m is

$$K_{t+1}^m = \theta^m p_H \frac{cI_t}{\Delta} [G_t(\bar{A}_t) - G_t(\underline{A}_t)] \quad (17)$$

and the law of motion of K_t^f is $K_{t+1}^f = \theta^f \Pi_t^f$, which can be simplified to:

$$\begin{aligned} K_{t+1}^f &= \theta^f \Pi_t^f = \theta^f \{(p_H R Q_t - 1) I_t [1 - G_t(\underline{A}_t)] \\ &\quad + K_t^f - p_H \frac{cI_t}{\Delta} (1 - \frac{1}{\beta_t}) [G_t(\bar{A}_t) - G_t(\underline{A}_t)]\} \end{aligned} \quad (18)$$

Now the eight equations (11)-(18) give $I_t, \underline{A}_t, \bar{A}_t, \beta_t, Q_t, \mu_t$ and the motion of K_t^m and K_t^f . Together with (1)-(10) and an assumption about the process for exogenous shocks, they complete the specification of the model.

2.4 The Choice Between Direct versus Indirect Finance

In spite of the complexity of the model, one can extract useful insight about the choice of direct versus indirect finance by studying the equilibrium conditions. Specifically, consider an unexpected increase of investment demand, which may be due to one of the shocks to be discussed in more detail later. Intuitively, in equilibrium, both the price and the quantity of investment must increase. Since the production of investment goods requires external finance, and the equity of both investment branches and banks is slow to adjust, the total amount of credit raised by the investment sector must increase, at least in the short run.

But we can say more. Increasing the production of investment goods in this model requires a combination of a larger investment project size I_t and of adjustments in the numbers of branches resorting to either direct or indirect finance. The latter is determined by the thresholds \bar{A}_t and \underline{A}_t , given by (11) and (12).

In this situation, for the model to generate an increase in direct finance relative to indirect finance, as in the data, it must be the case that (roughly speaking) the threshold \bar{A}_t fall relative

to \underline{A}_t . But such a fall must reflect that bank finance has become relatively more expensive, as given by an increase in the return to bank equity β_t . More precisely, note that (11) and (12) imply that

$$\frac{\bar{A}_t}{\underline{A}_t} = \frac{1 - p_H(RQ_t - \frac{B}{\Delta})}{1 - \frac{cp_H}{\beta_t \Delta} - p_H(RQ_t - \frac{b+c}{\Delta})}$$

An increase in investment demand raises the price of capital Q_t which, by itself, would raise the ratio.¹⁰ Increased investment demand also raises the return on bank equity, β_t , and this must be the dominant force if the ratio is to fall.

The intuition is simple and illustrates the crucial roles of corporate equity and bank equity. As emphasized by HT, an investment branch will undertake a project of size I_t if and only if it has enough equity to cover the shortfall between the unit cost of investment, which is one, and the *pledgeable income* from the investment, which is $p_H(RQ_t - \frac{B}{\Delta})$ per unit. The cutoff \bar{A}_t is the value of equity which is just enough to cover that difference: that is what (11) says. Branches with equity less than \bar{A}_t resort to their next best option, which is monitored finance. This reduces those branches's moral hazard problem (reflected in the fall in the parameter B to b) but entails two additional costs: monitoring costs reduce pledgeable income directly, as given by the term c/Δ ; but, also, banks appropriate part of the surplus if $\beta_t > 1$, that is, if the rate of return on bank capital exceeds the (within period) market return (of one). Hence, when the price of capital increases, the fact that bank capital is scarce means that β_t must increase in equilibrium; this reduces pledgeable income for bank-monitored projects (but not for projects with access to direct finance).

In this way, our model provides an economic explanation of the observed increase of bond issuance relative to bank loans in emerging markets: falling world interest rates led to increased demand for investment, raising the profitability of investment projects; in response, producers of investment goods increased project size (I_t , in our model) and adjusted the number of active branches and borrowing (\bar{A}_t and \underline{A}_t); total credit then increased, predominantly through direct finance, since bank finance became more expensive (higher β_t).

¹⁰To see this, take logs and note that $\partial (\log \bar{A}_t / \underline{A}_t) / \partial Q_t = p_H R (1/\underline{A}_t - 1/\bar{A}_t) > 0$

The above argument is somewhat loose in that refers to the thresholds \bar{A}_t and \underline{A}_t only. Under our assumptions, however, the measure of branches resorting to either direct or indirect finance depends also on the shape of the distribution $G_t(A)$. Also, as we have seen, the thresholds depend on project size I_t . Therefore it will be useful to define measures of the total amounts borrowed via bonds or bank loans. For bonds, a reasonable measure is

$$CB_t = \int_{\bar{A}_t}^{I_t} (I_t - A_t^i) G_t(dA_t^i)$$

CB_t is appropriate under the assumption that branches with access to direct finance put all their equity into their projects, and that branches with excess equity (those with $A_t^i > I_t$) do not issue bonds. The corresponding measure for bonds is

$$BL_t = \int_{\underline{A}_t}^{\bar{A}_t} (I_t - A_t^i) G_t(dA_t^i)$$

This expressions emphasize that the shape of G_t impacts both measures and their ratio. If G_t were a Uniform cdf, of course, it would follow directly from the reasoning given above that an increase in investment demand would raise the bond measure relative to the loans measure. It is more realistic to assume that G_t is not Uniform, however, and we will need to resort to numerical methods to examine the ratio. But the intuition given above remains valid.

3 Steady State and Calibration

We calibrate the model at the quarterly frequency. As we noted, our specification of households and production of final goods is fairly standard. Consequently, values for associated parameters are readily taken from the literature on small open economy models.

Our choices for H , σ , τ and α , $\frac{C}{Y}$, R^* , $\tilde{\Psi}$, and φ are taken from Fernández and Gulán (2015). We normalize the price of capital goods Q and the total factor productivity parameter A to 1. We then choose β^h and δ to qualitatively match the empirical ratios $\frac{X}{Y} = 0.2$ and $\frac{K}{Y} = 8$.

The last value translates into capital stock being worth two years of output and is consistent with the data for Mexico collected by Kehoe and Meza (2012) . The volatility and persistence parameters of the exogenous shocks to productivity are set to standard values as well. We calibrate the R^* shock to fit the interest on ten year US bonds deflated by the University of Michigan survey-based inflation expectations. All calibrated parameters, normalizations and matched ratios are summarized in Table 1.

The second step of the calibration is more novel and involved. It concerns the parameters of the investment supply side, that is, of the holding companies. Recall that $\Phi(z)$ denotes the cdf of $z_t^i = \log(Z_t^i)$. We assume that is Normal with standard deviation σ_G and mean $-\sigma_G^2/2$ (which is necessary to ensure that the expectation of Z_t^i is one). This implies that the distribution of equity within the holding, $G_t(\cdot)$ is log-normal, with mean K_t^f . Log normality is often assumed in macroeconomics (e.g. Bernanke, Gertler, and Gilchrist 1999) and in line with the literature on the size of firms (e.g. , Axell 2001, Quandt 1966).

We set the quarterly rate of return to bank equity $\beta = 1.0364$, based on the World Bank's Global Financial Development Database (see Cihak et al. 2013) for the United States.¹¹ This automatically gives the value of banks' dividend parameter $\phi^m = \frac{1}{\beta}$. We then set $p_H = 0.99$ following Meh and Moran (2010) , which reflects a quarterly bankruptcy rate of 1%. We then manually set $p_L = 0.96$, the minimum value satisfying $\beta > \frac{p_H}{p_L}$.

At this stage one is left with equation (14), describing the first-order condition of the holding. Normalizing all terms by K^f and simplifying, the equation reduces to an expression in only 6 unknowns: $c, b, B, \sigma_G, i = I/K^f$ and R . To pin down their values, we use five more independent restrictions:

- The ratio of quarterly bank operating costs-to-bank assets, which we set to 0.78 percent guided by recent observations for the U.S. in the World Bank's WFDD. Because empirically monitoring costs constitute only a part of all banks' operating costs, this number

¹¹Recall that banks are foreign-based in the model because we attempt to explain the empirical dynamics of foreign bank loans.

constitutes in fact an upper bound for monitoring costs that one would like to target in the model.

- The ratio of bank assets to bank equity (i.e. bank leverage) where we target the value 10.64, in line with the evidence reported in the World Bank’s WFDD for U.S. commercial banks.
- The typical holding’s leverage: Fernández and Gulán (2015) report an average value of 1.71 for publicly-traded firms in EME-13.
- The median ratio of gross external bank credit to quarterly GDP, reported in the BIS for 5 selected Latin American countries (Brazil, Chile, Colombia, Mexico and Peru), approximately equal to 6.28 percent.
- Using the same source as guidance as in the previous bullet, we set the fifth and final ratio, gross foreign corporate bond issuance to GDP, to 19.28 percent.

In addition to the six equations just listed, the unknowns c , b , B , σ_G , $i = I/K^f$ and R must satisfy some inequalities¹². Hence we choose values for those unknowns to minimize a weighted average of the differences between the model-generated and empirical ratios subject to the required inequalities. Details are given in the Appendix.

Table 2 presents the empirical targets of the ratios alongside those in the calibrated model whereas Table 3 summarizes the financial parameters’ values that deliver these targets. The overall match is satisfactory. We get very close to the chosen targets for bank leverage and corporate bonds-to-GDP ratio. We underestimate somewhat the volume of bank loans, but importantly, they are still over twice as large in the model than bonds, as it is the case in the data. We underestimate the bank operating costs, however, as discussed previously, the empirical target should be only interpreted as an upper bound for bank monitoring costs because

¹²Specifically, it follows from HT that, for the model to be well behaved, the parameters c , b , B and R must satisfy: $0 < \underline{A} < \bar{A} < I - I^m < I$, $b + c > B > b$. Also, the Lagrange multipliers associated with (11) and (12) must be positive. Finally, there are natural restrictions; for example, monitoring costs cannot be negative and the rate of return R should be greater than 1.

it reflects all banks' operating costs. The one dimension in which the match is not as close is the leverage of the holding: the target is 1.71 whereas the best we can generate with the model parameters is 4.76.

4 Dynamic Implications

4.1 Implications of Lower Interest Rates

Figure 3 describes impulse responses to a one percentage point drop in the world interest rate R^* . This exercise is intended to explore the response of the model to the fall in real interest rates observed since the start of the millennium.

As usual, lower world interest rates raise both the household's stochastic discount factor and the marginal utility of consumption. As a consequence, consumption, output, and hours increase for several periods (about 20 quarters in our calibration), reflecting the persistence of the R^* shock. Also as a consequence, households increase their demand for capital goods X_t . This is met, in equilibrium, with both an increase in the production of new capital goods and the price of capital Q_t .

The dynamic responses of investment and the mix of direct and indirect finance accord with the intuition presented earlier. Since the price of new capital increases, holding companies have an incentive to increase production. To do this, the size of the typical project relative to the holding's capital, $i_t = I_t/K_t^f$, increases for several quarters. Since K_t^f is predetermined, the project size I_t itself increases on impact; afterwards, the response of I_t is hump shaped.

To understand the responses of the quantities of bonds and loans, as argued earlier, the figure reports the responses of the thresholds \bar{A}_t and \underline{A}_t normalized by K_t^f (they are denoted by \bar{a} and \underline{a} in the figure, respectively). From (11) we know that the response of \bar{A}_t is ambiguous, since the increase in I_t raises it but the increase of Q_t lowers it. The latter dominates in our calibration: on impact, \bar{A}_t/K_t^f falls, and therefore \bar{A}_t does too, implying that the number of branches resorting to direct finance increases (these are labeled "Category 3"

branches). In contrast, A_t increases. As discussed, this reflects not only the impact of higher I_t and Q_t , but also an increase in the supranormal return to bank equity β_t ; the latter occurs, as discussed, because bank capital is predetermined.

The figure shows that both bonds and loans increase on impact, although bonds increase by more, so that the CB/BL ratio goes up. Once more, a key reason is that the increase in investment demand raises the relative cost of bank finance, which reflects the scarcity of bank capital.

The CB/BL ratio increases its steady state level for about a year and a half, and then undershoots. This reflects the dynamics imparted by the accumulation of profits, which leads to increases in both the holding's equity K_t^f and bank equity K_t^m . Both increase for about two years, which in turn supports more investment production and, therefore, bond financing and loan financing (i.e. the extensive margin expands). As a consequence, Q_t drops relatively quickly. Also, β_t also falls sharply, reflecting both the fall in Q_t as well as the accumulation of bank equity. The fall in β_t means that bank finance becomes more attractive; this is reflected in the fact that BL_t has a hump shaped response, while CB_t is monotonic. This also explains why the CB/BL ratio appears to be less persistent than investment.

Over time, the impact of the shock wanes, and all variables return to their steady state values. Overall, this experiment indicates that our model can replicate the recent observed increases in both direct and indirect finance, as the economy reacts to a fall in the world interest rate. In this sense, the model rationalizes the evidence presented in the introduction.

4.2 A Simulation

As a complement to the impulse response analysis of the previous subsection, we examine implications of our calibrated model when hit by a sequence of shocks to real interest rates akin to those observed in the data. To this effect, we obtain the fitted residuals from an AR(1) process that we estimate on the real *ex ante* 10 year US TBill rate. Then we feed these residuals as R^* shocks into the model. The simulation period goes from 3Q 2004 until 4Q 2015. Figure 4

plots the results of this experiment.

The left panel plots the total amount of corporate external debt implied by the model, adding up bond stock CB_t as well as bank loans BL_t , and normalizing the total stock of debt to 100 for the first period of the simulation. The right panel plots the simulated paths of CB_t and BL_t separately. Qualitatively, the process of total debt tracks well the one observed in Figure 4. First, the simulation captures a rise of debt in the pre-Lehman period, then a reversal during the crisis in 2008-2009, followed by a vigorous recovery in the years 2010-2013.

It is also worth stressing that the simulation mimics a stronger recovery of bond issuance in the post crisis, relatively to that of loans, which is a distinctive feature in the data presented in Figure 4. However, the simulation counterfactually predicts a considerable fall in the last two years of the period considered, 2014-2015, whereas the data displays only a stagnation.

This experiment is also consistent with the model's view of how low interest rates may help explaining the outburst of corporate external debt in emerging markets. Evidently, factors other than low interest rates may have also contributed to the considerable growth in debt in these economies, and indeed one of them, commodity prices, will be the subject of a later section. But before we turn to that, we explore the role and impact of some of the deep parameters of the model.

4.3 The Impact of Financial Frictions

Different values for the parameters in the model, in particular those related to financial frictions, can be interpreted as capturing the model's implications for countries at various levels of financial development. We focus on monitoring costs and the private benefit from moral hazard.

4.3.1 Monitoring Costs

Suppose that monitoring costs, c , are one third higher than in the benchmark calibration. The corresponding steady state is reported in the third column of Table 4.

Intuitively, a larger c reduces the supply of investment, so that aggregate investment X should go down and the price of capital Q should go up. In turn, the steady state levels of capital, output, and consumption all should go down. The table shows that all of these implications are borne out, although the magnitudes are small.

More noticeably, bank loans BL fall in the steady state. This is not surprising, since a larger monitoring cost not only induces less total borrowing, but also a switch away from bank finance. To put it in terms of our previous discussion, a larger c is associated with a lower project size I and a higher price of capital Q . Looking at (11) and (12), both have the same effect on \bar{A} and \underline{A} , reflecting that they affect pledgeable income in the same way. However, the higher value of c have an additional, direct effect on \underline{A} , reflecting that larger monitoring costs reduce pledgeable income of monitored projects. So it must be the case that, for given I , the difference $\bar{A} - \underline{A}$ must fall. (It is worth comparing this argument with our previous discussion, which relied on changes in β : the steady state value of β does not depend on c).

The switch away from bank finance explains why corporate bonds, CB , increase in the steady state. This reflects that more branches move to Category 3 (direct finance) which overcomes the fact that each branch borrows less (since project size I falls). In contrast, the fall in BL is explained by the fall in project size, since the measure of branches moving to Category 2 (bank finance) actually increases.

To see how the model's dynamics change when c is higher, Figure 5 plots impulse responses to a one percentage drop in the world interest rate R^* in the benchmark case (black) and the counterfactual case of higher c (red). In the counterfactual case, the response of the real variables is dampened relative to the benchmark. In other words, increasing the cost of monitoring puts sand in the wheels of the mechanism by which financial shocks translate into movements in economic activity. This can be clearly seen the responses of aggregate investment X , which increases in the counterfactual by much less relative to the benchmark, thus making the price of investment goods Q go upwards by more.

The explanation for the dampening can be traced back to the responses of the holding's

debt, particularly that channeled through banks. Indeed, total loans not only decrease in the steady state (as argued before), but their response to a drop in interest rates is less vigorous when c increases than in the benchmark. This comes intuitively from the fact that bank credit is more costly. Note also that the response of bond finance is stronger relative to the benchmark, increasing the bond to loan ratio.

Another direct consequence of higher monitoring costs and the associated reduction of the demand for bank loans is the reduction of banks' revenue. Consequently, bank equity accumulation is relatively more sluggish than in the benchmark, which inhibits banks lending later on. This has also negative implications for equity buildup of the holding companies which, likewise, experiences a relatively slower pace of equity accumulation. Lastly, household income is affected by this slower equity buildup of the holding insofar as the dividends are smaller than in the benchmark, reducing the extent to which consumption rises following the shock.

4.3.2 Private benefits

Suppose now that the private benefit B associated with moral hazard is ten percent smaller relative to the benchmark. This may capture an increase in transparency in the private sector, less corruption, or a stronger rule of law.

The impact on the steady state is given in the last column of Table 4. Intuitively, one should expect a lower B to lead to more investment, capital, output, and consumption, as well as a lower price of investment goods. Again, these predictions are confirmed by the table, although the magnitudes are small.

Lower private benefits also favor direct finance over bank finance. The table shows that, accordingly, the measure of branches obtaining direct finance (Category 3) increases, and so does the amount of bonds CB . In contrast, the measure of branches with bank loans falls; this reflects both the increase in project size I as well as the fall in the price of investment Q . As a consequence, bank loans BL fall in the steady state.

Figure 5 describes the impulse responses to a one percentage drop in the world interest

rate R^* in the benchmark (solid/dark) and the counterfactual case (dashed/red) of lower B . Perhaps the most remarkable feature of the counterfactual dynamics is reflected in the evolution of the holding's debt. The quantity of bonds increases by more relative to the benchmark while the opposite occurs with bank loans. Consequently, the bond-to-loan ratio increases more on impact, (in addition to the previously discussed increase in the steady state).

However, this change in the composition of debt does not translate into a stronger increase in the reaction of the real variables (e.g., output, investment, consumption) following an interest rate shock. If anything, the opposite occurs, i.e. the reactions of real variables are now dampened relative to the benchmark case when B was higher. The key to understand this is that, even with a lower B , the reaction of investment holdings to an increase in the price of capital is restricted by its equity, and also by bank equity (which determines the cost of bank finance). The accumulation of both types of equity is slower than in the benchmark, which dampens the impulse responses.

The observations in this subsection and the previous one raise the interesting possibility that the observed increase in bond financing relative to bank financing may reflect changes in the financial technology, as given by an increase in c or a fall in B . Such changes, in turn, would be not increase the economy's sensitivity to external shocks: here the responses of investment and aggregate demand to interest rate shocks are, if anything, smoother when c is higher or B lower. This should not be too surprising in the context of our model, because investment holdings do take advantage of an additional margin of adjustment when facing shocks. On the other hand, this perspective provides an interpretation of the data reviewed in the introduction that is more optimistic than that of Shin (2013) and others.¹³

¹³As mentioned in a previous footnote, Shin's (2013) perspective is largely grounded on the possibility of currency mismatches. Our model does not feature mismatches, so it is not suitable to evaluate such perspective. On the other hand, there is no obvious reason why mismatches should be worse for firms than for banks, and hence the increase of bond issue relative to bank loans has no clear implications for our analysis.

5 Bonds, Loans, and Commodity Prices

While world interest rates appear to be the obvious suspects in accounting for the observed dynamics of bonds and loans, emerging economies have been hit by other external shocks. Most noticeably, drastic fluctuations in commodity prices have been at center stage, as illustrated by Figure 7. The left panel of the figure plots the evolution of the price index for the three broadest categories of commodity goods, raw agricultural products, metals and fuels, since the 1990s. It shows a remarkable increase in the volatility of the prices of all three categories since the mid 2000s.¹⁴

The right panel of Figure 7 uses country-specific commodity price indices computed for Brazil, Chile, Colombia, and Peru, all net commodity exporters, and compares the indices with the Latin American EMBI spread. The plot shows that the four price indices were strongly correlated with each other, and also endured a marked increase in their volatility since the mid 2000s. At that time foreign financing these countries also began increasing; this was expressed by a remarkable negative comovement between commodity prices and country spreads, which is shown in the figure. That periods of booming commodity prices have coincided with low interest rate spreads on country debt has been observed not only for the four countries here but for emerging economies in general.¹⁵

These drastic fluctuations in the prices of commodities exported by emerging economies has motivated a recent literature on their business cycle implications as well as the appropriate monetary and fiscal policy responses.¹⁶ The literature, however, has largely ignored the related issue of how commodity prices and financial flows may be related. Specifically, can favorable shocks to commodity prices explain the stylized patterns of bond and bank financing in emerging

¹⁴The three price indices are computed by the IMF and are publicly available on the web. The figure presents a smoothed transformation of the original series using a centered rolling moving average of 6 months.

¹⁵Country-specific commodity prices come from Fernández et.al (2015), who calculated them combining the spot prices of 44 distinct commodity goods sold in international markets with country-specific shares of each of these commodities in total commodity exports. This work computes country-specific price indices for a large pool of emerging economies and quantifies the (strong) degree of comovement between them. It also provides more systematic evidence between country-specific commodity prices and measures of sovereign and corporate spreads of international debt issued by emerging economies.

¹⁶See e.g. Fernández et al. (2015) and the studies in Caputo and Chang (2015).

economies? In this section we outline an extension of our basic model that provides a positive answer. More generally, the model suggests interesting links between commodity prices and the type of capital flows to emerging economies.¹⁷

Doing full justice to this issue would require a separate paper, in our view; our treatment here is intended only to illustrate the main connections, as well as to reinforce the intuition of our model of alternative modes of finance. So, following Catao and Chang (2013), among others, we add a simple commodity export sector ("mining") of competitive "mines" to the benchmark model analyzed before. The representative mine produces an export commodity ("copper") whose world price (relative to traded final goods) is exogenous and denoted by P_t^C . It is assumed that P_t^C follows an AR(1) process:

$$P_t^C = (1 - \rho_C) \bar{P}^C + \rho_C P_{t-1}^C + \varepsilon_t^C$$

where \bar{P}^C is the real steady state price of copper and ε_t^C are normally distributed iid shocks with mean 0 and variance σ_C^2 .

Production only takes capital, and the production of the typical mine is:

$$Y_t^C = A_C (K_t^C)^{\alpha_C}$$

where Y_t^C denotes copper output and K_t^C the copper mine's capital. In addition, α_C and A_C are constants.

The mine's only cost is investment X_t^C , which governs the evolution of mining capital. For simplicity, assume adjustment costs are similar to the household's, although with possibly

¹⁷Recent works have studied the amplification mechanism of spreads that react to changes in commodity prices within a quantitative general equilibrium (see Fernandez et.al. 2015, and Shousha, 2016). Others have tried to provide microfoundations of movements in spreads following changes in commodity prices within a financial accelerator framework (Beltran, 2015; González et.al, 2015). None of these works, however, have studied the type of capital inflows into emerging economies and commodity prices.

different coefficients:

$$K_{t+1}^C = (1 - \delta^C)K_t^C + X_t^C - \frac{\varphi^C}{2}K_t^C \left(\frac{K_{t+1}^C}{K_t^C} - 1 \right)^2$$

The profits of the typical mine are then given by

$$\Pi_t^C = P_t^C A_C (K_t^C)^{\alpha_C} - Q_t X_t^C$$

In the preceding expression we have assumed that the mining sector uses the same investment goods as in the non mining sector, and buys them at the same price Q_t . Profits increase with the commodity price, and fall with the price of investment Q_t .

Finally, we assume that mines are wholly owned by the representative household. As a consequence, the mine's problem is to choose a dynamic investment plan to maximize the present value of its profits, with the discount factor given by the household's marginal utility of income. This results in an adjustment equation of mining capital which is similar to the one for non-mining capital:

$$\begin{aligned} & Q_t \left[1 + \varphi^C \left(\frac{K_{t+1}^C}{K_t^C} - 1 \right) \right] \\ = & \beta^h E_t \frac{\lambda_{t+1}^c}{\lambda_t^c} [r_{t+1}^C + Q_{t+1} \{ (1 - \delta^C) + \varphi^C \left(\frac{K_{t+2}^C}{K_{t+1}^C} - 1 \right) \frac{K_{t+2}^C}{K_{t+1}^C} - \frac{\varphi^C}{2} \left(\frac{K_{t+2}^C}{K_{t+1}^C} - 1 \right)^2 \}] \end{aligned}$$

where

$$r_t^C = \alpha_C P_t^C A_C (K_t^C)^{\alpha_C - 1}$$

is the return on mining capital. Note that it increases with the commodity price.

The addition of the commodity sector requires two further amendments to the baseline model. First, the household's budget constraint 4 must include profits from this sector, Π_t^C . And second, since total investment is now $X_t + X_t^C$, the market clearing condition for investment

(16) becomes

$$X_t + X_t^C = p_H RI_t [1 - G_t(\underline{A}_t)]$$

Calibrating the extended model involves choosing the parameters of the mining production function, α_C and A_C , a depreciation rate for mining capital δ^C , the capital adjustment parameter φ^C , and the parameters in the process for the world price of commodities, P^C . Regarding the production function in the commodity sector, in a similar specification Fornero et.al (2014) calibrate the capital share parameter to 0.31, using available data of physical capital from Codelco, the main copper producing company in Chile. Since this is almost the same as the capital share $\alpha = 0.32$ of the baseline model, we just set $\alpha_C = \alpha = 0.32$. Likewise, we set δ^C and φ^C at the same levels of their counterparts in the non-commodity sector. The two parameters in the process of the commodity price are set to $\rho_C = 0.73$ and $\sigma_C = 0.063$ following Fernández et.al (2015) who estimated an AR(1) process using country-specific commodity prices for various emerging economies that are net commodity exporters. Finally, we choose A_C and adjust the nonstochastic steady state value of A_t so that, in the nonstochastic steady state, the total amount of investment in the model with commodities, $X + X^C$, equals the amount of investment in the model without commodities; and also so that the value of mining output as a fraction of total home output is equal to 13.36 percent. The latter figure is the average of the commodity production to GDP ratio for Brazil, Chile, Colombia and Peru using estimates from Fernández et.al (2015).

Figure 8 presents impulse responses to a one percent favorable shock to commodity prices, P^C . Intuitively, one would expect an exogenous increase in the commodity price to raise profitability in the export sector, increasing investment and capital accumulation there, and also lead to increased consumption. The impulse responses are indeed consistent with such expectations. Total investment increases, and the price of capital Q jumps up. Note, however, that investment in the non-commodities sector falls on impact. This is not too surprising given the increase in Q , and is reminiscent of "Dutch Disease" models.

The increase in total investment demand and the price of capital lead to by now familiar

effects on the investment production side, as well as the behavior of bonds and loans. As in the baseline model, both bonds and loans increase, with the bonds to loans ratio increasing over its steady state value for about a year. Again, two forces are key: the increase in investment production leads to an expansion of both modes of finance; at the same time, the return to bank equity goes up, which makes bank finance relatively more costly to investment producers, and provides an incentive to switch from loans to bonds.

We see, therefore, that the dynamic behavior of bonds and loans in emerging economies can be a response to improvements in the prices of those countries' main exports. Also, that the mechanism by which such shocks affect bonds and loans when we add commodities to the model is quite similar to the one in the baseline model. In that sense, the analysis of this section complements and reinforces the insight of our specification of investment supply.

The model of this section can and should, of course, be extended in several plausible directions. Also, one may want to investigate whether commodity prices are a better (or worse) candidate than world interest rates in accounting for observed dynamics; or whether the two kinds of shocks have reinforced each other in that regard. These extensions are outside the scope of the present paper.

6 Final Remarks

We have developed a tractable and intuitive dynamic model of the endogenous determination of direct versus indirect finance, and its relation with macroeconomic outcomes. While the model yields several interesting insights, it has relied on several strong assumptions. Most notably, we have assumed that the distribution of equity across investing branches is given by exogenous idiosyncratic shocks. We made that assumption for tractability: it ensures that the distribution of equity from changes over time only through its first moment K_t^f . Relaxing it may require adding the whole distribution to the set of aggregate states, which is known to be a hard computational issue; on the other hand, it would make the fiction of investment holdings

unnecessary, allowing for that fiction to be dropped altogether. It is unclear to us whether such an extension would significantly affect the model's implications for aggregate outcomes, but it is an obvious question for our research agenda.

Other assumptions should be easier to relax. For instance, we assumed that investment projects, and their financing, are all resolved within the period. This simplifies the analysis, but loosens the mapping between the model's variables and empirical variables. We plan to address these and other issues in future work.

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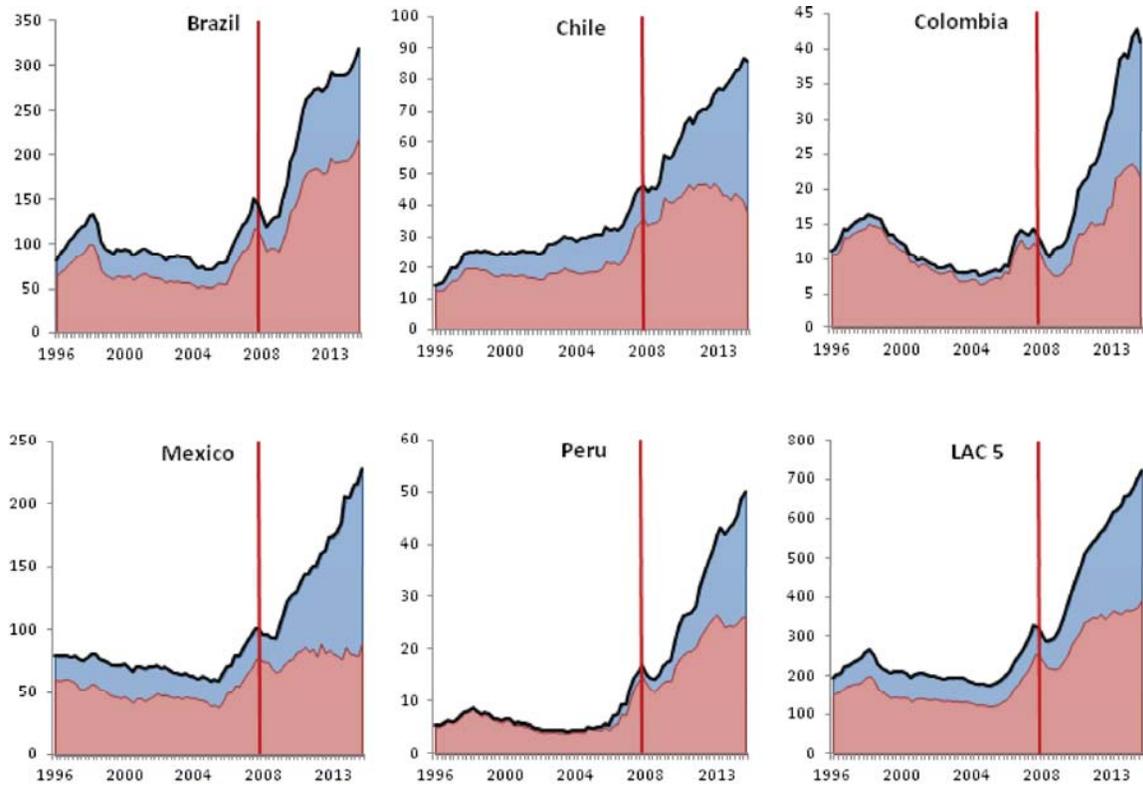
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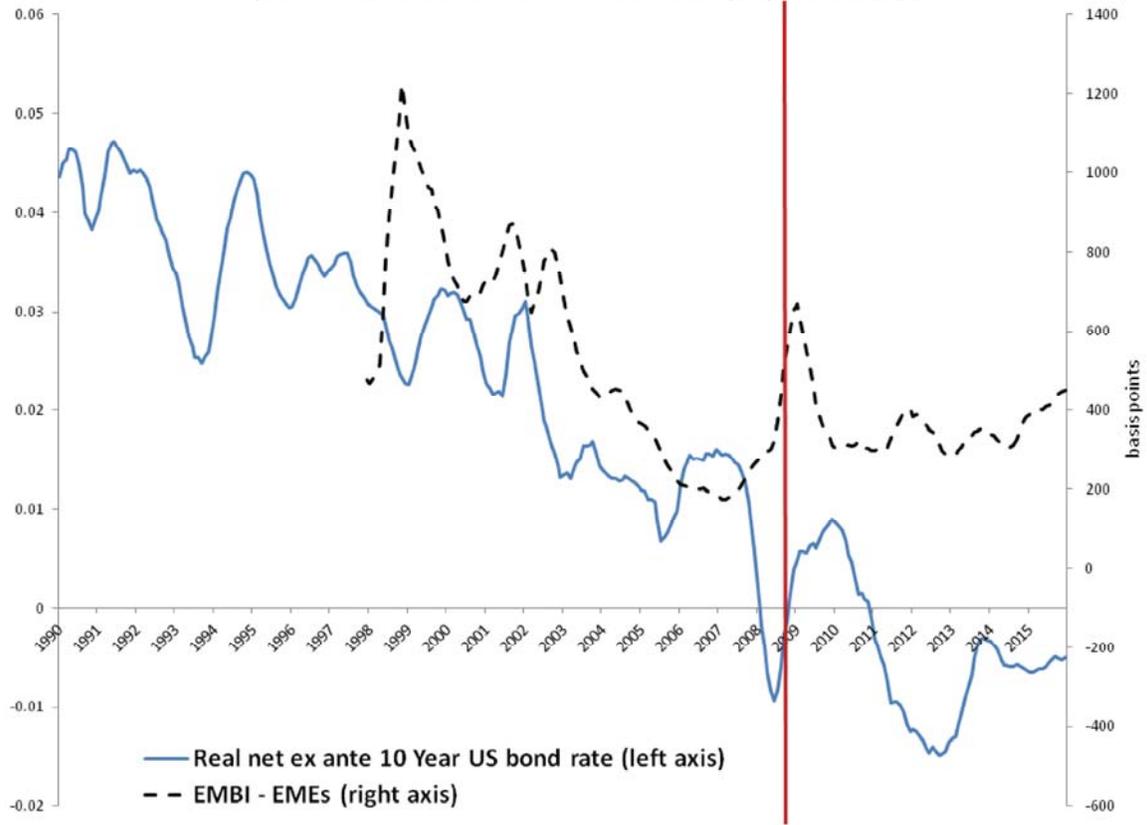
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Figure 1: Stock of foreign corporate debt in Latin America



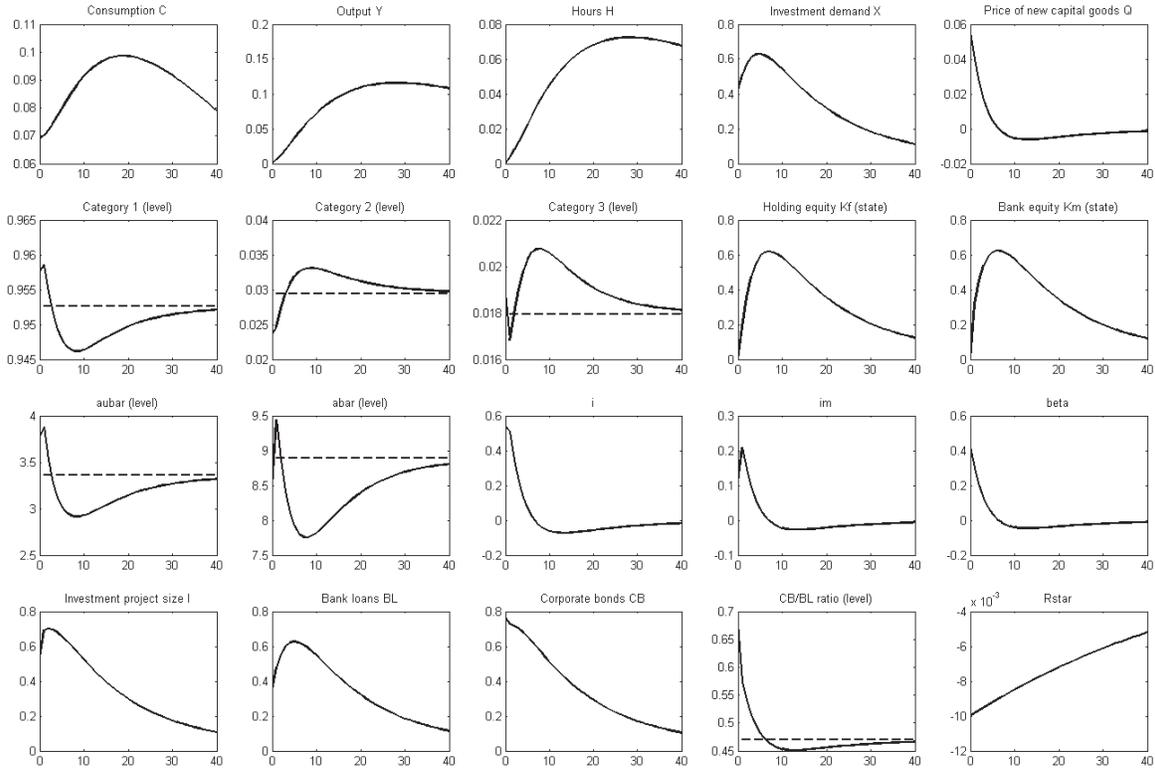
Notes: Units are billion USD. Red (bottom) areas indicate the stock of outstanding bank loans and blue (top) areas indicate outstanding corporate bonds. Vertical lines indicate the collapse of Lehman Brothers. Sources: IDB (2014) and BIS.

Figure 2: Global Interest rates for Emerging Economies.



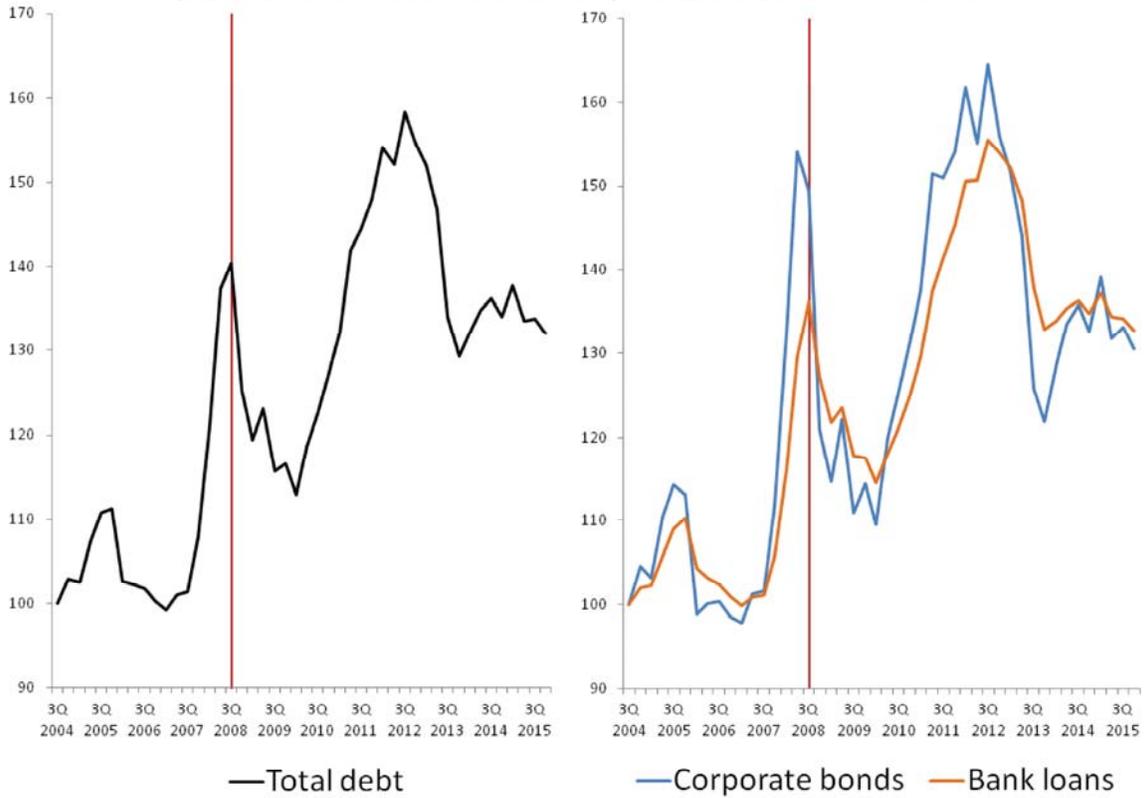
Notes: Vertical line indicates the collapse of Lehman Brothers. The 10 Year U.S. bond rate is deflated using the University of Michigan Consumer Survey Inflation Expectations. *Sources:* Bloomberg and University of Michigan.

Figure 3: Impulse responses to one percentage point drop in R^* .



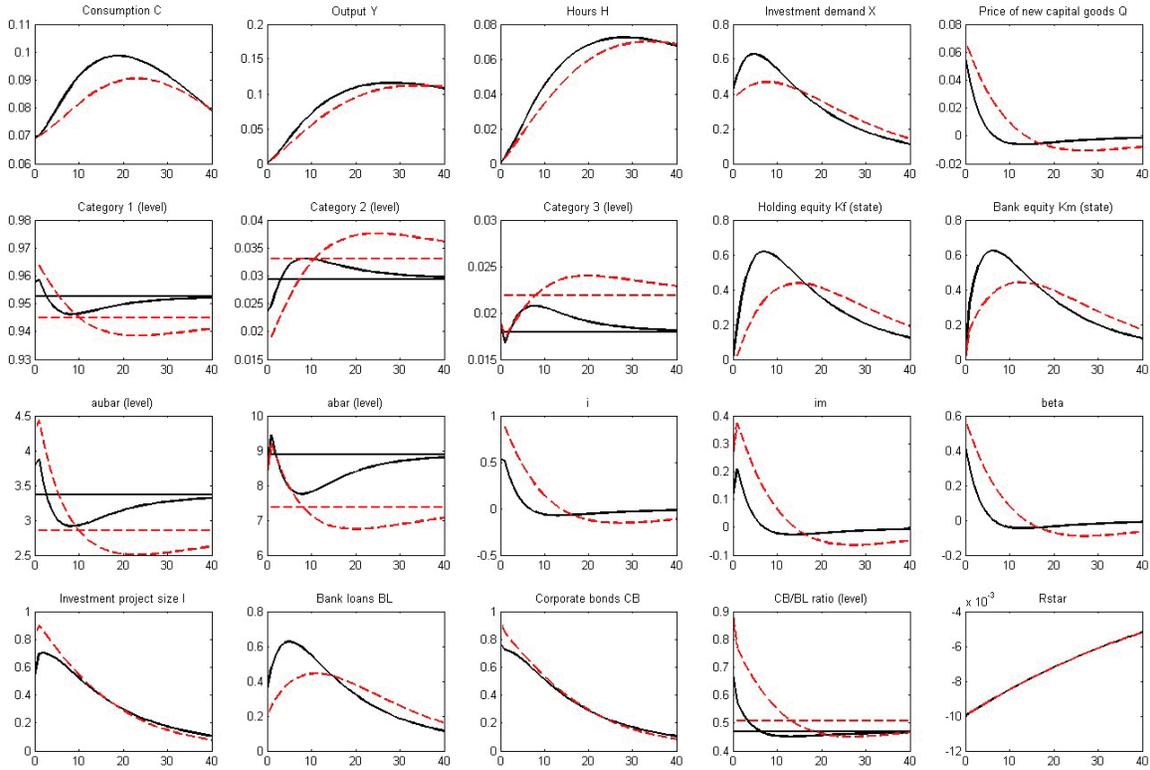
Notes: All variables plotted are percentage deviations from the non-stochastic steady state, unless indicated that they are in levels. This applies to the IRFs for the three categories, cutoffs and the bond-to-loan ratio. Horizontal dashed lines denote steady state values of the variables plotted in levels.

Figure 4: Simulation of debt following R^* shocks, 3Q 2004 - 4Q 2015.



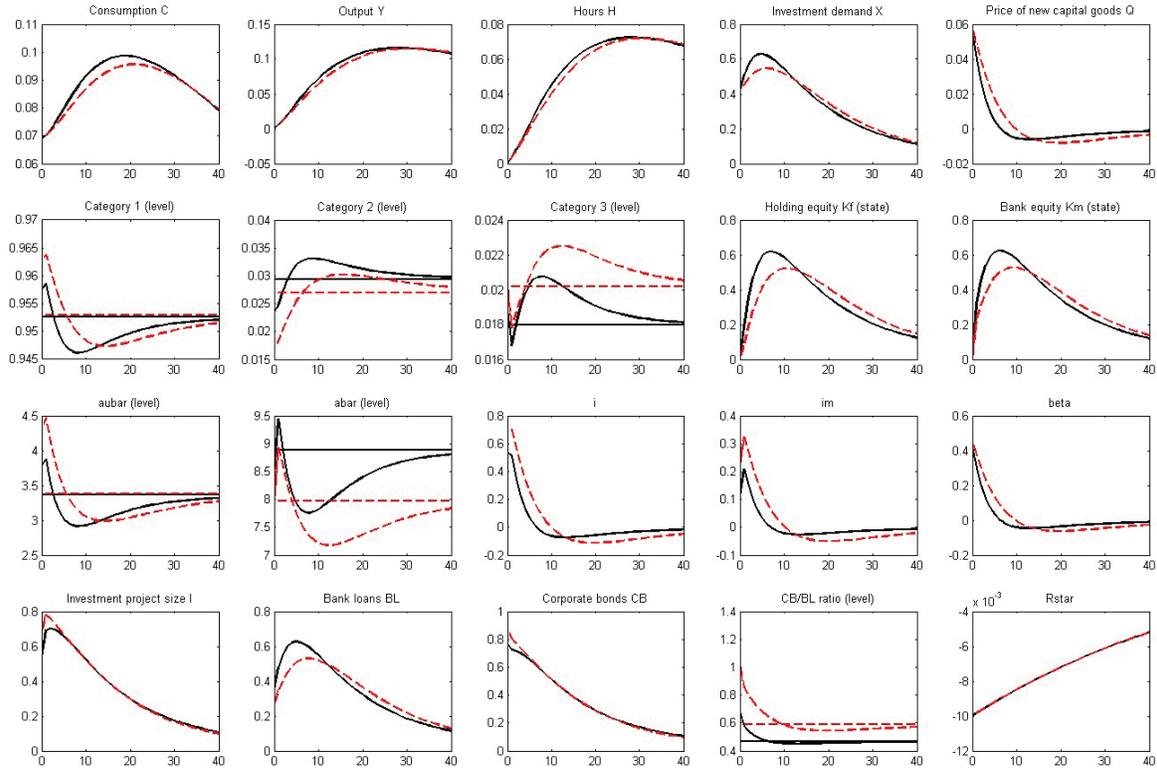
Notes: In the simulation the real interest rate shocks proxied by fitted residuals from an AR(1) process on the real *ex ante* 10 year US bonds rate are fed to the model. The left panel plots the total amount of corporate external debt implied by the model, whereas the right panel splits this debt into stocks of bank loans BL_t and bonds CB_t . All simulated series are normalized to 100 for the first period of the simulation. Vertical line indicates the collapse of Lehman Brothers. *Sources:* Bloomberg, University of Michigan and authors' computations.

Figure 5: Counterfactual impulse responses to one percentage point drop in R^* with high c .



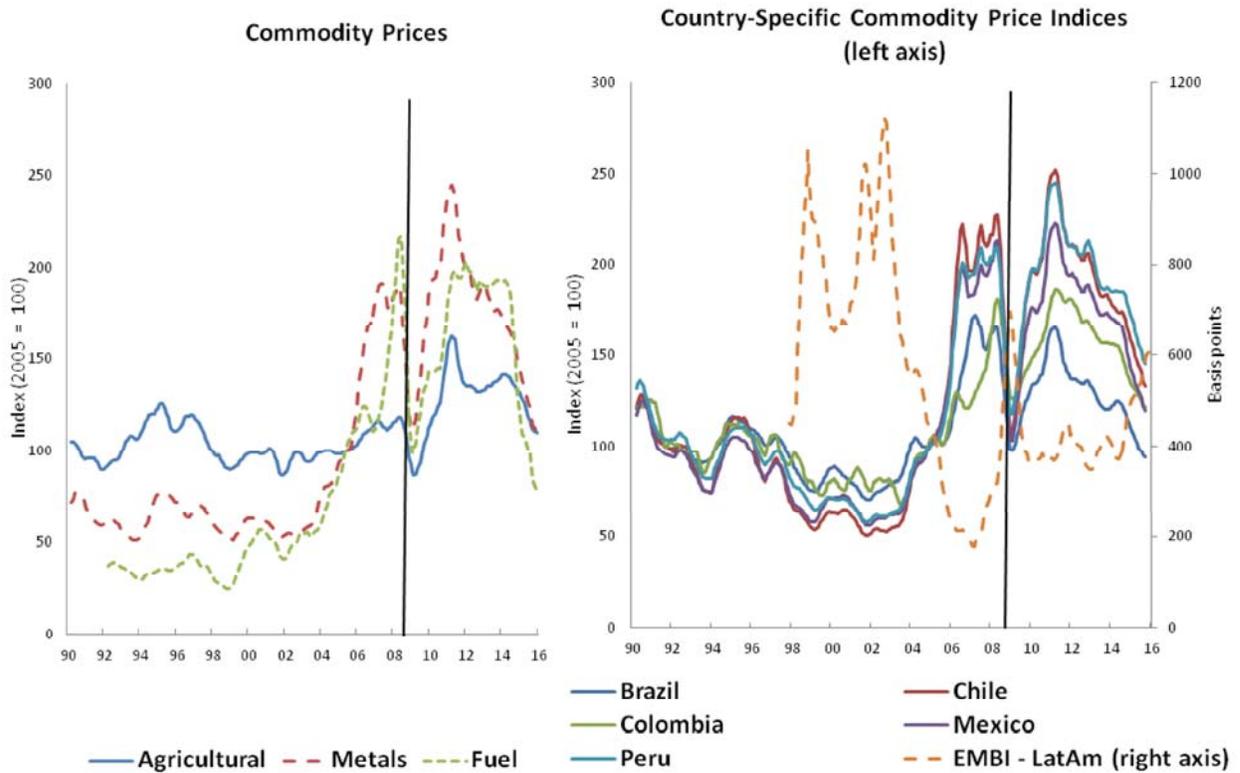
Notes: All variables plotted are percentage deviations from the non-stochastic steady state, unless indicated that they are in levels. This applies to the IRFs for the three categories, cutoffs and the bond-to-loan ratio. Black lines denote the benchmark and red lines denote the counterfactual. Horizontal dashed lines denote steady state values of the variables plotted in levels.

Figure 6: Counterfactual impulse responses to one percentage point drop in R^* with low B .



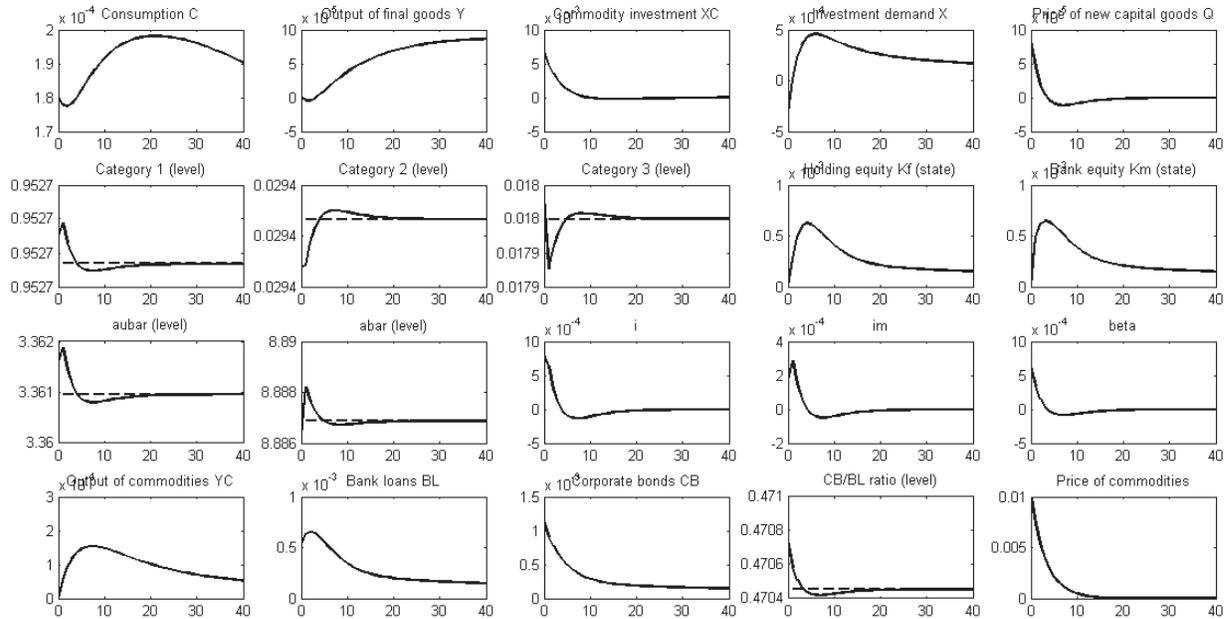
Notes: All variables plotted are percentage deviations from the non-stochastic steady state, unless indicated that they are in levels. This applies to the IRFs for the three categories, cutoffs and the bond-to-loan ratio. Black lines denote the benchmark and red lines denote the counterfactual. Horizontal dashed lines denote steady state values of the variables plotted in levels.

Figure 7: Commodity Prices and Interest Rate Spreads in Emerging Markets.



Notes: The left panel plots the price indices for each of the three broadest categories of commodity goods: raw agricultural products, metals and fuels. The right panel plots country-specific commodity price indices for Brazil, Chile, Colombia, Mexico and Peru alongside the Latin American EMBI spread. Vertical lines indicate the collapse of Lehman Brothers. *Sources:* IMF, Bloomberg and Fernández et.al. (2015)

Figure 8: Impulse responses to one percentage increase in commodity price P^C .



Notes: All variables plotted are percentage deviations from the non-stochastic steady state, unless indicated that they are in levels. This applies to the IRFs for the three categories, cutoffs and the bond-to-loan ratio. Horizontal dashed lines denote steady state values of the variables plotted in levels.

Table 1: Calibrated parameters.

Parameter	Description	Value	Source
φ	cost of capital adjustment	4.602	[15]
$\tilde{\Psi}$	risk premium elasticity	0.001	[25]
β	rate of return to bank equity	1.0364	[10]
p_H	high probability of project success	0.99	[20]
p_L	low probability of project success	0.96	min. satisfying $\beta > \frac{p_H}{p_L}$
α	Cobb-Douglas capital share	0.32	[2]
K/Y	capital-to-output ratio	8	[19]
β^h	Households' discount factor	0.9852	found endogenously
δ	Depreciation rate	0.025	found endogenously
A	TFP	1	normalization
H	labor time	0.33	[2]
Q	price of capital	1	normalization
$\frac{X}{Y}$	investment to output ratio	0.2	Data
C/Y	consumption-to-output ratio	0.746	[15]
R^*	foreign interest rate on HH debt	0.49%	Data (non-annualized)
τ	GHH labor parameter	1.6	[21]
σ	relative risk aversion	2	[2]
ρ_{R^*}	persistence of R^* shock	0.9837	Data (non-annualized)
ρ_A	persistence of A shock	0.95	
σ_{R^*}	std dev. of R^* shock	0.001	Data (non-annualized)
σ_A	std dev. of A shock	0.01	

Table 2: Matched empirical financial ratios.

Condition	Target	Model
Bank operating costs to bank assets	0.0078	0.0032
Bank assets to bank equity	10.6444	9.7639
Holding assets to holding equity	1.7100	4.7582
Gross foreign bank loans to GDP	19.28%	11.64%
Gross foreign corporate debt to GDP	6.28%	5.48%
FOC of the holding	0	0

Table 3: Calibrated financial parameter values.

Parameter	c	b	B	σ_G	$i = \frac{I}{KJ}$	R
Calibrated value	0.0030	0.0011	0.0031	2.2789	92.3384	1.0149

Table 4: Counterfactual steady state.

Variable	Benchmark	High c	Low B
i	92.3384	77.2777	92.3520
I	3.6931	3.1759	3.7098
Q	1.0000	1.0007	0.9998
X	0.1756	0.1753	0.1757
K	7.0240	7.0128	7.0266
r^K	4.000%	4.0028%	3.9994%
Y	0.8780	0.8772	0.8782
C	0.6550	0.6544	0.6645
K^f	0.0400	0.0411	0.0402
K^m	0.0105	0.0135	0.0097
\bar{a}	8.8869	7.3821	7.9702
\underline{a}	3.3610	2.8481	3.3763
Category 2	0.0294	0.0331	0.0270
Category 3	0.0179	0.0219	0.0202
CB	0.0481	0.0501	0.0558
BL	0.1022	0.0989	0.0945