

# Interest Rates, Leverage, and Business Cycles in Emerging Economies: The Role of Financial Frictions

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*Countercyclical country interest rates have been shown to be an important characteristic of business cycles in emerging markets. In this paper we provide a microfounded rationale for this pattern by linking interest rate spreads to the dynamics of corporate leverage. For this purpose we embed a financial accelerator into a business cycle model of a small open economy and estimate it on a novel panel dataset for emerging economies that merges macroeconomic and financial data. The model accounts well for the empirically observed countercyclicality of interest rates and leverage, as well as for other stylized facts.*

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A well documented stylized fact in international macroeconomics is the significant difference in business cycles between emerging and developed economies. Fluctuations in emerging markets are characterized by a relatively large volatility in output and an even higher volatility of consumption and investment, which leads to countercyclical dynamics of the trade balance. Another key difference lies in the cyclical nature of borrowing costs faced in international financial markets. While in emerging economies real interest rates are strongly countercyclical and volatile, in developed economies they are mildly procyclical and considerably less variable.

In this paper we focus on amplification mechanisms that provide a microfounded ratio-

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nale for interest rate dynamics in emerging economies. In particular, we analyze frictions that may arise on the market for private debt due to asymmetric information and moral hazard. We also argue that the dynamics of interest rates cannot be fully understood in disconnect from entrepreneurial borrowing. Therefore we start our analysis by constructing a novel dataset on leverage of nonfinancial as well as financial corporate firms in emerging countries and providing evidence on its dynamics over the cycle. We extend it with updated series from national accounts as well as sovereign and corporate interest rates. Besides corroborating that the aforementioned stylized facts are robust to the inclusion of the recent financial crisis episode, we also find that leverage, measured as assets-to-equity ratio, is countercyclical in the data. Hence we find evidence that leverage dynamics are strikingly similar to those of interest rates, lending support to a connection between the two that has not been explored thus far in the literature.

In order to account for these empirical facts, we build a business cycle model in which domestic interest rates are fully endogenous and determined by default risk in the private sector. We do so by embedding a financial contract à la Bernanke, Gertler and Gilchrist (1999), henceforth BGG, into an otherwise standard real business cycle model of a small open economy in which productivity shocks are the sole driving force. This financial structure also allows for endogenous fluctuations of leverage. The interest rate premium stems endogenously from agency problems between foreign lenders and domestic borrowers. We focus on the propagation role of the financial accelerator in accounting for the stylized facts, especially the dynamics of interest rates and leverage. We argue that this mechanism is well suited to account for the data patterns in emerging economies, because it naturally gives rise to countercyclical interest rates and leverage akin to those observed in the data. For example, a positive productivity shock not only increases output, but also increases the net worth of entrepreneurs, thereby reducing leverage as well as the aggregate default rate and hence lowering the country premium.

We take our model to emerging economies' data and estimate the parameters governing the financial contract as well as the productivity process. We do so by matching some of the key second moments that distinguish emerging economies from their developed counterparts. To do so we use a panel of countries from our dataset. In that sense, another contribution of the paper lies in using a more comprehensive set of emerging economies instead of focusing on a single country.

The main findings of the estimation exercise can be summarized as follows. The financial structure of our model allows to properly account for the dynamics of emerging economies' business cycles. Most importantly, it endogenously generates a strong volatility and countercyclicity of interest rates. The results indicate that, through the lens of our model, the data is seen as characterized by relatively high levels of steady state leverage. This leverage allows the model to generate large movements in entrepreneurial net worth and, in consequence, in the country risk premium. The intuition behind this is simple. Following a positive productivity shock, an initially leveraged entrepreneur will experience high profits, increase equity by more than debt and therefore deleverage. This implies that leverage and income move in opposite directions. Therefore, the model also accounts for the counter-

cyclicalities of leverage observed in the data. Based on these findings we argue that leverage has an important role in accounting for both the volatility and countercyclicality of interest rates in emerging economies. Accordingly, another contribution of our work is to provide a model that rationalizes such dynamics.

These results hold when we include the average level of leverage in the information set of the structural estimation and in the set of moments that we match with our model. We consider two measures of leverage: one of nonfinancial firms only and another which also includes financial corporations. We also consider two other robustness checks. First, we show that the model continues to properly account for the dynamics of interest rates and leverage when the persistence of the productivity shock is changed. Secondly, we present evidence that the results persist even after accounting for other potentially important drivers of interest rates in emerging markets such as sovereign risk and exogenous shocks in world interest rates.

Our work is a continuation of the research program on business cycles in emerging economies. Since at least the work of Agénor, McDermott and Prasad (2000), it is known about the key differences in aggregate dynamics between developing and advanced economies. Subsequent work by Neumeyer and Perri (2005) and Uribe and Yue (2006) provided further evidence of these differences by documenting that interest rates are countercyclical in these economies. Motivated by those stylized facts, these works built business cycle models in which exogenous interest rate shocks are the main driving force and reduced-form frictions act as powerful amplification mechanisms for standard productivity shocks. Such frictions take the form of working capital requirements and country specific spreads that react to country fundamentals. In Aguiar and Gopinath (2008) it is shown that a business cycle model in which country interest rate movements are not orthogonal to productivity shocks does well in matching the features of the data in emerging market countries. The relevance of spreads linked to fundamentals has also been stressed recently by Fernández (2010) Chang and Fernández (2013) when accounting for business cycles in, respectively, Colombia and Mexico. García-Cicco, Pancrazi and Uribe (2010) have shown that a high elasticity of interest rate premia to debt levels is needed to mimic the trade balance dynamics in Argentina. Lastly, Fernandez-Villaverde et al. (2011) have shown that changes in the volatility of the real interest rate at which small open emerging economies borrow have an important impact on the business cycle.

Up to that point, however, the literature has been silent about why the country premium would depend upon domestic variables such as output or the productivity level. Arellano (2008) provides a theoretical framework for the link between country spreads and fundamentals within a model of strategic sovereign default. In her model of an endowment economy sovereign default probabilities are high when expectations of productivity are low. This framework has recently been extended by Mendoza and Yue (2012) who also study sovereign default in a production economy. However, this line of research focuses exclusively on sovereign risk. Virtually no study has jointly assessed quantitatively the relationship between corporate default, business cycles and emerging markets' interest rates within a dynamic general equilibrium framework. We think such gap in the literature

is an important one because high business cycle volatility characterizes several emerging economies which have experienced neither sovereign default nor serious fiscal solvency concerns within the time intervals under study. Our work aims to fill this gap.<sup>1</sup>

This paper is divided into seven sections apart from this introduction. In Section I we report some updated empirical evidence on the stylized facts about business cycles in emerging economies. We compare the fluctuations of sovereign and corporate interest rates and present novel evidence on the cyclical patterns of leverage. Section II presents our business cycle model of a small open economy. Section III summarizes our estimation strategy. The results of the paper are then presented in Section IV. In Section V we discuss the key leverage mechanism which is at work in our model and which drives our results. Section VI presents the robustness analysis and concluding remarks are given in Section VII. An online appendix gathers some technical details of our analysis.

### I. Stylized Facts in Emerging Market Business Cycles

In this section we present updated evidence on business cycle characteristics of emerging countries. Our dataset uses the panel of emerging and developed small open economies compiled by Aguiar and Gopinath (2007) as main input. We extend it in three dimensions. First, all series have been updated until 3Q 2010. This means an extension of 7 years which allows us to assess whether the existing stylized facts are robust to the inclusion of the 2007-2009 financial crisis period. Second, the dataset is complemented with information on real sovereign and corporate interest rates. Finally, we provide information on corporate leverage across emerging economies.

Table 1 presents some of the key unconditional second moments that characterize business cycles across emerging market economies as well as developed countries.<sup>2</sup> Aggregate volatility, measured by percentage deviation of GDP from its Hodrick-Prescott (HP) trend, is almost twice as large in emerging markets as in developed ones.<sup>3</sup> The relative volatilities of the two largest components of aggregate demand, consumption and investment, are also roughly 50 percent larger in the former group than in the latter. Correlations of both consumption and investment with output are nonetheless quite similar across the two pools of economies. In consequence, emerging economies exhibit much more volatile and countercyclical trade balances than developed ones. This evidence is in line with earlier

<sup>1</sup>Other works that analyze emerging economies within the BGG framework include Céspedes, Chang and Velasco (2004), Gertler, Gilchrist and Natalucci (2007), Devereux, Lane and Xu (2006) and, recently, Akinci (2011). Dagher (2014) stresses the role of leverage in the private sector, but in a framework other than BGG, and focuses on sudden stop episodes, rather than regular business cycles or interest rate fluctuations.

<sup>2</sup>Data on nominal income, private consumption, investment and trade balance come from IFS. Lack of sector-specific deflators forces us to use GDP deflators to render the data in real terms. The dataset is an unbalanced panel between 4Q 1993 and 3Q 2010. Emerging countries include Argentina, Brazil, Colombia, Ecuador, Malaysia, Mexico, Peru, Philippines, South Africa, South Korea, Thailand and Turkey. Developed countries are Australia, Austria, Belgium, Canada, Denmark, Finland, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden and Switzerland. Relative to Aguiar and Gopinath (2007) we dropped Israel and Slovak Republic from the dataset due to lack of information on interest rates. Instead, we included Colombia. Details on the dataset and construction of real interest rates, as well as country-specific moments are all reported in section A of the online appendix.

<sup>3</sup>To be consistent with the model presented in the next section, our measure of GDP does not incorporate government spending.

studies of emerging market business cycles and shows that the stylized facts are robust to the inclusion of the recent period of global financial turmoil.

TABLE 1—EMERGING AND DEVELOPED MARKETS' BUSINESS CYCLE MOMENTS.

Moment	Emerging markets		Developed markets	
$\sigma(Y)$	3.32	(0.27)	1.68	(0.19)
$\sigma(C)/\sigma(Y)$	1.26	(0.07)	0.65	(0.02)
$\sigma(I)/\sigma(Y)$	3.76	(0.40)	2.44	(0.11)
$\sigma(TB)$	3.21	(0.35)	1.29	(0.09)
$\rho(TB, Y)$	-0.40	(0.06)	0.33	(0.04)
$\rho(C, Y)$	0.77	(0.05)	0.58	(0.04)
$\rho(I, Y)$	0.69	(0.04)	0.63	(0.05)
$\sigma(R)$	0.92	(0.06)	0.35	(0.03)
$\rho(R, Y)$	-0.36	(0.06)	0.17	(0.07)

*Notes:*  $Y$ ,  $C$ ,  $I$ ,  $TB$  and  $R$  denote, respectively, real GDP net of government spending, private consumption, investment, trade balance and gross real interest rates. Interest rates used are quarterly (nonannualized).  $\sigma$  denotes standard deviation and  $\rho$  denotes correlation coefficient. All series were logged (except for  $TB$ ), and then HP filtered. The GMM estimated moments are computed as weighted averages, i.e. based on unbalanced panels. Standard deviations are expressed in percent. Standard errors are reported in brackets. Sources: Bloomberg, IFS, OECD. See Footnote 2 for details on the data and the list of countries used.

We now turn our attention to real interest rates. In emerging economies, these rates include relatively large country-specific risk spread components. In Table 1 we report real interest rates constructed using the sovereign bonds-based Emerging Markets Bond Index (EMBI), as frequently done in the literature.<sup>4</sup> The results show that the rates in emerging economies tend to be countercyclical as indicated by the statistically significant correlation coefficient value of  $-0.36$ .<sup>5</sup> This is in contrast to the number for developed economies,  $0.17$ , which indicates moderate procyclicality. Interest rates are also more than twice as volatile in the former group of countries as in the latter.

Importantly for our purposes, the strong volatility and countercyclicality of interest rates is robust to nonsovereign measures of risk, for example the corporate emerging market bond index (CEMBI) spreads.<sup>6</sup> This is reported in Table 2 where we compare the correlation, volatility and cyclicity of CEMBI- and EMBI-based measures of interest rates. While lack of data prevents us from conducting the analysis for the whole sample of emerging

<sup>4</sup>Following Uribe and Yue (2006), these rates are computed as a product between country-specific EMBI spreads and the 3-Month real U.S. T-Bill rate (see section A of the online appendix for details of the derivation). For developed economies' interest rates, we follow Neumeyer and Perri (2005) who proxy them with short term commercial rates.

<sup>5</sup>This number is very similar ( $-0.30$ ) if one uses sovereign credit default swap spreads, another commonly used proxy for risk.

<sup>6</sup>CEMBI is an index of the spread of corporate bonds over U.S. yields. Hence CEMBI is not a spread over EMBI. Both indices include liquid USD-denominated bonds and are stripped of cash flow collaterals to reflect pure default risk.

economies, one can easily observe that the two measures of interest rates are highly correlated.<sup>7</sup> Furthermore, with the CEMBI-based measure the countercyclicality and volatility of interest rates are even higher. The correlation coefficient is now  $-0.61$  as opposed to  $-0.51$  when EMBI was used, whereas the standard deviation increases from  $0.33$  to  $0.42$  percent. In addition to this, Figure 1 reports the serial correlation between the GDP cycle in period  $t$  and CEMBI-based interest rates in  $t + j$  for the countries in Table 2. The U-shape pattern means that, on average, these interest rates are strongly countercyclical and coincident with the cycle.

TABLE 2—EMBI AND CEMBI-BASED QUARTERLY INTEREST RATE MOMENTS IN EMERGING ECONOMIES.

Country	$\rho(R_{EMBI}, R_{CEMBI})$	$\sigma(R_{EMBI})$	$\sigma(R_{CEMBI})$	$\rho(Y, R_{EMBI})$	$\rho(Y, R_{CEMBI})$
Brazil	0.96 (0.02)	0.33 (0.07)	0.35 (0.07)	-0.73 (0.12)	-0.74 (0.13)
Malaysia	0.98 (0.01)	0.33 (0.05)	0.34 (0.05)	-0.50 (0.22)	-0.56 (0.22)
Mexico	0.80 (0.06)	0.34 (0.05)	0.51 (0.13)	-0.33 (0.32)	-0.61 (0.19)
Peru	0.96 (0.08)	0.39 (0.07)	0.45 (0.10)	-0.60 (0.22)	-0.58 (0.18)
<b>All</b>	0.89 (0.03)	0.34 (0.03)	0.42 (0.06)	-0.51 (0.13)	-0.61 (0.10)

*Notes:* The sample periods are: for Malaysia and Mexico 4Q 2001-3Q 2010, for Brazil 4Q 2003-3Q 2010 and for Peru 3Q 2005-3Q 2010. All series were logged and then HP filtered. Moments and their corresponding standard errors were computed using GMM.  $\sigma$  denotes standard deviation,  $\rho$  denotes correlation coefficient. Standard deviations are expressed in percent. Standard errors are reported in brackets. Interest rates used are quarterly (i.e. not annualized). Sources: Bloomberg, IFS.

The final empirical exercise we perform is an analysis of leverage fluctuations in emerging economies over the business cycle. We think that it is a natural follow-up of the analysis of interest rate and risk spread movements. Leverage plays a key role in many macroeconomic models of financial frictions with endogenous risk premia. For example, leverage measured as assets-to-equity ratio enters as argument in the loan supply curve in BGG. However, the empirical evidence on leverage behavior in the literature on emerging economies remains scarce. A notable exception is Mendoza and Terrones (2008) who show a strong link between credit booms and corporate leverage levels. We are instead interested in unconditional leverage fluctuations over the whole cycle.

Finance literature distinguishes between several measures of firm leverage, potentially varying in properties and dynamics. In this paper we focus on the assets-to-equity ratio. For each firm, the ratio can be computed either using historical (book) or market values. Equity is proxied by market capitalization of firms, (i.e. we use market value of firms). The data is readily available for publicly traded firms. On the other hand, we use book value of debt because trade in corporate debt is rare, except for largest firms, and frequently illiquid, not least in emerging economies, so no reliable data is available. We then proxy the market value of assets by adding the market value of equity (i.e. firm value) to the

<sup>7</sup>While it is beyond the scope of the paper to dig deeper into causality between sovereign and corporate interest rates, simple Granger-causality tests do not point to systematic causality going from EMBI to CEMBI spreads. Results are available upon request.

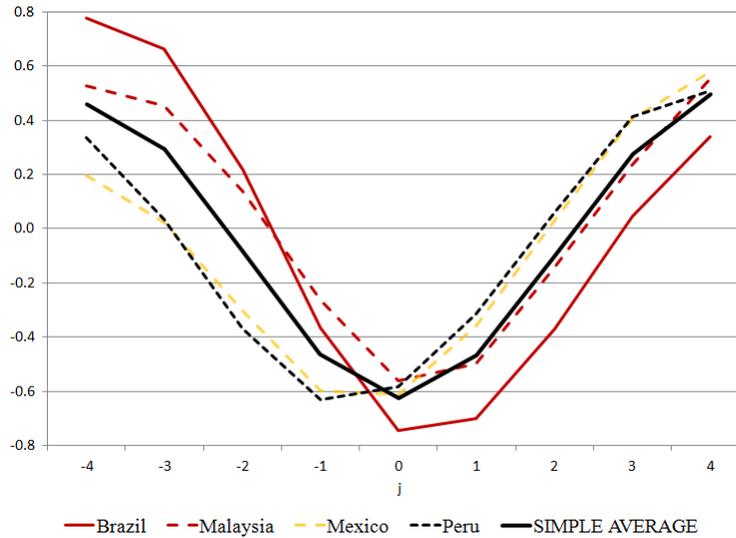


FIGURE 1. CEMBI-BASED INTEREST RATE CYCLICALITY IN EMERGING ECONOMIES.

*Notes:* Cyclicalities are measured as correlation of (leads and lags of) the interest rates with current output  $Y$ , i.e.  $Corr(R_{t+j}, Y_t)$ . Interest rates are real U.S. T-Bill rates plus country-specific CEMBI. The series are logged and then HP filtered. Simple averages are arithmetic means taken across countries for every year. Quarterly data, 4Q 2001 – 3Q 2012 (country-dependent), Sources: Bloomberg, IFS.

book value of debt.<sup>8</sup>

Firm-level data of quarterly frequency is taken from Bloomberg.<sup>9</sup> The average market leverage ratio for a given country in a given year is computed using market capitalization as weights attached to firm-specific leverage.<sup>10</sup> We focus on corporate firms from nonfinancial sectors. We do so because the leverage in our model describes the asset structure of entrepreneurs in the production sector, not of lenders. Also, financial firms may potentially hold sovereign debt on their assets. Therefore, their leverage and interest rate dynamics may potentially be influenced by the performance of the sovereign. Nevertheless, in our robustness analysis in Section VI we study also the dynamics of leverage of financial firms.

Leverage dynamics over the business cycle are reported in the left panel of Figure 2. The first important message is that in the data the average assets-to-equity ratio is countercyclical.

<sup>8</sup>This is a standard measure of leverage, used e.g. by Rajan and Zingales (1995). The fact that we don't have market prices for corporate debt shouldn't qualitatively affect the dynamics of leverage because traded debt volatility is by nature much lower than the volatility of equity.

<sup>9</sup>The firms reported in Bloomberg are publicly traded and tend to be large. For Latin America their total market capitalization is on average 66 percent of GDP, while for others in our sample it is 157 percent. Arguably, there are many small firms that our analysis leaves behind. However, as stressed by Dagher (2014) it is large firms that tend to be hit by fluctuations in credit during downturns, which is the mechanism that we are trying to stress in this work. Smallest firms don't suffer as much precisely because they are self-financed in the first place.

<sup>10</sup>See section A of the online appendix for details on the number of firms used in the computation of leverage.

cal.<sup>11</sup> Contemporaneous correlation with the cycle is  $-0.30$  on average and statistically significant. It peaks at  $j = -1$  with  $-0.32$ . A clear shift to positive correlation occurs only for  $j = 2$ . According to the graph, one should expect leverage to have been above its long run mean during the previous three periods if output is below its trend in  $j = 0$ . Deleveraging starts only at  $j = 0$  and lasts for the following periods.

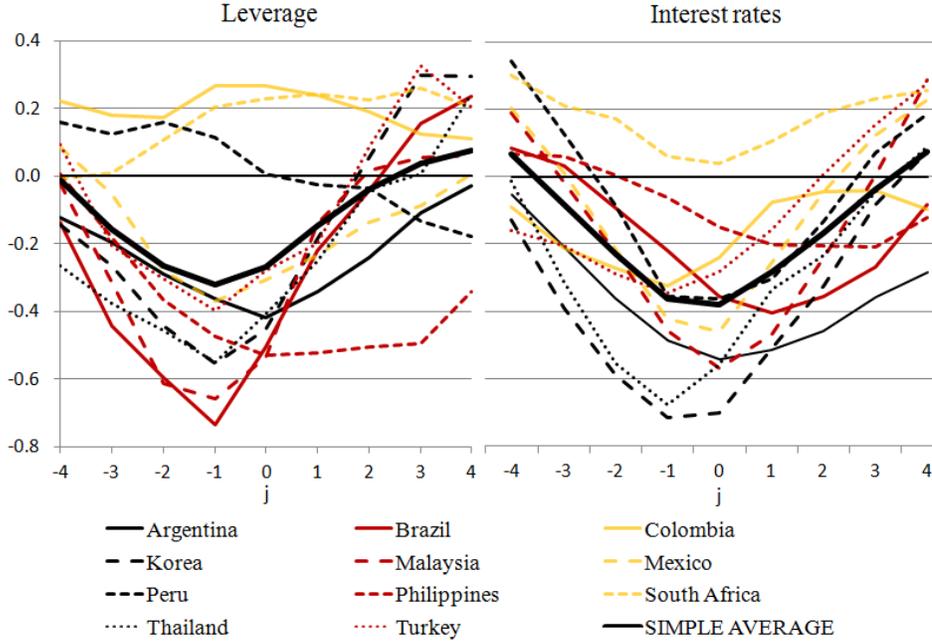


FIGURE 2. LEVERAGE AND INTEREST RATE CYCLICALITY IN EMERGING ECONOMIES.

*Notes:* Cyclicity is measured as correlation of (leads and lags of) a variable with current output  $Y$ , i.e.  $Corr(Leverage_{t+j}, Y_t)$  in the left panel and  $Corr(R_{t+j}, Y_t)$  in the right panel. Leverage is computed as assets-to-equity ratio, i.e.  $Leverage_t = \frac{Q_t K_{t+1}}{N_{t+1}}$ . Interest rates are real U.S. T-Bill rates plus country-specific EMBI. All series are logged and then HP filtered. Simple averages are arithmetic means taken across countries for every year. Quarterly data, 4Q 1993 – 3Q 2012 (country-dependent), Sources: Bloomberg, IFS.

Another important stylized fact emerges when one compares the cyclicity of leverage and interest rates. The U-shape pattern of interest rate dynamics, plotted in the right panel of Figure 2, is qualitatively the same as that for leverage.<sup>12</sup> Indeed, the correlations of leverage and interest rates with output both exhibit a U-shape.

These findings suggest an important role for a financial accelerator mechanism in which interest rate premia are linked to leverage. Thus, in the next section we embed such

<sup>11</sup>Technically, countercyclicality of leverage occurs here because equity (measured as stock market capitalization) is procyclical whereas debt is acyclical. Both equity and debt are an order of magnitude more volatile than output.

<sup>12</sup>This time we are using EMBI-based interest rates in order to be able to make a wider comparison across countries.

mechanism into a business cycle model of a small open economy in which interest rates are endogenously determined and driven by fluctuations of leverage.

## II. Model

The findings presented in the previous section suggest the existence of a financial accelerator mechanism in which interest rate premia are linked to leverage. In this section we develop a model that rationalizes such mechanism. Our starting point is a one-good real business cycle model of a small open economy (see e.g. Mendoza, 1991). A key modification is to extend it with a financial accelerator developed by Carlstrom and Fuerst (1997) and BGG. We follow the latter exposition and describe it in detail in Subsection II.A. The model economy is inhabited by four types of agents: households, entrepreneurs, capital producers, as well as a foreign sector which is the only source of credit for the domestic economy.

### A. Entrepreneurs

In this framework the key role is played by entrepreneurs who are perfectly competitive and produces a homogenous final good which is later consumed or used for investment. At the heart of the financial accelerator mechanism is the fact that entrepreneurs have to borrow funds from lenders in order to finance their production, in particular to purchase capital from capital producing firms. Therefore, the assets of an  $i$ -th entrepreneur are the sum of her net worth  $\tilde{N}_{i,t+1}$  and borrowed funds  $\tilde{B}_{i,t+1}$ :

$$(1) \quad Q_t \tilde{K}_{i,t+1} = \tilde{N}_{i,t+1} + \tilde{B}_{i,t+1}$$

where  $\tilde{K}_{i,t+1}$  is the capital stock,  $Q_t$  is the price of capital expressed in terms of final goods and  $\frac{Q_t \tilde{K}_{i,t+1}}{\tilde{N}_{i,t+1}}$  is referred to as leverage.<sup>13</sup> The production function of an  $i$ -th entrepreneur is given by

$$\tilde{Y}_{i,t} = \omega_{i,t} A_t \tilde{K}_{i,t}^\alpha \left( \tilde{X}_t L_{i,t} \right)^{1-\alpha}$$

where  $L_{i,t}$  is labor input and  $A_t$  is the economy-wide level of total factor productivity which follows a stationary stochastic process:

$$(2) \quad \ln A_t = \rho_A \ln A_{t-1} + (1 - \rho_A) \ln A + \epsilon_{A,t}, \quad |\rho_A| < 1, \quad \epsilon_{A,t} \stackrel{i.i.d}{\sim} N(0, \sigma_A^2)$$

Additionally, every entrepreneur is subject in each period to a random idiosyncratic productivity shock  $\omega$ . The shock comes from a log-normal distribution  $\ln \omega \sim N\left(\frac{-\sigma_\omega^2}{2}, \sigma_\omega^2\right)$

<sup>13</sup>The model economy is assumed to follow a deterministic trend  $\tilde{X}$  with the growth rate  $\frac{\tilde{X}_{t+1}}{\tilde{X}_t} = g \geq 1$ . We use tildes to denote variables that trend in equilibrium, e.g.  $\tilde{K}_t = K_t \tilde{X}_t$ . Also, all variables (except for  $\omega$ ) without time subscripts denote nonstochastic steady state values.

so that  $E\omega = 1$  and  $F(\omega)$  is the CDF. It is assumed that the realization  $\omega_{i,t}$  of the shock is private information of the entrepreneur. In order to learn this value, the foreign lender has to pay a monitoring cost  $\mu$ , which is a fraction of the entrepreneur's remaining assets (output plus undepreciated capital). The optimal contract between lenders and an entrepreneur specifies a cutoff value of  $\omega$ , denoted as  $\bar{\omega}_{i,t}$ , the value of which is contingent upon the realization of shocks at  $t$ . Entrepreneurs, whose realized  $\omega_{i,t}$  falls below  $\bar{\omega}_{i,t}$  are considered bankrupt, monitored, and their estate  $\omega_{i,t}R_{i,t}^K Q_{t-1}K_{i,t}$  is taken over by lenders. Entrepreneurs with  $\omega_{i,t} \geq \bar{\omega}_{i,t}$  will pay their debts  $Z_{i,t}B_{i,t}$  and retain the profit  $\omega_{i,t}R_{i,t}^K Q_{t-1}K_{i,t} - Z_{i,t}B_{i,t}$ , where  $Z_{i,t}$  is the no-default contractual interest rate. Optimality implies that solvent firms will not be monitored. Therefore, the optimal contract can alternatively be seen as one specifying a state-contingent rate  $Z_t$  which, in aggregate terms, is linked to  $\bar{\omega}_t$  through the relationship<sup>14</sup>

$$\bar{\omega}_t R_t^K Q_{t-1} K_t = Z_t B_t$$

The timing of events is as follows. At the end of  $t - 1$ , there's a pool of entrepreneurs, whose equity is  $\tilde{N}_t$  on aggregate. Those firms decide upon the optimal demanded level of capital  $\tilde{K}_t$ , and hence the level of borrowing  $\tilde{B}_t$ . At this point the (ex post) return on capital  $R_t^K$  is not known, since time  $t$  TFP shock has not yet realized. However, the riskless international rate  $R^*$  over which the risk premium is determined (i.e. the rate from  $t - 1$  until  $t$ ) is known. The cutoff value for the optimal contract  $\bar{\omega}_t$  is not yet determined because of uncertainty over the time  $t$  aggregate shocks, so entrepreneurs make their decision based upon  $E_{t-1}\bar{\omega}_t$ , subject to the zero-profit condition of the lenders. Formally, they solve the following profit-maximization problem:

$$\max_{\tilde{K}_t, E_{t-1}\bar{\omega}_t} \left\{ E_{t-1} \int_{\bar{\omega}_t}^{\infty} [\omega R_t^K Q_{t-1} \tilde{K}_t - Z_t \tilde{B}_t] dF(\omega) = E_{t-1} [1 - \Gamma(\bar{\omega}_t)] R_t^K Q_{t-1} \tilde{K}_t \right\}$$

subject to

$$(3) \quad R^* (Q_{t-1} \tilde{K}_t - \tilde{N}_t) = [\Gamma(\bar{\omega}_t) - \mu G(\bar{\omega}_t)] R_t^K Q_{t-1} \tilde{K}_t$$

where

$$\Gamma(\bar{\omega}_t) \equiv \bar{\omega}_t \int_{\bar{\omega}_t}^{\infty} f(\omega) d\omega + \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega \quad \text{and} \quad G(\bar{\omega}_t) \equiv \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega$$

<sup>14</sup>Note that the optimal contract is homogenous and standardized across entrepreneurs. Also, there exists one aggregated loan supply curve, identical for all entrepreneurs. Therefore the  $i$  index has been dropped. This aggregation is possible due to constant returns to scale of the entrepreneurial production function, independence of  $\omega_{i,t}$  from history as well as the constant number of entrepreneurs in the economy, their risk neutrality and perfect competitiveness. See Carlstrom and Fuerst (1997) or BGG for a more detailed discussion.

and

$$(4) \quad R_t^K = \frac{\alpha \frac{\tilde{Y}_t}{\tilde{K}_t} + Q_t (1 - \delta)}{Q_{t-1}}$$

The left-hand side of the optimization constraint expresses the opportunity cost of lending, i.e. the gross return on a riskless loan. The right-hand side expresses returns of the lenders on a risky loan net of monitoring costs. It includes the repayment from solvent borrowers (a fraction given by the first component of  $\Gamma(\bar{\omega}_t)$ ), as well as the bankrupt's estate (i.e. second component of fraction  $\Gamma(\bar{\omega}_t)$ ), net of monitoring costs  $\mu G(\bar{\omega}_t)$ . Next, the morning of  $t$  comes and the aggregate TFP shock is realized. Its value pins down the aggregate output  $\tilde{Y}_t$ , the return on capital  $R_t^K$  as well as the other nonpredetermined variables, including the values of  $\bar{\omega}_t$  (i.e. the threshold which determines the bankruptcy cutoff) and  $Z_t$ . Since lenders are perfectly competitive,  $\bar{\omega}_t$  simply solves the zero-profit condition (3). Once  $\bar{\omega}_t$  is set, the idiosyncratic productivity shock is realized, some firms go bust, others remain solvent. However, this is important only at the firm level, because the distribution of idiosyncratic shocks  $\omega$  is stationary.

We also assume that a fraction of entrepreneurial profit  $1 - \phi$  is paid out as dividend and consumed every period.<sup>15</sup> Therefore, shareholders' consumption is expressed as:

$$(5) \quad \tilde{C}_t^e = (1 - \phi) \tilde{V}_t$$

where

$$(6) \quad \tilde{V}_t = R_t^K Q_{t-1} \tilde{K}_t - \left( R^* + \frac{\mu \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega R_t^K Q_{t-1} \tilde{K}_t}{Q_{t-1} \tilde{K}_t - \tilde{N}_t} \right) (Q_{t-1} \tilde{K}_t - \tilde{N}_t)$$

and  $\tilde{V}_t$  is the aggregate ex post value of entrepreneurial firms, computed as the gross return on their capital (first term) less debts of the solvent firms captured by  $R^*(Q_{t-1} \tilde{K}_t - \tilde{N}_t)$ , less total monitoring costs  $\mu \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega R_t^K Q_{t-1} \tilde{K}_t$ . Note that  $\tilde{V}_t$  is also equal to entrepreneurial profit because we assume that the entire capital stock is traded every period.

To keep the number of entrepreneurs constant, bankrupt firms are replaced in every period by "newborn" ones. In order to endow those starting entrepreneurs with some initial capital we assume that they also work and receive wages  $\tilde{W}^e$ . The net worth of the entrepreneurs for the next period is then simply the ex-dividend value of the remaining fraction of firms, combined with the proceeds from their own work  $H^e$ :

$$(7) \quad \tilde{N}_{t+1} = \phi \tilde{V}_t + \tilde{W}_t^e$$

<sup>15</sup>In the BGG framework  $1 - \phi$  is usually referred to as a "death rate" of entrepreneurs. As argued later in the text, we believe that a dividend interpretation is better suited for this parameter.

It is important to realize that the zero-profit condition (3) can be, after taking expectations, interpreted as an economy-wide loan supply curve of the following form:

$$(8) \quad E_t \left\{ \frac{R_{t+1}^K}{R^*} \right\} = E_t \left\{ \frac{1}{\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})} \left[ 1 - \left( \frac{Q_t \tilde{K}_{t+1}}{\tilde{N}_{t+1}} \right)^{-1} \right] \right\}$$

Clearly, it implies a positive relationship between leverage  $\frac{Q_t \tilde{K}_{t+1}}{\tilde{N}_{t+1}}$  and the risk premium  $E_t \left\{ \frac{R_{t+1}^K}{R^*} \right\}$ . In Figure 2 we have seen that both leverage and risk premium tend to have very similar dynamic patterns over the cycle and, in particular, they have a very similar degree of countercyclicality. We regard this as evidence that the majority of interest rate dynamics over the business cycle occurs *along* the loan supply curve and hence might be due to fluctuations in the demand for credit. This is because shocks to the demand for loans induce a positive comovement between leverage and the premium, as in Figure 2. In fact, in the presence of TFP shocks only, the countercyclicality of the risk premium will be always exactly the same as the countercyclicality of leverage.<sup>16</sup>

### B. Capital producers

Entrepreneurs are not permanent owners of capital which is used as input for production. Instead, they purchase it from perfectly competitive capital producing firms at the end of period  $t - 1$ . This capital is used in production at  $t$  and its undepreciated part  $(1 - \delta) \tilde{K}_t$  is resold to capital producers once the production is over. Capital producers combine this capital with new investment using the following technology:

$$(9) \quad \tilde{K}_{t+1} = (1 - \delta) \tilde{K}_t + \tilde{I}_t - \frac{\varphi}{2} \left( \frac{\tilde{K}_{t+1}}{\tilde{K}_t} - g \right)^2 \tilde{K}_t$$

where the last term captures the presence of adjustment costs. The new capital stock  $\tilde{K}_{t+1}$  is then sold again to the entrepreneurs and the cycle closes.<sup>17</sup> Formally, capital producers

<sup>16</sup>Note that any shocks to the financial accelerator, e.g. a risk shock in the spirit of Christiano, Motto and Rostagno (2014) would affect the position of the loan supply curve and possibly break this pattern. For this reason we decided to abstain from shocks to the accelerator and work with a parsimonious model in which the TFP shock is the sole source of uncertainty.

<sup>17</sup>Trading all capital in every period is an innocuous assumption for the strength of the financial accelerator. To see this note that the optimal  $\bar{\omega}_t$  defined by equation (3) is a function of the entire capital stock. The lender determines the conditions of the loan according to the market value of these assets, regardless if they are actually traded every period or not. Alternatively, one could assume that capital is held by entrepreneurs and that only investment is financed through borrowing, as in Gertler, Gilchrist and Natalucci (2007). What matters is that, rather realistically, all firm's assets serve as collateral for a loan in this framework, not only the investment project, as in Carlstrom and Fuerst (1997). Intuitively, lenders would take over the entire remaining assets in case of default and therefore price them to market when the loan is issued regardless of whether later the entrepreneurs actually trade them in entirety.

solve the following profit-maximization problem:

$$\max_{\tilde{K}_{t+1}, \tilde{I}_t} E_0 \sum_{t=0}^{\infty} \beta^t \left[ Q_t \tilde{K}_{t+1} - Q_t (1 - \delta) \tilde{K}_t - \tilde{I}_t \right]$$

subject to equation (9). From the point of view of capital producers the timing of events is as follows. At dawn of  $t$ , the aggregate TFP shock becomes known. Because this determines the aggregate levels of  $\tilde{Y}_t$  and  $R_t^K$ , all information necessary to determine  $\tilde{I}_t$  and hence the supply of  $\tilde{K}_{t+1}$  becomes known. This is when their maximization problem is solved. Therefore, time  $t$  TFP shock affects both investment and the price of capital on impact.

### C. Households

The small open economy is inhabited by a continuum of identical atomistic households. A representative household maximizes its expected lifetime utility

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left( \tilde{C}_t - \tau \tilde{X}_t \frac{H_t^\gamma}{\gamma} \right)^{1-\sigma}}{1-\sigma}$$

where  $\sigma$  is the constant relative risk aversion coefficient. Preferences are assumed to take the Greenwood, Hercowitz and Huffman (1988) form. Households obtain income from working for the entrepreneurs. Their optimal labor supply function is given by

$$(10) \quad \tau \tilde{X}_t H_t^{\gamma-1} = \tilde{W}_t$$

This equation reflects the key property of GHH preferences, i.e. labor supply is not dependent on the level of consumption. In other words, the income effect on labor is absent. This in turn allows these preferences to replicate more closely some important business cycle properties for emerging economies.

In order to smooth consumption, households can issue debt or lend in world capital markets. Because consumers are assumed never to default on their debts they face the world riskless interest rate  $R^*$ .<sup>18</sup> The budget constraint is given by

$$(11) \quad \tilde{C}_t - \tilde{D}_{t+1} = \tilde{W}_t H_t - \Psi_t R^* \tilde{D}_t$$

<sup>18</sup>In the working paper version of our work, Fernández and Gulán (2012), we relax this assumption by considering foreign lenders who do not know ex-ante that consumers will not default and therefore charge a premium over the (ex-ante) risky consumer debt. In that setup the consumers' interest rate is linked to the risky corporate interest rate  $E_{t-1} R_t^K$ . However, the results change very little because, as documented below, most of the dynamics of consumption are driven by the persistence of the productivity shock rather than the exact specification of consumers' interest rates.

The interest rate is, however, augmented by a small risk premium elasticity term  $\Psi_t$

$$(12) \quad \Psi_t = \left\{ \bar{\Psi} + \tilde{\Psi} \left[ \exp \left( \frac{\tilde{D}_t^A}{\tilde{X}_t} - d \right) - 1 \right] \right\}$$

where  $\tilde{D}_t^A$  is the aggregate level of debt, equal to  $\tilde{D}_t$  in equilibrium. The term  $\bar{\Psi}$  allows us to calibrate  $\beta$ , the subjective discount factor.<sup>19</sup> On the other hand,  $\tilde{\Psi}$  is calibrated to a very low number and its sole purpose is to induce stationarity of net debt, consumption and the trade balance (see e.g. Schmitt-Grohé and Uribe (2003)). It has no other bearing on the dynamics of the model.

#### D. Labor market and remaining specification

Recall that labor is supplied both by households and entrepreneurs. Therefore the total labor input  $L_t$  is the aggregate of the two:

$$(13) \quad L_t = (H_t^e)^\Omega H_t^{1-\Omega}$$

where the working hours of entrepreneurs  $H_t^e$  are normalized to 1 and  $\Omega$  is the entrepreneurs' share in total labor. This gives rise to two separate labor demand functions:

$$(1 - \alpha) \Omega \frac{\tilde{Y}_t}{H_t^e} = \tilde{W}_t^e, \quad (1 - \alpha) (1 - \Omega) \frac{\tilde{Y}_t}{H_t} = \tilde{W}_t$$

We close the model by specifying the market clearing condition for final goods:

$$(14) \quad \tilde{Y}_t = \tilde{C}_t + \tilde{C}_t^e + \tilde{I}_t + \tilde{N}X_t + \mu \int_0^{\tilde{\omega}_t} \omega f(\omega) d\omega R_t^K Q_{t-1} \tilde{K}_t$$

where  $\tilde{N}X$  denotes net exports and the term with the integral captures resources wasted for monitoring.

### III. Parametrization and Estimation

We turn now to the empirical part of the exercise where we take the model to emerging economies' data. In order to match the moments that characterize these economies, as documented in Section I, we estimate some of the key parameters of the model, including those of the financial contract, and calibrate some others. Since we want to focus on the role of the accelerator and do not want to attribute the results to idiosyncrasies in preferences, long run shares, etc., we calibrate the related parameters following the previous literature and the data. Table 3 summarizes the values that we use. We set the discount factor  $\beta$  to

<sup>19</sup>See section C of the online appendix for details of steady state computation.

TABLE 3—CALIBRATED PARAMETERS.

Parameter	Description	Value	Source
$g$	deterministic trend growth rate	1.0091	data
$\frac{C}{Y}$	consumption-to-GDP ratio	0.746	data
$\alpha$	capital share in production	0.32	Aguiar and Gopinath (2007)
$\beta$	subjective discount rate	0.98	Aguiar and Gopinath (2007)
$\gamma$	GHH labor parameter	1.6	Neumeyer and Perri (2005)
$\delta$	depreciation rate	0.05	Aguiar and Gopinath (2007)
$\sigma$	relative risk aversion	2	Aguiar and Gopinath (2007)
$\Omega$	entrepreneurial labor share	0.01	BGG
$R^*$	foreign interest rate	1.002	data
$H$	steady state labor	0.33	Aguiar and Gopinath (2007)

Notes: All rates are quarterly.

0.98, the capital share in output  $\alpha$  to 0.32, the depreciation rate  $\delta$  to 0.05, the relative risk aversion parameter  $\sigma$  to 2 and adjust  $\tau$  so that the steady state fraction of time devoted to labor is one third. The GHH labor supply elasticity parameter  $\gamma$  is set to 1.6 in accordance with Neumeyer and Perri (2005). Using our dataset, we match the private consumption-to-GDP ratio, the short-run real foreign interest rate, and we proxy the deterministic trend using the unconditional mean of the GDP growth rate. Finally, as in BGG, we set  $\Omega$ , the share of labor income accruing to entrepreneurs, to 0.01 so that the inclusion of entrepreneurial labor does not have any significant direct effects on the dynamics of the model.

We estimate six parameters, listed in Table 4. Three of them,  $\mu$ ,  $\sigma$  and  $\phi$ , define the financial accelerator. The remaining ones are the persistence and the variance of the shock in the TFP process as well as the capital adjustment cost parameter. We perform Gener-

TABLE 4—ESTIMATED PARAMETERS.

Parameter	Description
$\mu$	monitoring costs
$\sigma_\omega$	std dev. of idiosyncratic productivity
$\varphi$	capital adjustment costs parameter
$\phi$	dividend parameter
$\rho_A$	persistence of TFP shock
$\sigma_A$	std dev. of TFP shock

alized Method of Moments (GMM) using the Driscoll and Kraay (1998) estimator which operates on panel data and is a modification of the heteroskedasticity- and autocorrelation-consistent (HAC) estimator allowing for cross-correlations of errors.

We choose the following 9 model-based second moments:

$$(15) \quad m(\boldsymbol{\theta}) = \left[ \sigma^2(Y) \frac{\sigma^2(C)}{\sigma^2(Y)} \frac{\sigma^2(I)}{\sigma^2(Y)} \frac{\sigma^2(TB)}{\sigma^2(Y)} \rho(TB, Y) \rho(C, Y) \rho(I, Y) \frac{\sigma^2(R)}{\sigma^2(Y)} \rho(R, Y) \right]'$$

where  $\boldsymbol{\theta} = [\mu \ \sigma \ \varphi \ \phi \ \rho_A \ \sigma_A]'$  is the vector of parameters,  $\sigma^2$  denotes a variance and  $\rho$  indicates a correlation coefficient. Also,  $TB = \frac{NX}{Y}$ , denotes the trade balance, i.e. the ratio of net exports to output. Our model proxy for the risky interest rate  $R$  is the expected return on capital  $E_t R_{t+1}^K$ . The moments' empirical counterparts are based on five series: output (net of government spending), private consumption, investment, trade balance and the domestic interest rate.<sup>20</sup> We use the EMBI-based real interest rates, rather than the CEMBI-based ones in benchmark estimation. We do so because the latter are much scarcer and both series are very highly correlated, as documented in Section I. Nevertheless, in Section VI we report a robustness estimation using available CEMBI-based series. Importantly, the EMBI/CEMBI indices don't exclude bonds on which payers have defaulted. Therefore, the empirical rates can be thought of more as average rates of return rather than contractual rates. It is for that reason that we do not use the rate  $E_t Z_{t+1}$  to match the data. Also, the correlation between  $E_t R_{t+1}^K$  and  $E_t Z_{t+1}$  is equal to 1 in the model, although the former tends to be somewhat more volatile.

Note that (15) doesn't include moments related to leverage. We exclude this variable because, as discussed in Subsection II.A, a model with TFP shocks only will always predict the same degree of cyclicity for both the risk premium and leverage. Therefore, by targeting interest rate cyclicity we automatically target leverage cyclicity as well, a very close number, as we know from Section I. However, in Subsection V.C we report results of estimation where we include the average level of leverage as an additional moment.

When identifying the parameters in the TFP process we follow Aguiar and Gopinath (2007) and use the information on output, consumption and the trade balance.<sup>21</sup> Similarly, aggregate investment series allows us to identify  $\varphi$ . Finally, in order to identify the three parameters associated with the financial contract, we use the information on country-specific interest rates. As will be shown in Section V, the variance and cyclicity of interest rates are particularly informative regarding their values.

#### IV. Results

This section presents the main results of the GMM estimation. We assess the model performance in terms of matching the key moments for emerging economies as well as the dynamics of leverage. We also report the estimated parameters and document their

<sup>20</sup>The dataset used in estimation is an unbalanced panel of the 12 emerging economies described in Section I between 4Q 1993 and 3Q 2010. Empirical moments were derived using HP cycle components of logs of series in levels. The exception is trade balance where no logarithms were taken prior to HP filtering.

<sup>21</sup>An alternative to identify the persistence and variance of the TFP process in the model would be to include information on the Solow residual in the GMM estimation. However, in practice the lack of reliable data on factor inputs in most of the EMEs in our sample, notably labor, renders this alternative unfeasible.

similarities and differences with other studies. A further exploration of the link between the parameters and the model's performance is postponed until the next section.

#### A. Main business cycle moments

Table 5 presents the model's performance along the empirical moments. The upper panel reports the moments included in the GMM (see eq. 15) while the lower panel reports other moments not included in the estimation. Table 6 reports the estimated parameter values. The most important result that emanates from Table 5 is that the model is able to reproduce the dynamics of interest rates for emerging economies, i.e. their volatility and countercyclicality. Simultaneously, the model performs well in terms of matching the other seven moments included in the GMM. In particular, it is able to generate a high volatility of output, despite slightly overestimating it, as well as the relative volatility of investment. As in the data, consumption in the model is more volatile than output, although a bit less than its empirical counterpart. Also, the model is able to reproduce the behavior of the trade balance, both in terms of its volatility and countercyclicality.

TABLE 5—MODEL GENERATED MOMENTS FOR EMERGING MARKETS.

GMM-matched moments				
Moment	Emerging markets		Model	
$\sigma(Y)$	3.32	(0.27)	3.75	(0.10)
$\sigma(C)/\sigma(Y)$	1.26	(0.07)	1.07	(0.06)
$\sigma(I)/\sigma(Y)$	3.76	(0.40)	3.54	(0.18)
$\sigma(TB)$	3.21	(0.35)	3.07	(0.25)
$\rho(TB, Y)$	-0.40	(0.06)	-0.55	(0.03)
$\rho(C, Y)$	0.77	(0.05)	0.99	(0.00)
$\rho(I, Y)$	0.69	(0.04)	0.77	(0.01)
$\sigma(R)$	0.92	(0.06)	0.79	(0.16)
$\rho(R, Y)$	-0.36	(0.06)	-0.43	(0.05)
nonmatched moments				
Moment	Emerging markets		Model	
$\rho(R, C)$	-0.39	(0.09)	-0.55	(0.06)
$\rho(R, I)$	-0.35	(0.06)	-0.91	(0.02)
$\rho(R, TB)$	0.30	(0.10)	0.99	(0.01)
$\rho(TB, C)$	-0.69	(0.05)	-0.66	(0.04)
$\rho(TB, I)$	-0.72	(0.05)	-0.96	(0.01)

Notes:  $\sigma$  denotes standard deviation and  $\rho$  denotes correlation coefficient. Standard deviations are expressed in percent. Standard errors are reported in brackets. Sources: Bloomberg, IFS.

TABLE 6—ESTIMATED PARAMETER VALUES.

Parameter	$\mu$	$\sigma$	$\varphi$	$\phi$	$\rho_A$	$\sigma_A$
<b>Estimated value</b>	0.324	0.125	4.602	0.915	0.999	0.014
	(0.467)	(0.014)	(0.672)	(0.035)	(0.004)	(0.001)

*Notes:* Standard errors are reported in brackets.

The procyclicality of investment in the model is also in line with the data. The model performs slightly worse in terms of the comovement of consumption with output. In the model consumption correlation is as high as 0.99, as opposed to 0.77 in the data. Although the model doesn't perform well in this dimension, it is also true that the empirical moment that we try to match differs from what has been reported in previous studies.<sup>22</sup> Finally, the model performs well also along the dimensions not included in the estimation. It captures the negative comovement of consumption and investment with interest rates and the trade balance. It also reproduces the positive correlation between interest rates and the trade balance, although the model largely overstates it.<sup>23</sup> In sum, these results illustrate that a model in which interest rate dynamics are endogenously driven by variation of the risk premium markup in the financial accelerator serves well in accounting for some of the main business cycle patterns in emerging economies.

Arguably, the most relevant result in Table 6 is the value taken by  $\phi$ , equal to 0.915. It is significantly lower than what has been commonly used in previous studies using the BGG framework. For quarterly frequency (and for developed economies), it has usually been set in the range of 0.9728 – 0.99. As was mentioned above (Footnote 15),  $1 - \phi$  refers to the death rate of entrepreneurs in BGG. In that framework the origins of  $\phi$  are purely technical. In particular, in a model where  $\phi$  converges to 1 entrepreneurs would be able to accumulate capital until they became totally self-financed and so the agency problem would disappear. However, given that a fraction  $1 - \phi$  of the net profit of firms  $\tilde{V}_t$  in the model is passed for (entrepreneurial) consumption  $\tilde{C}_t^e$ , the most natural interpretation for this parameter is that of a dividend paid to shareholders.<sup>24</sup> In particular,  $1 - \phi$  corresponds to the fraction of firm value that is paid as dividends. A similar interpretation has been used by Gertler and Kiyotaki (2010) where  $\phi$  occurs in the context of banks' equity. Indeed,

<sup>22</sup>For example, Aguiar and Gopinath (2007) match only the correlation for Mexico, which they report to be 0.92. Their model also generates correlations above 0.9, depending on the specification. In Neumeyer and Perri (2005) the reported empirical correlation for emerging economies is around 0.8. Yet, they match the correlation for Argentina, 0.97. Depending on the version, their model generates correlations between 0.82 and 0.97.

<sup>23</sup>One dimension in which we do not compare the model dynamics against the data is the labor market. We refrain from doing it given the widespread labor informality in emerging economies, a dimension clearly beyond the scope of this paper. See Fernández and Meza (2013) for progress in this area.

<sup>24</sup>Traditionally,  $1 - \phi$  has been interpreted as the fraction of firms that leave the market despite not having defaulted in a given period. In BGG  $\phi$  is calibrated to 0.9728, which translates into almost 37 quarters, or over 9 years of firms' average lifetime. Finance literature on deaths and life cycles of firms estimates the average life expectancies to be, roughly, 7-11 years based on firm registers in the U.S. See Morris (2009) for an informative survey. However, the predominant reason why firms disappear from registers is *precisely* bankruptcy. Therefore, following this interpretation,  $\phi$  may be significantly underestimated as  $1 - \phi$  should only capture firms disappearing from registers for reasons other than bankruptcy.

empirical evidence for this financial measure is roughly in line with our estimated value of  $\phi$ . Table 7 reports average dividend-to-equity ratios for our sample of emerging economies.<sup>25</sup> Clearly, our estimated value of  $1 - \phi = 0.085$  is rather close to the average dividend-

TABLE 7—AVERAGE DIVIDEND-TO-EQUITY RATIOS ACROSS EMERGING ECONOMIES IN PERCENT.

Argentina	8.51	Korea	2.83
Brazil	3.93	Malaysia	4.28
Colombia	3.64	Philippines	4.47
Ecuador	N/A	South Africa	4.70
Mexico	3.05	Thailand	5.59
Peru	7.85	Turkey	6.14

**Average 5.00**

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*Notes:* Nonfinancial publicly traded firms taken.  
Source: Bloomberg.

to-equity ratio found in the data, 0.050. The fact that our estimations (including some alternative specifications reported in subsequent sections) tend to somewhat underestimate this parameter may also be indicating an active role for the “tunneling” phenomenon. As described by Johnson et al. (2000), it is a process of (legal or illegal) transferring profits out of firms to benefit shareholders or escape creditors, which hampers equity accumulation.

Why does the GMM estimation favor relatively lower values of  $\phi$ ? While a detailed answer to this question is provided in the following section, we point out here that this parameter reflects the “leverage mechanism” at work in our model. The parameter plays a key role in determining the relatively high steady state levels of leverage and risk premium and, ultimately, the model’s performance, particularly in terms of the dynamics of interest rates and leverage. The leverage level implied by our estimated value of  $\phi$  is  $\frac{QK}{N} = 4.263$ , whereas the risk premium is  $\frac{R^K}{R^*} = 1.025$ . In the data, the corresponding numbers are 1.71 (for nonfinancial firms) and 1.007, respectively. In Subsection V.C we run an estimation in which the leverage level is one of the GMM-targeted moments. We show that the steady state leverage can be lowered to match empirical values without significantly reducing the overall fit of the model.

The leverage elasticity of the risk premium in the estimated model is 0.093, a bit larger than in other studies that work with developed countries (in the range of 0.04–0.08). The implied default rate in the optimal contract of 1.3 percent, or 5.1 percent annualized. This is a somewhat higher number than those seen in some previous studies, e.g. 3 percent annualized in BGG. The data on failure rates beyond the U.S. is scarce and also poses considerable problems of interpretation. The only multi-country study which reports official bankruptcy rates that we are aware of is that of Claessens and Klapper (2005). According

<sup>25</sup>The ratio takes annual data on all dividends reported by publicly traded nonfinancial firms and relates them to the equity value proxied by total market capitalization. See section A of the online appendix for details.

to their data, the average annual rate for Argentina, Chile, Colombia, Peru, Korea and Thailand is 0.15 percent a year, as opposed to e.g. 4.62 percent for South Africa. This large heterogeneity in the data on official rates is largely a reflection of differences in regulation and legal systems across the world. In particular, bankruptcy rates are higher in countries with more creditor rights and higher judicial efficiency.<sup>26</sup> Given that our theoretical framework does not take these two institutional features explicitly into account, the empirical bankruptcy numbers are not directly comparable with the model.

The estimated monitoring cost fraction  $\mu$  of 0.324 is larger, albeit with a high degree of uncertainty, than the value 0.12 calibrated originally by BGG based on U.S. data.<sup>27</sup> It is in the upper range of other studies focusing on the U.S. For example, Carlstrom and Fuerst (1997) consider calibrations with 0.2, 0.25 and 0.36. Christiano, Motto and Rostagno (2014) obtain the value 0.215 using Bayesian estimation. In Fuentes-Albero (2013) the number is 0.24 until 1983, but only 0.04 from 1984 on. A proxy for direct costs can also be found in the Doing Business database of the World Bank. The average cost of closing a business (expressed as a percent of estate) is 16.08 percent for our sample of 13 developing and 6.46 percent for the sample of small open developed economies. Yet, we share the view of Carlstrom and Fuerst (1997) who argue that  $\mu$  should be regarded in a broader sense and also include other indirect costs. The relatively high value of monitoring costs should be treated as a broad indicator that financial frictions are at work in emerging market economies, possibly even more so than in developed ones.

The value of  $\sigma$ , the standard deviation of the idiosyncratic productivity, is estimated to 0.125, a number slightly lower to those used in the literature. The numbers reported for the U.S. range from 0.15 in Queijo von Heideken (2009) to 0.529 in the original BGG paper. For the Euro Area, Christiano, Motto and Rostagno (2014) report  $\sigma = 0.26$ . This then implies that the productivity distribution is tighter in emerging economies.

The GMM estimation points to the capital adjustment costs parameter value of 4.602. This is a reduced-form parameter and its value depends on the functional specification of capital adjustment costs. Since there's no consensus on its feasible value range, it suffices to say that our estimate is broadly in line with previous literature.<sup>28</sup>

While the TFP shock volatility of 1.4 percent is a number similar to the values reported in previous studies for emerging economies (e.g. 1.47–1.98 percent in Neumeyer and Perri, 2005), the autoregressive component,  $\rho_A = 0.999$ , essentially points to unit root persistence of the productivity shock. Thus, our estimate clearly suggests a significant role for a “trend shock” as in Aguiar and Gopinath (2007). This is not a surprising result given the very simple way in which the consumer side is modeled. In particular, the fact that consumers face a riskless interest rate makes a (quasi-) unit root process the only effective channel through which the model can replicate high consumption volatility.<sup>29</sup> However, in Section

<sup>26</sup>As another example, compare the official annual bankruptcy rate for Spain which is 0.02 versus 3.65 percent for the U.S. or 2.62 percent for France.

<sup>27</sup>In the next section we analyze more extensively the sources of the high uncertainty around the point estimate of  $\mu$ .

<sup>28</sup>In particular, our estimated value is very close to those calibrated/estimated in Aguiar and Gopinath (2007) and García-Cicco, Pancrazi and Uribe (2010).

<sup>29</sup>Evidently, labor income fluctuations are also indirectly amplified by the financial accelerator. This, however,

VI we present evidence that the good performance of the model in terms of replicating the dynamics of interest rates does not hinge on the high persistence of the productivity shock. Neither does it depend on whether consumers face a riskless or risky interest rate.

### B. Leverage dynamics

A natural next step is to ask to what extent can the estimated model replicate the leverage patterns depicted in Figure 2. The model counterpart of the empirical assets-to-equity ratio analyzed in Section I is the expression  $(Q_t \tilde{K}_{t+1})/\tilde{N}_{t+1} = (\tilde{N}_{t+1} + \tilde{B}_{t+1})/\tilde{N}_{t+1}$ , where firms' assets are represented by  $Q_t \tilde{K}_{t+1}$ , debt by  $\tilde{B}_{t+1}$  and equity by  $\tilde{N}_{t+1}$ . The empirical value of assets is computed as the sum of firms' total debt and equity. The empirical counterpart of equity  $\tilde{N}_{t+1}$  is the firms' total market value, i.e. current market capitalization. For debt, we use book value as a proxy. Although one would optimally like to use market values for debt as well, such data is very scarce because private debt is publicly traded only for largest corporations in emerging economies (see Section I and Footnote 8 for details).<sup>30</sup> Table 8 reports the model generated serial correlations between leverage and output together with their empirical counterparts from Figure 2.<sup>31</sup>

TABLE 8—LEVERAGE DYNAMICS  $Corr(Y_t, Lev_{t+j})$ .

$j$	-4	-3	-2	-1	0	1	2	3	4
<b>Model</b>	-0.34 (0.03)	-0.39 (0.04)	-0.43 (0.04)	-0.45 (0.04)	-0.43 (0.05)	0.11 (0.08)	0.38 (0.06)	0.50 (0.02)	0.52 (0.01)
<b>Data</b>	0.01 (0.07)	-0.11 (0.08)	-0.22 (0.08)	-0.32 (0.07)	-0.30 (0.04)	-0.22 (0.04)	-0.14 (0.06)	-0.07 (0.08)	0.07 (0.06)

Notes: Standard errors are reported in brackets. Sources: Bloomberg, IFS.

What can be seen is that, qualitatively, the model is able to reproduce a considerable part of data dynamics. The reasonably good fit of the instantaneous correlation follows from the fact that the model generated cyclicity of interest rates is the same as the cyclicity of interest rates by construction. Since these two values are similar in our data and the model

this doesn't in practice create enough consumption volatility.

<sup>30</sup>In the model, as in the data, all the variables that define leverage ( $Q_t$ ,  $\tilde{K}_{t+1}$  and  $\tilde{N}_{t+1}$ ) are forward looking. To see this, note that eq. 4 can be rearranged by solving for  $Q_{t-1}$ , moving it one period forward, taking expectations as of  $t$  and iterating forward to get

$$Q_t = E_t \left\{ \sum_{s=t+1}^{\infty} \frac{(1-\delta)^{s-(t+1)}}{\prod_{j=t+1}^s R_j^K} \alpha \frac{\tilde{Y}_s}{\tilde{K}_s} \right\}$$

This means that  $Q_t$  is a sum of discounted expected future marginal productivities of capital. This in turn makes  $R_t^K$  and hence  $\tilde{V}_t$  and  $\tilde{N}_{t+1}$  forward looking as well.

<sup>31</sup>The empirical numbers in the table differ very slightly from those in Figure 2. The numbers in the table are obtained by GMM estimation on an unbalanced panel, whereas in the figure the leverage is a simple average across countries.

does a good job in matching interest rate cyclicity, a good match for leverage follows. In addition to this, the model captures many leads and lags correlations. In particular, it is able to roughly replicate the countercyclicality of leverage lags with the cycle (in the data the correlations are slightly weaker than in the model) as well as the fact that the serial correlation peaks at  $j = -1$ . It also replicates the procyclicality of leverage leads, although it overstates it. If a recession hits at  $j = 0$ , the deleveraging in the model occurs much more abruptly than in the data, where it is more moderated and prolonged. We consider this to be a satisfactory result given that lags and leads of leverage were not even a part of the GMM objective function. It should also be noted that the model generated leverage volatility (8.5 percent) is similar, although somewhat smaller, to that in the data (14.31 percent).

Summing up, the results reported in this section show that the estimated model can successfully account for many of the documented business cycle patterns in emerging economies, in particular the dynamics of interest rates and leverage. These results were obtained by estimating some structural parameters in the financial contract at values different than those commonly used in calibrations. In particular the estimation chooses a value of  $\phi$  that is in line with dividend-to-equity ratios observed in emerging economies. Our results also indicate that emerging economies' data can be seen through the lens of a model characterized by a relatively high level of steady state leverage. In the next section we further explore this issue.

## V. Inspecting the mechanism

### A. Steady State

In what follows, we inspect the mechanism behind our benchmark results by focusing on the role played by the estimated parameters in determining the model's performance. We start by analyzing the impact of the estimated parameter values on the nonstochastic steady state. In the next subsection we document how this in turn affects the dynamics of interest rates and other variables. Finally, in Section V.C we assess the results of the model when we include the average level of leverage in the set of empirical moments in the GMM.

We are particularly interested in studying the impact of the parameters in the financial contract on the steady state levels of leverage and the risk premium. Consider first the equation that determines the optimal steady state cutoff  $\bar{\omega}$

$$(16) \quad s(\bar{\omega}) - \frac{1 - \delta}{R^*} = \frac{\alpha}{\Omega(1 - \alpha)} \left[ \frac{g}{R^*} \frac{1}{k(\bar{\omega})} - \phi(1 - \Gamma(\bar{\omega}))s(\bar{\omega}) \right]$$

where  $s(\bar{\omega}) = \frac{R^K}{R^*}$  and  $k(\bar{\omega}) = \frac{QK}{N}$  are the risk premium and leverage respectively.<sup>32</sup> This equation can be treated as an implicit function of optimal solvency threshold  $\bar{\omega}$  condi-

<sup>32</sup>See section C of the online appendix for a detailed derivation.

tioned on the levels of the other parameters, most notably the estimated parameters in the financial contract, i.e.  $\mu$ ,  $\sigma$  and  $\phi$ .

We perform three comparative statics experiments. In particular, we assess how the steady state levels of leverage and risk premium are affected when  $\phi$ ,  $\mu$  or  $\sigma$  is varied, while the remaining five parameters are fixed according to the estimation results reported in Section IV. The experiments are summed up in Figure 3, where the crosses denote the estimated parameter values. The most remarkable result of the first experiment is that, as

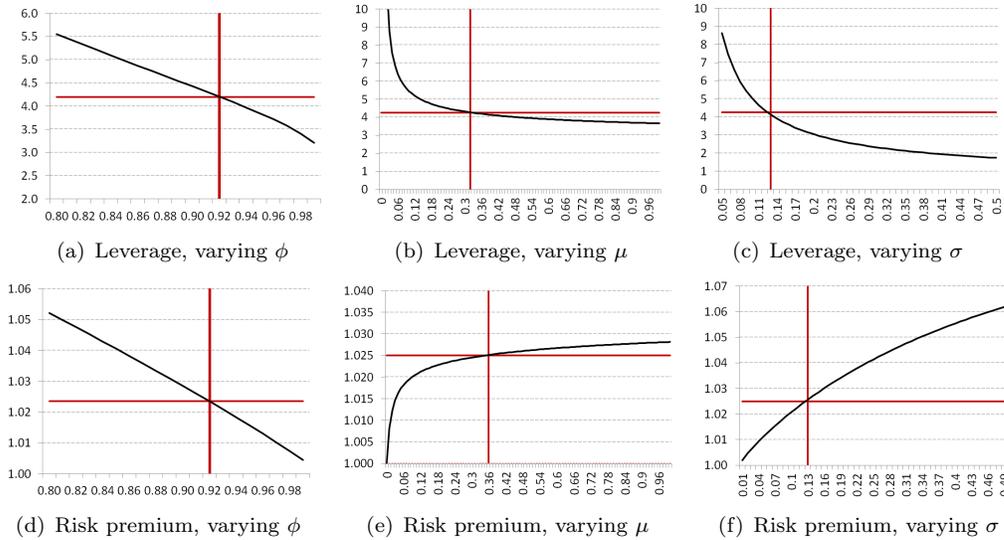


FIGURE 3. STEADY STATE LEVERAGE AND RISK PREMIUM UNDER DIFFERENT  $\phi$ ,  $\mu$  AND  $\sigma$ .

Notes: Crosses denote the estimated parameter values and the corresponding levels of leverage and the risk premium.

we move to higher levels of  $\phi$ , the steady state level of leverage falls significantly, dropping to 3 for  $\phi$  close to 1, as seen in 3(a). This pattern can be intuitively explained with eq. 7 which is used to derive eq. 16. The higher the  $\phi$ , *ceteris paribus*, the higher is the net worth and hence lower the leverage. This also implies lower steady state level of the risk premium, as in Figure 3(d). As the economy gets less leveraged, the risk premium markup over the risk free interest rate almost disappears.

In the second experiment, reported in the middle column, we manipulate the monitoring costs  $\mu$ . As they get lower, the economy approaches a model with no asymmetric information. In consequence, the risk premium approaches zero and optimal leverage becomes unbounded. Note also that the curves around the estimated value are relatively flat. This explains the high standard error of the estimated  $\mu$  reported in Section IV. This parameter is much better identified at lower value intervals.

Finally, we vary the standard deviation of idiosyncratic productivity  $\sigma$ , which is summed

up in the right column. This parameter has an impact on the steady state mainly because of the asymmetry of the log-normal distribution function. To some extent, the impact of varying  $\sigma$  is similar to that of  $\mu$ . In particular, steady state leverage is higher for low idiosyncratic productivity volatility. Risk premium rises as volatility goes up, as it was the case with  $\mu$ . Taken together, these results signal that the estimation is pointing to a steady state with, simultaneously, relatively high leverage and risk premium. Such combination can only be achieved via levels of  $\phi$  that are relatively lower than those calibrated in other studies. As we document next, this has important implications for the dynamics around the steady state.

One can also explain these results by analyzing the steady state position of the supply and demand curves on the credit market. Changing  $\mu$  as well as  $\sigma$  translates into a change in the costs of borrowing. This in turn affects the steady state position of the loan supply curve (8) while keeping the demand curve fixed. This can be seen by confronting the subfigures for leverage (a decreasing function of  $\mu$  and  $\sigma$ ) and the risk premium (an increasing function of  $\mu$  and  $\sigma$ ). Varying the dividend rate parameter  $\phi$ , on the other hand, moves the steady state demand for loans, while keeping the loan supply curve 8 unchanged, as shown in the first column of Figure 3. This induces a positive relationship between leverage and the risk premium.

Summing up, we have shown the link between the parameters of the financial contract and the steady state levels of leverage and the risk premium. As we will show next, this relationship is crucial for the dynamics of interest rates predicted by the model. It will allow us to identify these parameters using second moments of interest rate data in the GMM estimation.

### B. Dynamics and impulse responses

In this subsection we analyze the model dynamics by assessing the impulse response functions across various parameterizations of the steady state. The results are reported in Figures 3 through 5 where we present the impulse responses of the key variables over 12 quarters following a one standard deviation positive shock to TFP. The figures are plotted in three dimensions as we also report the sensitivity of these functions to different levels of  $\phi$  while all the other parameters are set at their estimated values.

The most important message from these figures is that as  $\phi$  decreases, the reaction of both capital ( $\tilde{K}_{t+1}$ ) and its price ( $Q_t$ ) after a positive productivity shock gets stronger. However, the net worth ( $\tilde{N}_{t+1}$ ) increases by even more. This is precisely because lower  $\phi$  is associated with higher steady state leverage. For a more leveraged economy the same shock generates a stronger windfall in profits  $\tilde{V}_t$  and in consequence a bigger jump in the entrepreneurial net worth than for a less leveraged one. In consequence, leverage starts falling more abruptly on impact. This in turn drives the risk premium and the interest rate down. This drop is the more pronounced the stronger the drop in leverage.

Compare this to a situation with high  $\phi$ , e.g. 0.98 – 0.99, as used in the literature for developed economies. The dynamics are now very different. Since the corresponding steady state leverage is relatively very low, entrepreneurial profit is reduced and the increases in

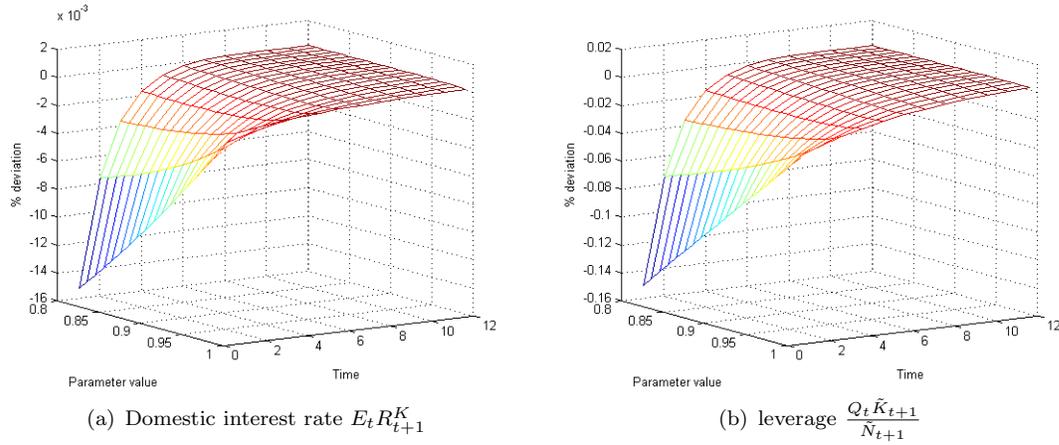


FIGURE 4. RESPONSES OF INTEREST RATE AND LEVERAGE AFTER A POSITIVE TFP SHOCK FOR DIFFERENT VALUES OF  $\phi$ .

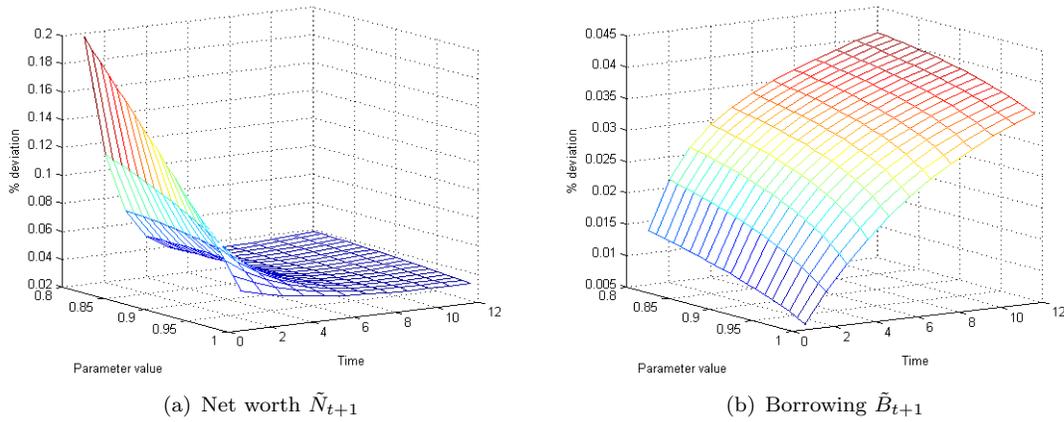


FIGURE 5. RESPONSES OF NET WORTH AND BORROWING AFTER A POSITIVE TFP SHOCK FOR DIFFERENT VALUES OF  $\phi$ .

$\tilde{V}_t$  and  $\tilde{N}_{t+1}$  become low as well. With capital adjustment costs unchanged, assets  $Q_t \tilde{K}_{t+1}$  increase on impact by only slightly less than net worth. Also, all these variables respond by much less in absolute terms. In consequence, both leverage and the interest rate go down on impact by only very little, which can be seen in Figures 4(a) and 4(b). In fact, if capital adjustment costs were slightly lower, the response of  $Q_t \tilde{K}_{t+1}$  would become larger than that of  $\tilde{N}_{t+1}$  and in consequence both leverage and interest rates would become procyclical as it is the case for a standard BGG parameterization. Importantly, in such case the strong

volatility of leverage and interest rates would vanish.

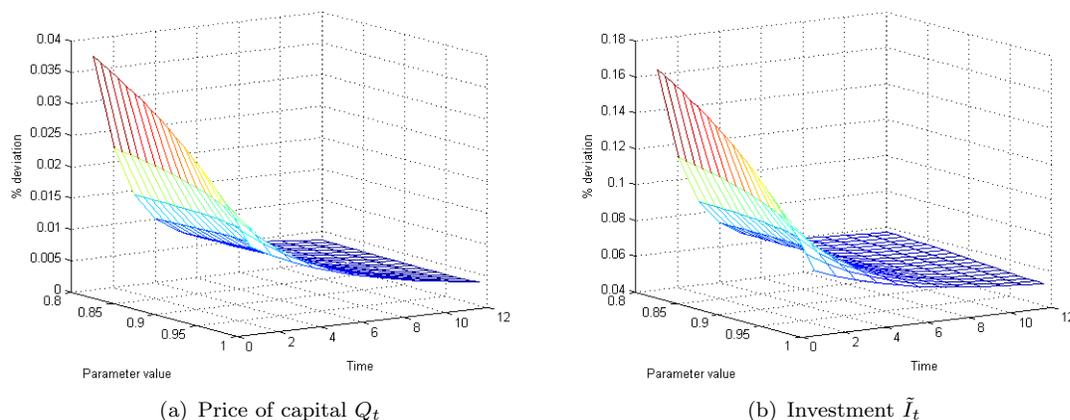


FIGURE 6. RESPONSES OF PRICE OF CAPITAL AND INVESTMENT AFTER A POSITIVE TFP SHOCK FOR DIFFERENT VALUES OF  $\phi$ .

To fully understand the model dynamics, consider the market for capital. A significant increase in the net worth allows for a major rise in assets and hence generates a very high demand for capital. Since capital is predetermined on impact, this demand is reflected in a large increase in capital price  $Q_t$  as well as investment  $\tilde{I}_t$ , as can be seen in Figure 6. Also, although this increase in assets comes predominantly from new equity (internal funding), borrowing goes slightly up as well. This is because lower leverage has dropped the external funding costs, as can be seen in Figure 5(b). In the period after the shock (i.e. at  $t+1$ ) the price of capital falls significantly. First, the supply of capital is now higher due to large investment at  $t$ . Secondly, the demand is now lower. This is due to the fact that leverage has fallen in the previous period  $t$  (on impact) and limited the increase in  $\tilde{V}_{t+1}$  and  $\tilde{N}_{t+2}$  relative to the previous period. In consequence, there's a capital loss between  $t$  and  $t+1$  and the return on capital in  $t+1$  falls. Since this mechanism is expected as of  $t$ , it further decreases  $E_t R_{t+1}^K$  and allows the model to match the large interest rate volatility in emerging economies.

Finally, these results also indicate that interest rate data used in the GMM conveys information about the size of the parameters defining the financial contract. Importantly, it also suggests that the role these parameters play has a large impact on the cyclicity of leverage, which therefore allows to assess their relative strength.

### C. Matching leverage

We have just emphasized that the mechanism through which the model accounts for the dynamics of interest rates is closely tied to the steady state leverage level. In the

benchmark results in Section IV, however, we noted that the implied leverage in the model was roughly twice the one we observe empirically. We now assess the extent to which the model can get closer to the data in this dimension by adding the empirical average level of leverage to the moments included in (15). Importantly, while we continue to work with nonfinancial leverage, we also study the consequences of including financial leverage in our analysis. We do this given that, arguably, one could interpret the model broadly so that financial frictions encompass both financial and nonfinancial firms.

Table 9 and Figure 7 present the first set of results. The table reports the average leverage ratios for each of the countries in our dataset. The first column reports the measure of nonfinancial leverage that we have been using, whereas the last three columns document leverage for all financial firms, only banks, and for all available firms, respectively. The figure plots the cyclical dynamics of leverage of all financial firms (right panel) and, for comparison, it reproduces the dynamics of nonfinancial leverage presented earlier in Figure 2 (left panel).

TABLE 9—LEVERAGE ACROSS FIRM TYPES - AVERAGES.

Country	Nonfinancials	Financials	Banks	All
Argentina	1.95	8.30	9.33	3.07
Brazil	1.84	4.82	13.89	2.16
Colombia	1.37	3.37	4.46	1.81
Ecuador	-	12.97	12.97	12.97
Korea	1.70	4.94	6.76	1.86
Malaysia	1.67	6.34	7.83	2.60
Mexico	1.73	4.79	5.20	1.93
Peru	1.42	5.53	5.57	2.32
Philippines	1.90	4.18	6.88	2.67
South Africa	1.37	-	-	1.37
Thailand	1.95	8.68	11.41	3.13
Turkey	1.92	6.38	6.81	3.62
<b>Simple average</b>	<b>1.71</b>	<b>6.39</b>	<b>8.28</b>	<b>3.29</b>

Notes: Data source: Bloomberg.

Two key findings are apparent. First, as expected, financial institutions are more leveraged than nonfinancial firms, close to four times as much. Banks, a subset of all the financial firms considered, are leveraged even more. As a result the capitalization-weighted total leverage in the pool of emerging market economies considered nearly doubles. The second main finding is that financial leverage exhibits a similar degree of countercyclicality as that of nonfinancial firms. In addition, financial leverage also tends to lead the GDP cycle given that the correlation between leverage at  $t+j$  and the cycle at  $t$ , peaks at  $j < 0$ .

The lower-right panel of Table 10 presents the results of incorporating the average leverage level into the GMM estimation as an additional moment. We use nonfinancial leverage first and then consider aggregate leverage. In both cases the results indicate that a closer match between the empirical and model based leverage can be achieved without sacrificing the good performance of the model in other dimensions. In particular, the model continues

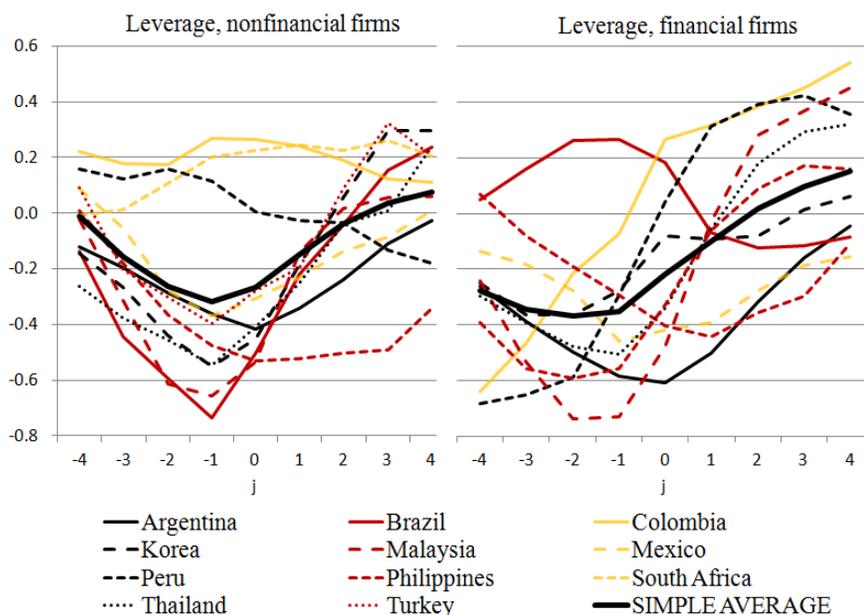


FIGURE 7. LEVERAGE OF FINANCIAL AND NONFINANCIAL FIRMS.

*Notes:* Cyclicalities are measured as correlations of (leads and lags of) leverage with current output  $Y$ , i.e.  $\text{Corr}(\text{Leverage}_{t+j}, Y_t)$ . Leverage is computed as assets-to-equity ratio, i.e.  $\text{Leverage}_t = \frac{Q_t K_{t+1}}{N_{t+1}}$ . All series are logged and then HP filtered. Simple averages are arithmetic means taken across countries for every year. Quarterly data, 3Q 1995 – 3Q 2012 (country-dependent), Sources: Bloomberg, IFS.

to account for the countercyclical and volatile interest rates in the data together with the countercyclical dynamics of leverage (Table 15). Interestingly, this is done without modifying much the value of the estimated  $\phi$ . The estimation is now forced to match a low level of leverage relative to the benchmark while still accounting for interest rate dynamics. This is achieved by a stronger elasticity of the risk premium via higher levels of  $\mu$  and  $\sigma$ .<sup>33</sup> It is also coupled with slightly stronger TFP shocks.

## VI. Robustness

In this section we assess the robustness of our benchmark results to several extensions. First, we explore how the results vary when changing the persistence of the TFP process. Second, we account for other potentially important drivers of interest rates in emerging markets, such as sovereign risk and exogenous fluctuations of the world interest rate.

<sup>33</sup>In particular, the elasticity reaches 0.315 when matching nonfinancial firms' leverage and 0.222 for all firms, relative to 0.093 in the benchmark case.

TABLE 10—MATCHING LEVERAGE LEVELS - MOMENTS.

Moment	Benchmark		Matching leverage of nonfinancials		Matching leverage of all firms	
	Data	Model	Data	Model	Data	Model
I	II	III	IV	V	VI	VI
$\sigma(Y)$	3.32	3.75	3.43	4.32	3.43	3.90
$\sigma(C)/\sigma(Y)$	1.26	1.07	1.20	1.01	1.20	1.08
$\sigma(I)/\sigma(Y)$	3.76	3.54	3.42	2.74	3.42	3.09
$\sigma(TB)$	3.21	3.07	2.88	1.56	2.88	2.14
$\rho(TB, Y)$	-0.40	-0.55	-0.44	-0.48	-0.44	-0.55
$\rho(C, Y)$	0.77	0.99	0.82	0.99	0.82	0.99
$\rho(I, Y)$	0.69	0.77	0.73	0.85	0.73	0.81
$\sigma(R)$	0.92	0.79	0.82	0.61	0.82	0.67
$\rho(R, Y)$	-0.36	-0.43	-0.39	-0.32	-0.39	-0.34
$\frac{Q^k}{N}$	N/A	N/A	1.73	1.98	2.40	2.50

Notes: Standard deviations are expressed in percent. In the estimations with leverage matching, Ecuador is excluded from the panel due to lack of sufficient data on leverage. Sources: Bloomberg, IFS.

TABLE 11—MATCHING LEVERAGE LEVELS - PARAMETER VALUES.

Parameter	$\mu$	$\sigma$	$\varphi$	$\phi$	$\rho_A$	$\sigma_A$
<b>Benchmark</b>	0.324	0.125	4.602	0.915	0.999	0.014
<b>Nonfinancials' leverage</b>	0.920	0.316	4.704	0.902	0.994	0.017
<b>All firms leverage</b>	0.876	0.220	4.407	0.908	0.999	0.015

TABLE 12—MATCHING LEVERAGE LEVELS - LEVERAGE DYNAMICS  $Corr(Y_t, Lev_{t+j})$ .

$j$	-4	-3	-2	-1	0	1	2	3	4
<b>Data</b>	0.01	-0.11	-0.22	-0.32	-0.30	-0.22	-0.14	-0.07	0.07
<b>Benchmark</b>	-0.34	-0.39	-0.43	-0.45	-0.43	0.11	0.38	0.50	0.52
<b>Nonfinancials' leverage</b>	-0.26	-0.29	-0.32	-0.33	-0.32	0.27	0.51	0.57	0.52
<b>All firms leverage</b>	-0.28	-0.32	-0.35	-0.36	-0.34	0.23	0.48	0.55	0.51

Notes: Data sources: Bloomberg, IFS.

### A. Persistence in Productivity Shocks

Our benchmark results point to a near unit root in the productivity process in line with the results in Aguiar and Gopinath (2007). This comes from the fact that consumers face a riskless interest rate, making very persistent productivity shocks the only effective channel through which the model can replicate high consumption volatility.<sup>34</sup> In light of this, it

<sup>34</sup>In the working paper version of this work, Fernández and Gulán (2012) we also show that such results are robust to assuming that consumers face a risky interest rate linked to the one faced by entrepreneurs.

is important to explore the extent to which this very high persistence is relevant for the model's good performance when matching the other moments of interest, most notably those describing interest rate dynamics in emerging economies. To answer this question we counterfactually set the persistence of the stationary productivity shock to  $\rho_A = 0.95$ , a somewhat standard value in the literature on business cycles in developed economies, while keeping other parameters at their estimated values.

The results are reported in the column IV of Table 13. For comparability, in columns I-III we report the moments from the benchmark estimation. While consumption volatility is now much lower relative to the data and the benchmark case, neither leverage nor interest rate dynamics are significantly changed. The latter is due to the fact that  $\rho_A$  does not affect the steady state of the financial accelerator.<sup>35</sup> In addition, leverage dynamics continue to be countercyclical (see Table 15).

TABLE 13—ROBUSTNESS CHECKS - MOMENTS.

Moment	Benchmark			no ARG ECU	
	Data	Model	$\rho_A = 0.95$	Data	Model
I	II	III	IV	V	VI
$\sigma(Y)$	3.32	3.75	3.64	3.06	3.40
$\sigma(C)/\sigma(Y)$	1.26	1.07	0.76	1.21	1.07
$\sigma(I)/\sigma(Y)$	3.76	3.54	3.07	3.67	3.54
$\sigma(TB)$	3.21	3.07	1.83	2.92	2.92
$\rho(TB, Y)$	-0.40	-0.55	-0.33	-0.45	-0.57
$\rho(C, Y)$	0.77	0.99	1.00	0.76	0.99
$\rho(I, Y)$	0.69	0.77	0.81	0.74	0.78
$\sigma(R)$	0.92	0.79	0.75	0.46	0.47
$\rho(R, Y)$	-0.36	-0.43	-0.60	-0.38	-0.46
Moment	Foreign shock			CEMBI	
	Data	with $R^*$	only $R^*$	Data	Model
VI	VII	VIII	IX	X	XI
$\sigma(Y)$	3.32	3.80	1.15	2.03	2.06
$\sigma(C)/\sigma(Y)$	1.26	1.18	2.89	1.02	0.96
$\sigma(I)/\sigma(Y)$	3.76	3.51	10.75	3.97	4.08
$\sigma(TB)$	3.21	3.29	3.18	1.58	1.61
$\rho(TB, Y)$	-0.40	-0.29	-0.06	-0.08	-0.39
$\rho(C, Y)$	0.77	0.90	0.40	0.33	1.00
$\rho(I, Y)$	0.69	0.70	-0.01	0.73	0.67
$\sigma(R)$	0.92	1.03	1.02	0.38	0.67
$\rho(R, Y)$	-0.36	-0.32	-0.12	-0.58	-0.36

Notes: Standard deviations are expressed in percent. Sources: Bloomberg, IFS.

<sup>35</sup>To be precise,  $\rho_A$  does affect the dynamics of leverage and interest rates but only marginally via a slight change in the dynamics of investment (and hence in  $Q_t$  and  $\tilde{K}_{t+1}$  as well). This happens because, *ceteris paribus*, investment response will be lower the less persistent TFP shocks are. In consequence, the price and quantity of capital react less relative to net worth which increases somewhat the countercyclicality of leverage and interest rates. The quantitative effects of such mechanism are, however, very limited as shown in the results.

TABLE 14—ROBUSTNESS CHECKS - PARAMETER VALUES.

Parameter	$\mu$	$\sigma$	$\varphi$	$\phi$	$\rho_A$	$\sigma_A$	$\rho_{R^*}$	$\sigma_{R^*}$
<b>Benchmark</b>	0.324	0.125	4.602	0.915	0.999	0.014	N/A	N/A
$\rho_A = 0.95$	0.324	0.125	4.602	0.915	0.950	0.014	N/A	N/A
<b>no ARG ECU</b>	0.210	0.125	3.827	0.933	0.999	0.013	N/A	N/A
<b>CEMBI</b>	0.651	0.119	3.502	0.852	0.979	0.007	N/A	N/A
<b>with <math>R^*</math></b>	0.235	0.284	6.538	0.849	0.998	0.015	0.999	0.003
<b>only <math>R^*</math></b>	0.335	1.793	3.093	0.635	N/A	N/A	0.981	0.008

TABLE 15—ROBUSTNESS CHECKS - LEVERAGE DYNAMICS  $Corr(Y_t, Lev_{t+j})$ .

$j$	-4	-3	-2	-1	0	1	2	3	4
<b>Data</b>	0.01	-0.11	-0.22	-0.32	-0.30	-0.22	-0.14	-0.07	0.07
<b>Benchmark</b>	-0.34	-0.39	-0.43	-0.45	-0.43	0.11	0.38	0.50	0.52
$\rho_A = 0.95$	-0.33	-0.42	-0.50	-0.56	-0.60	-0.06	0.24	0.39	0.44
<b>no ARG ECU</b>	-0.36	-0.41	-0.45	-0.47	-0.46	0.06	0.35	0.49	0.53
<b>CEMBI</b>	-0.30	-0.35	-0.39	-0.41	-0.36	0.22	0.42	0.46	0.43
<b>with <math>R^*</math></b>	-0.29	-0.33	-0.36	-0.37	-0.35	0.12	0.37	0.47	0.49
<b>only <math>R^*</math></b>	0.41	0.58	0.74	0.88	0.97	0.90	0.74	0.54	0.32

Notes: Data sources: Bloomberg, IFS.

More generally then, our GMM estimation points to a potentially relevant role of trend shocks despite the fact that the model already has a built-in microfounded financial accelerator mechanism. Aguiar and Gopinath (2007) argued that trend shocks should be interpreted precisely as an emanation of deeper frictions. One could therefore postulate that any frictions that can be recovered through nonstationary productivity processes are orthogonal to the financial frictions that we have studied here. Under such conjecture "the cycle is the trend" hypothesis still holds even when one explicitly considers financial frictions in the form of a financial accelerator.

### B. Sovereign Risk

Motivated by the countercyclical nature of leverage and interest rates in emerging economies data, our model postulated that corporate risk is an important driver of interest rates in these economies. It may be argued, however, that there are other important drivers, sovereign risk being one of the first obvious candidates. To properly disentangle the contributions of corporate and sovereign risk in driving interest rates one would require a model of its own, which goes beyond the scope of this paper. Nonetheless, here we address this issue by running two separate experiments in which we assess the robustness of the benchmark model to two changes in the dataset. Both of them aim at minimizing the impact of the sovereign as an independent driver of interest rates. First, we exclude Argentina and

Ecuador from our panel, the only two countries that have experienced sovereign default in our sample. Secondly, we use CEMBI interest rates. In both cases we reestimate the model using the two different samples and compare the results to the ones obtained in the benchmark case presented in Section IV.<sup>36</sup>

The results from the two experiments, reported in columns V-VI and X-XI of Table 13, are in line with our benchmark results. When we remove Argentina and Ecuador from our sample, the empirical moments look very similar to the benchmark case. Average interest rates remain countercyclical but their volatility reduces considerably. The model can account for this change by slightly increasing  $\phi$ , while still matching the empirical dynamics of leverage, as reported in Table 15.

On the other hand, when the model is estimated using only CEMBI data<sup>37</sup> it continues to replicate the volatile and countercyclical dynamics of interest rates relatively well by resorting to the same mechanism as in the benchmark case, i.e. relatively high levels of leverage. The short sample on which the model is estimated, however, implies some important changes to the empirical moments targeted. For example, consumption volatility is significantly reduced in this sample and lower than that of output. This in turn explains the lower persistence of the productivity shock (see Table 14).

We conclude this subsection by stating that our focus on corporate risk as a driver of emerging economies' business cycles does not mean that we oppose the idea that sovereign risk plays an important role as well. We view our results as complementing rather than overturning this idea, while at the same time providing new elements to the understanding of business cycles in emerging economies.

### C. Interest Rate Shocks

A second potentially important driver of interest rates in emerging market economies that we have thus far abstracted from is the occurrence of sudden stops of the kind stressed by Calvo (1998), among others. These are periods of systemic rises in risk premia that are, by and large, unrelated to fundamentals. We address this issue by introducing an exogenous process for the world interest rate into our benchmark model and comparing the new results with our benchmark case.<sup>38</sup> To be concrete, we respecify the benchmark model by assuming that  $R^*$  follows an AR(1) process in deviations from steady state:

$$\ln R_{t+1}^* = \rho_{R^*} \ln R_t^* + (1 - \rho_{R^*}) \ln R^* + \epsilon_{R^*,t}, \quad \epsilon_{R^*,t} \stackrel{i.i.d.}{\sim} N(0, \sigma_{R^*}^2)$$

<sup>36</sup>As mentioned in Footnote 7, we also ran simple Granger-causality tests between EMBI and CEMBI which failed to identify any evidence of a causality running from sovereign to corporate risk. These results, however, should be taken with caution as they are only reduced-form approximations to the complex interlinkages between corporate and sovereign risk.

<sup>37</sup>Due to lack of CEMBI data for some countries, we were able to run the robustness estimation on only 6 economies: Brazil, Colombia, Korea, Malaysia, Mexico and Peru. The longest range of the unbalanced panel is 4Q 2001 - 4Q 2011.

<sup>38</sup>In a separate experiment we estimated a SVAR between the country interest rates and several proxies for global risk. The results, available upon request, show that the average contribution of exogenous risk to the variance of domestic interest rates across countries is not large and ranges between 10 and 22 percent, depending on the proxy used. See Akinici (2013) for a similar analysis.

where  $\rho_{R^*}$ , and  $\sigma_{R^*}$  are two additional parameters in the GMM estimation and  $R_{t+1}^*$  denotes the riskless interest rate between  $t$  and  $t + 1$ . We consider two separate cases. We first continue to assume that productivity shocks are present, but later also consider an extreme case where only  $R^*$  shocks are present (i.e. we set  $\rho_A = \sigma_A = 0$ ).<sup>39</sup>

The results of both estimations are reported in the bottom panel of Table 13. Column VIII reports the moments when both shocks are turned on, while column IX presents the results when only  $R^*$  is on. The last two rows of Table 14 report the estimated parameter values.

The benchmark results are largely robust to the inclusion of the  $R^*$  shock. Steady state leverage continues to be relatively high. Hence, the main propagation mechanism highlighted in the benchmark case continues to be of relevance. This explains why the model continues to display a good performance in terms of the dynamics of interest rates and leverage. In particular, adding  $R^*$  shocks allows the countercyclicality of leverage in the model to get closer to that in the data, as reported in Table 15. Other moments are now matched more closely. We also achieve a closer match of both output and relative consumption volatility. However, the lion's share of the action continues to come from productivity shocks amplified via financial frictions. The standard deviation of these shocks is close to what was estimated in the benchmark case while that of interest rates is an order of magnitude lower.<sup>40</sup>

Another interesting property of the model that is worth noting is the way in which the financial accelerator mechanism propagates shocks to the external interest rate. This is illustrated in Figure 8 where we plot the impulse responses to an estimated one standard deviation shock to  $R^*$  of the model with both shocks estimated. Following this shock, the opportunity cost of lending to entrepreneurs goes up, which increases  $\bar{\omega}_t$  and shrinks the set of viable projects. This in turn reduces the amount of aggregate borrowing and stifles investment demand. As investment falls, the price of capital drops in tandem, which also reduces the return on capital on impact, decreases profits and the net worth. Since the drop in equity is stronger relative to the drop in credit, leverage goes up. Both lending and investment are then further reduced because of the subsequent increase in the risk premium triggered by higher leverage, which further amplifies the impact of the shock on capital and output.

The model in which shocks to  $R^*$  are the only source of uncertainty performs badly in terms of matching the moments of interest. The two most salient shortcomings of this model are the lack of comovement between investment and output (Table 13) and the strong procyclicality of leverage (Table 15). Both of these are strongly at odds with the data. It thereby indicates the need for a productivity shock amplified by financial frictions.

<sup>39</sup>We also considered a robustness in which  $R^*$  is calibrated to the real U.S. T-Bill rate. The results are similar to the case with estimated  $R^*$  and are available upon request.

<sup>40</sup>While we do not use data on foreign interest rates to identify the parameters in the process for  $R^*$ , our estimates for  $\rho_{R^*}$  and  $\sigma_{R^*}$  are close to those in Neumeyer and Perri (2005) who calibrated these two parameters using the data on U.S. Junk Bonds, arguably a proxy of global risk. Therefore, our estimates seem to pick up this external factor. We think that our approach of not calibrating  $R^*$  directly to any particular data gives the model the best chance to inform about the extent to which interest rate shocks not connected to fundamentals matter for the business cycle.

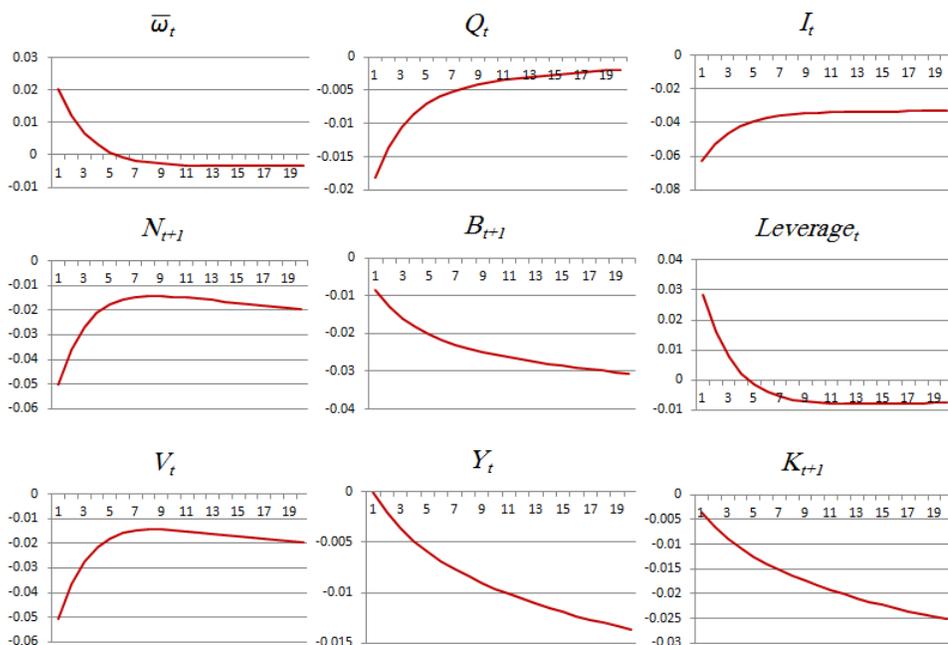


FIGURE 8. IMPULSE RESPONSE FUNCTIONS TO A POSITIVE SHOCK IN  $R_{t+1}^*$ .

Notes: The shock is a one standard deviation increase in  $R_{t+1}^*$  in the model with estimated TFP and  $R^*$  shocks.

This result echoes that of Mendoza (1991) who documented how little interest rate shocks contribute to aggregate dynamics in RBC-SOE models. Our results then extend Mendoza's earlier findings to a richer model with financial frictions.

To conclude, the results reveal that systemic rises in risk premia of the kind stressed by the sudden stop literature account for a small, although not trivial part of interest rate fluctuations in emerging economies. Most likely their relevance increases when one restricts the analysis to crisis times. Seen through the lens of our model, such shocks contribute only marginally to business cycle dynamics in emerging economies. The model continues to favor the financial accelerator mechanism as a powerful mechanism to propagate productivity shocks. These findings are in line with those of Neumeyer and Perri (2005), and more recently Chang and Fernández (2013), who show that interest rate shocks alone cannot account for business cycles in these economies and that financial frictions are crucial for amplifying productivity shocks. Our results extend theirs to an environment with microfounded financial imperfections.

## VII. Concluding Remarks

The key task reported in this paper was to show how structural financial frictions in the form of a financial accelerator can provide a rationale for some of the distinctive business cycle patterns in emerging markets. To this end, we embed a financial contract á la Bernanke, Gertler and Gilchrist (1999) into a standard business cycle model of a small open economy. We show that many of these characteristics can be accounted for without the use of ad hoc, reduced-form processes or exogenous shocks for country interest rates. In particular, we take the model to the data for emerging market economies and show that it reproduces the key stylized facts, notably the volatility and the countercyclicality of the risky country interest rate. The model's relatively good performance stems from a strong financial accelerator that delivers countercyclical risk premia in a leveraged economy. In good times, i.e. after a positive productivity shock, net worth of firms goes up, which reduces the leverage as well as the fraction of bankrupt firms and hence drives the risk premium down. We thereby offer a structural, yet tractable, mechanism by which some of these business cycle patterns can be explained. To rationalize this mechanism, we provide novel empirical evidence that assets-to-equity ratios of firms in emerging economies indeed tend to be countercyclical.

Our modeling technique also addresses another important point made by Aguiar and Gopinath (2008), namely that fluctuations of interest rates should be linked to changes in productivity. For the same reason we abstain from incorporating working capital requirement to our model, because, as shown by Chang and Fernández (2013), such friction is empirically not relevant relative to another friction that links the country interest rate to productivity. Nevertheless, the financial accelerator still shares, in a more structural form, part of the idea of the working capital constraint in that production (and therefore implicitly payments for input factors) is financed with borrowed funds.

The ongoing research program in financial frictions literature, including e.g. papers of Christiano, Motto and Rostagno (2014) and Fuentes-Albero (2013), provides evidence that the financial accelerator plays a significant role in explaining fluctuations in developed economies, e.g. in the U.S. and the Euro Area. Our work suggests that the mechanism may have an even higher potential in the context of business cycles in emerging economies.

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