Financial Frictions and Macroeconomic Fluctuations in Emerging Economies[*]

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Abstract

The country risk premium predicted by the dynamic real business cycle models in emerging markets is procyclical, whereas it is countercyclical in the data. This paper proposes a model in which a time-varying risk premium emerges endogenously through a variant of the Bernanke-Gertler-Gilchrist financial accelerator mechanism. The estimated model can account for the volatility and the countercyclicality of risk premium as well as for other key business cycle moments. Time-varying uncertainty in firm-specific productivity significantly contributes to delivering a countercyclical default rate and explains more than half of the variances in the trade balance and risk premium.

Keywords: Financial Frictions; Country risk premium; International business cycles; Bayesian Estimation.

JEL classification: E32; E44; F44; G15.

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1 Introduction

Real business cycles in emerging markets are characterized by three distinct features: (1) excessive volatility of consumption relative to output (2) strong countercyclicality of the trade balance and (3) high, volatile, and countercyclical country risk premia. Existing estimated models of business cycles in emerging markets place significant emphasis on matching observed movements in output, consumption, and the trade balance, but deemphasize capturing the cyclical behavior of country premia. This strand of the literature either assumes frictionless access to international financial markets or treats the country premium in a reduced form, without explicitly incorporating a microfounded default mechanism. A difficulty faced by estimated versions of these models is that they deliver counterfactual predictions for the country interest rate premium. In particular, the interest rate predicted by these models is either acyclical or procyclical while it is countercyclical in the data.

This paper proposes and estimates a small open economy model in which a time-varying country premium emerges endogenously through a variant of the financial accelerator model of Bernanke et al. (1999) (henceforth BGG). In the model, due to a costly state verification problem, external funds will be more expensive than internal funds. Assuming that households are the owners of the leveraged firms which might default on their debts, both the country interest rate premium and the premium firms pay to borrow in the international markets are driven by the endogenous probability of default. In response to an unanticipated negative shock to productivity, a realization of the return on the inputs financed by external funds will be lower than its expected value. To guarantee an expected return to foreign lenders which is equal to a risk-free return, the share of earnings promised to them from investing in inputs financed by external funds has to rise. This necessitates an increase in the productivity default threshold. A higher default threshold, then, implies a higher default rate and a higher risk premium.

The endogenous risk premium also contributes to generating a countercyclical trade balance and higher consumption volatility relative to income volatility in the model. An unexpected decrease in productivity leads to a higher risk premium and hence less borrowing from abroad. The country's trade balance thus increases, leading to a negative correlation between trade balance and output. Moreover, the total consumption of households varies more in response to productivity shocks in a model with endogenous spreads. Upon a higher cost of borrowing, firms deleverage by decreasing the real dividends distributed to the households, which tightens the latter agents' budget constraints. As a result, households adjust consumption by more than in the absence of an endogenous risk premium.

I econometrically estimate the model on Argentine data using Bayesian methods. I augment the data series that are used in the standard estimations of frictionless or reduced form financial frictions models with country risk premium data. The estimated model accounts for a volatile and countercyclical interest rate and key emerging market business cycle moments. In the estimation, the model is subjected to a variety of shocks, such as stationary and nonstationary shocks to total factor productivity (the latter is also called a shock to trend growth), and a financial shock. The financial shock introduced in this paper is inherent in the financial accelerator mechanism; therefore, it is more primitive than an exogenous shock to the country risk premium, which is a standard way of incorporating financial shock in this literature. In the model, firms acquire capital goods to be used in the production process through a combination of their own resources and borrowing from foreign lenders. Loans extended to an emerging economy are risky to foreign lenders because firms experience idiosyncratic productivity shocks which, if sufficiently severe, prevent them from repaying their loans. The magnitude of the idiosyncratic risk shock is determined by its standard deviation, and I assume that this standard deviation is the realization of a stochastic process as in Dorofeenko et al. (2008), Christiano et al. (2011), Christiano, Motto and Rostagno (2014) (henceforth CMR) and Chugh (2016).[1]

Incorporating time-varying uncertainty, or risk, shocks into an emerging market business cycle model is appealing for three reasons. First, it helps the model to account for the countercyclical risk premium and other key emerging market business cycle moments. In response to an increase in the standard deviation of the idiosyncratic productivity shock (implying higher uncertainty or risk), foreign lenders will charge a higher risk premium on their lending to an emerging economy. This occurs because foreign lenders have to bear the cost of more bankruptcies after an increase in uncertainty. Raising the risk premium is the only way they can shed this risk. With the higher cost of borrowing, firms reduce the amount of capital goods used in the production process because they are now more expensive to finance. In addition, households' demand for domestic goods diminishes because of the decrease in the dividend income they receive from firms. This leads firms to reduce their demand for labor, which further tightens the budget constraint of the households as the real wages declines. As a result of these dynamics, investment, consumption and output decrease

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[1] The financial frictions introduced into the model in these models are related to domestic financial markets and the macroeconomic models are estimated using data for developed economies. Among those, Chugh (2016) follows a different approach by using the micro-estimated risk shocks as an input to a baseline small-scale financial accelerator model to assess how well the model reproduces business cycle fluctuations.

and a countercyclical interest rate premium emerges. Second, this shock is important in delivering a volatile country risk premium, which is a good leading indicator in emerging economies. Finally, as I show, time-varying uncertainty shocks in the model with financial frictions replace some of the role of the nonstationary technology shock in the frictionless real business cycle (RBC) model in explaining fluctuations in investment and the trade balance.[2]

The importance of time-varying volatility in country interest rates has also recently been emphasized in the emerging economy RBC literature. In an influential paper, Fernandez-Villaverde et al. (2011) first document the strong evidence of time-varying volatility in the real interest rates faced by four emerging economies including Argentina, and then embed this mechanism exogenously into an otherwise standard open economy macroeconomic model. A recent paper by Dueber (2018) also shows that a model with time-varying volatility in the interest rate premium can generate a countercyclical trade balance and excess volatility in consumption. In this paper, I explore the role of risk shocks (*ala* CMR) in the context of a microfounded financial accelerator emerging economy business cycle model that give rise to endogenous country borrowing rates in the international markets.

I investigate the sources of business cycle fluctuations in emerging economies using the estimated model. I find that time-varying uncertainty in the firm-specific productivity explains more than half of the variance of trade balance-to-output ratio and country risk premium. I also find that stationary productivity shocks play an important role in explaining the economic fluctuations in output, consumption and investment. Shocks to a nonstationary component of productivity, on the other hand, are non-negligible but not dominant.

The present paper is related to a large body of existing literature on emerging-market business cycles. Most models in this literature build on the canonical small open economy RBC model presented in Mendoza (1991) and Schmitt-Grohe and Uribe (2003). Neumeyer and Perri (2005) and Uribe and Yue (2006) augment the canonical model with reduced form financial frictions without explicitly incorporating a microfounded default mechanism. Aguiar and Gopinath (2007) introduce shocks to trend output in an otherwise standard small open economy RBC model. However, the estimated frictionless model implies excessive volatility of trade balance-to-output ratio. Partly motivated by this feature of the model, Garcia-Cicco et al. (2010) propose and estimate an encompassing model for an emerging economy with both trend shocks and financial frictions. However, as I show, their model predicts a procyclical interest rate, while it is strongly countercyclical in the data.[3]

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[2] Aguiar and Gopinath (2007) argue that the nonstationary technology shock is the single most important shock for the emerging economy in the context of a frictionless RBC model.

[3] Chang and Fernandez (2013) and Miyamoto and Nguyen (2017) also estimate a reduced form financial

The work by Mendoza and Yue (2012) incorporate a slightly modified version of the default risk model of Eaton and Gersovitz (1981) into an otherwise standard RBC model. Their model is successful in replicating the countercyclical spreads. However, their results crucially depend on the assumption that defaults on public and private foreign obligations occur simultaneously.[4]

In a contemporaneous work, Fernandez and Gulan (2015) have introduced corporate default *ala* BGG into an otherwise small open economy RBC model. My framework differs from theirs in several important ways. In Fernandez and Gulan (2015), the consumption side of the model is formulated in a relatively simple way so that the persistence of productivity shocks (which is the only source of business cycle fluctuations in their model) drive most of the dynamics of consumption. By contrast, in my framework the households are the owners of leveraged firms and the distribution of dividends from firms to households are endogenous (in the BGG and related frameworks, the firms pay dividends with a fixed probability). The latter feature is critical for the model to capture how endogenous changes in the risk premium contribute to consumption volatility in the model economy.[5,6]

Another novel feature of my framework relative to the existing models in the emerging economy RBC literature, including the one proposed in Fernandez and Gulan (2015), is that I allow for time-varying uncertainty in the firm-specific productivity (also called risk shocks in the CMR) in addition to aggregate productivity shocks, and fully estimate the macroeconomic model. As I show, uncertainty shocks explain a non-negligible share of the variance of the trade balance and the country risk premium in a version of the model calibrated to Argentina and Mexico. One final difference is that estimation of the baseline model using Bayesian methods enables me to contribute to the debate of importance of financial frictions versus the shocks to trend growth in emerging markets, as my model nests the canonical small open economy RBC model with nonstationary technology shocks.

The important role of the endogenous country risk premium has recently received a lot

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frictions model augmented with trend shocks to productivity. Similarly, they place significant emphasis on explaining observed movements in output, consumption and the trade balance-to-output ratio.

[4] Aguiar and Gopinath (2006) in a quantitative model of sovereign default based on the classic setup of Eaton and Gersovitz (1981) argue that permanent productivity shocks successfully generate the cyclicality of the risk premia seen in the data. However, this model cannot explain the cyclical output dynamics that are critical for their results, as they assume an exogenous output endowment.

[5] One of the important predictions of my model is that the correlation between the risk premia implied by the uncovered interest rate parity condition of the households and of the corporations are very high, in line with the empirical findings documented in Mendoza and Yue (2012) and Du and Schreger (2015).

[6] Section 7.2 considers a version of the baseline model with only stationary technology shocks, and compares its predictions to models with standard BGG frictions.

of attention in the literature as being the key element of spillovers from global financial conditions to small open emerging economies. Recent work by di Giovanni et al. (2017) shows using bank level data that the country risk premium fluctuates countercyclically in emerging economies, with the premium on domestic relative to foreign borrowing costs rising as global financial conditions tighten. As the authors show, this mechanism is key to account for changes in domestic credit conditions in emerging economies due to changes in global risk conditions. Earlier empirical contributions that highlight the importance of endogenous country risk premium in transmitting global financial conditions to emerging countries include Uribe and Yue (2006) and Akinci (2013) among others. Differently from these works, my paper emphasizes the importance of an endogenous country risk premium in properly accounting for macroeconomic fluctuations as well as key empirical regularities in emerging economies in the context of a fully estimated RBC model with financial frictions.

My work is also related to the literature studying the role of monetary and exchange rate policies within the context of a small open economy monetary business cycle model with financial frictions *ala* BGG (see, for example, Gertler et al. (2007), Elekdag et al. (2006), and Curdia (2007)).[7] While the introduction of nominal rigidities might amplify the impact of financial shocks on the real economy, I chose to work with a *real* macroeconomic model to facilitate the comparison of my results to the ones reported in the recent emerging economy real business cycle literature.

The remainder of the paper is organized as follows: Section 2 discusses key empirical regularities of business cycles in Argentina. Section 3 estimates both the frictionless and the reduced form financial frictions model. The purpose of this section is to evaluate these models in terms of their ability to produce countercyclical interest rate premia and other stylized facts of emerging economy business cycles. Section 4 outlines the RBC model of an emerging economy with endogenous corporate default and uncertainty shocks. Section 5 presents functional forms and calibration, and section 6 describes the econometric estimation of the baseline model. Section 7 evaluates the model in terms of its ability to match the business cycle regularities in Argentina. Section 8 discusses empirical regularities for the Mexican business cycle, and evaluates the performance the baseline model to account for Mexican data. Section 9 presents robustness, and section 10 concludes.

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[7] More recently Akinci and Queralto (2019) developed a two-country monetary DSGE model with endogenous country risk premium. The authors show that this empirically well-grounded feature of the model is important to account for financial spillovers from advanced economy policies onto emerging markets.

2 Business Cycles in Emerging Countries

Real business cycles in emerging markets are characterized by three distinct features: (1) excessive volatility of consumption relative to output (2) strong countercyclicality of the trade balance, and (3) high, volatile, and countercyclical country risk premia.[8] In this section I briefly discuss empirical regularities of business cycles in Argentina over the period 1983Q1-2001Q3. Argentina is one of the few countries frequently used in the quantitative small open economy RBC literature. The other one is Mexico, which I analyze in Section 8. The interest rate series for Argentina starts in 1983 while for other emerging markets (for example, Mexico) it starts in 1994. However, I exclude the post 2001 period from the baseline analysis because Argentina was in default between 2002 and 2005 and was excluded from the international capital markets. Excluding this period is required for the purpose of this study because in my model the firm never loses its access to the international financial markets. As a result, the sample period for Argentina (1983-2001) differs from that of Mexico (1994-2018), but the sample size of the data in each country is comparable.

Table 1 presents second moments for the growth rates of output per capita, consumption per capita, investment per capita, the trade balance-to-output ratio and the country interest rate premium. Notably, per-capita consumption growth in Argentina is significantly more volatile than per-capita output growth. Investment growth is highly volatile. The trade balance-to-output ratio is about as volatile as output growth. The volatility of the interest rate premium faced by Argentina in the international markets in this period is quite high. The observed correlation between the trade balance-to-output ratio and output growth is negative and significantly different from zero. There is negative co-movement between the country risk premium and output growth. The correlation of the country risk premium with the growth rate of the components of the domestic absorption; i.e, with consumption growth and investment growth, is also negative and significantly different from zero. Therefore, this table illustrates that in Argentina, similar to other emerging economies including Mexico (as discussed in Section 8), consumption is more volatile than output, the trade balance to output ratio is strongly countercyclical, and the country risk premium is high, volatile, and negatively co-moves with the economic activity.

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[8] See, for example, Neumeyer and Perri (2005) and Aguiar and Gopinath (2007) among others.

Table 1. Business Cycle Moments: Argentina

Statistics	g^Y	g^C	g^I	*tby*	*prem*
Standard Deviation	2.73	3.15	6.07	2.61	4.46
	(0.42)	(0.47)	(0.78)	(0.26)	(0.71)
Correlation with g^Y	—	0.94	0.86	-0.19	-0.25
		(0.01)	(0.03)	(0.08)	(0.07)
Correlation with *tby*	—	-0.15	-0.24	—	0.87
		(0.07)	(0.08)		(0.03)
Correlation with *prem*	—	-0.21	-0.32	—	—
		(0.08)	(0.09)		
Serial Correlation	0.10	0.19	0.39	0.95	0.90
	(0.12)	(0.12)	(0.09)	(0.01)	(0.02)

Note: g^Y, g^C, g^I and *tby* denote the growth rates of output per capita, consumption per capita, and investment per capita, respectively, and tby denotes the trade balance-to-output ratio. The country interest rate premium is denoted by prem, and is expressed in annual terms. Except for tby, all variables are measured in logs. Standard errors are shown in parenthesis, and calculated using the Delta method. Sample covers the period from 1983Q1 until 2001Q3. The data sources are given in the Appendix A.

3 The Real Business Cycle Model

This section estimates and evaluates the performance of a canonical RBC model augmented with a shock to trend growth as in Aguiar and Gopinath (2007) and a reduced form financial frictions model as in Garcia-Cicco et al. (2010) (henceforth GPU), in terms of their ability to match key moments of Argentine data between 1983Q1-2001Q3.[9] In particular, I investigate the ability of these models to match the statistical properties of the country interest rate premia. It is important because these models usually place significant emphasis on matching observed movements in output, consumption and the trade balance, but deemphasize capturing the cyclical behavior of country premia. This strand of the literature either assumes frictionless access to international financial markets or treats a country premium in a reduced form, without explicitly incorporating a microfounded default mechanism. I argue that a difficulty faced by estimated versions of these models is that they

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[9] The sketch of the GPU model is presented in Appendix B, and the bayesian estimation results are shown in Appendix C.

Table 2. Second Moments implied by RBC and GPU Models

Statistics	g^Y	g^C	g^I	*tby*	*prem*
Standard Deviation					
- RBC model	2.78	3.08	5.37	**10.0**	0.75
- GPU model	2.90	3.17	5.18	1.56	4.20
- Data	2.73	3.15	6.07	2.61	4.46
	(0.42)	(0.47)	(0.78)	(0.26)	(0.71)
Correlation with g^Y					
- RBC model		0.99	0.94	-0.07	**0.04**
- GPU model		0.94	0.83	-0.13	**0.10**
- Data		0.94	0.86	-0.19	**-0.25**
		(0.01)	(0.03)	(0.08)	(0.07)
Correlation with *prem*					
- RBC model		**0.03**	**0.01**	**0.94**	
- GPU model		**0.05**	**-0.03**	**0.57**	
- Data		**-0.21**	**-0.32**	**0.87**	
		(0.08)	(0.09)	(0.03)	
Serial Correlation					
- RBC model	0.13	0.06	0.01	0.99	0.99
- GPU model	0.12	0.05	-0.01	0.82	0.94
- Data	0.10	0.19	0.39	0.95	0.90
	(0.12)	(0.12)	(0.09)	(0.01)	(0.02)

Notes: Empirical moments are computed at the median of the posterior distribution. The moments for the GPU model belong to the Bayesian estimation of the model with working capital constraint on Argentine data including output growth, consumption growth, investment growth, the trade balance–to-output ratio and country interest rate premium over the period 1983Q1–2001Q3.

deliver counterfactual predictions for the country interest-rate premium.

Table 2 displays second moments predicted by these models. Both the RBC model augmented with a shock to trend growth and the GPU model perform similarly in explaining movements in output and consumption. The GPU model better matches the statistical properties of the trade balance-to-output ratio. However, both models perform poorly in matching the interest rate process seen in the data.[10] In particular, the interest rate predicted by these models is either acyclical or procyclical while it is countercyclical in the data.[11]

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[10] I estimate the GPU model without working capital constraints using quarterly Argentine data, which cannot account for the cyclicality of interest rate premium either. The GPU model estimated using annual Argentine data over a longer sample period, as in Garcia-Cicco et al. (2010), also produces counterfactual predictions for the cyclicality of country risk premium.

[11] There is disagreement in the literature regarding the contribution of nonstationary productivity shocks to business cycle fluctuations in emerging economies. In the RBC model nonstationary productivity shocks

Next, I outline a small open economy RBC model augmented with corporate default and uncertainty shocks. I argue that these new model features over the standard RBC model of an emerging economy are key to successfully accounting for the volatility and cyclicality of the country interest rate premium in the data. After establishing that the model matches the data reasonable well in several dimensions, I investigate the sources of business cycle fluctuations in emerging economies using the estimated model.

4 Model with Corporate Default and Uncertainty Shocks

The model is a canonical small open economy RBC model augmented with financial frictions through a variant of the BGG financial accelerator mechanism.[12] It consists of households, firms and the foreign sector. The households consume and provide labor for the production firms, as well hold shares of the firms that have access to the international markets. The domestic goods are produced via constant returns to scale technology that requires labor and capital. The firms rent labor from households in a perfectly competitive market and purchase capital from capital producing firms. However, it takes one period for the capital to be ready for use in the production process. Therefore, I assume that firms borrow from risk neutral foreign lenders to finance the purchase of capital goods.

4.1 Households

The economy is populated by a continuum of infinitely-lived representative households who choose per-period consumption, C_t, labor effort, h_t, and the amount of one-period domestic bond, B_{t+1}, which is in zero net supply in equilibrium. Agents seek to maximize the discounted expected future flow of utility,

$$\max_{\{C_t,h_t,B_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \tilde{X}_{t-1}h_t), \tag{1}$$

subject to the budget constraint

$$C_t + B_t \quad = \quad \frac{B_{t+1}}{R_t} + W_t h_t + \Phi_t^F \tag{2}$$

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are the main source of aggregate fluctuations, while in the GPU the contribution of these shocks is negligible. The variance decompositions predicted by the these models (not shown) confirm the earlier results.

[12] See, also, Gertler et al. (2007) and Curdia (2007) among others.

The variable R_t denotes the gross real interest rate of the one period domestic bond in period t. W_t is the household's real wage rate, and Φ_t^F denotes dividends received from the firms. In addition, consumers are subject to a borrowing constraint that prevents them from engaging in Ponzi financing. Under the preferences we assume, the disutility of labor must be detrended in order for the economy to have a balanced growth path. Following Akinci and Chahrour (2018), I generalize the approach taken by Garcia-Cicco et al. (2010) and assume that this term follows an exponential moving average process, $\tilde{X}_t = \tilde{X}_{t-1}^{\varphi} X_t^{1-\varphi}$, where X_t is a non-stationary aggregate labor-augmenting productivity shock. When $\varphi = 0$, this specification reduces to the case presented in Garcia-Cicco et al. (2010). Setting φ close to one smoothes the discontinuity in the hours response to productivity shocks that occurs when past productivity shocks affect the disutility of labor.[13]

4.2 Firms

4.2.1 Final Goods Firms

Firms operate as price takers in a competitive market. They hire labor, h_t, from households and use capital, K_t, rented from capital producers in the previous period to produce a (tradable) good sold at a world-determined price (normalized to unity without loss of generality) using the production technology:

$$Y_t(i) = A_t Y(\omega_t(i) K_t(i), X_t h_t(i)) \tag{3}$$

where A_t is a stationary aggregate shock to total factor productivity (TFP). The labor-augmenting productivity shock is nonstationary and its growth rate is defined as $\gamma_t \equiv \frac{X_t}{X_{t-1}}$. Capital goods used in the final goods production are shifted by an idiosyncratic productivity shock, $\omega_t(i)$, that is *i.i.d.* across firms and time. The shock is assumed to be log-normally distributed with cumulative density function $F(\omega)$ and parameters $\mu_{\omega,t}$ and $\sigma_{\omega,t}$ such that $E_{t-1}[\omega_t^i] = 1$ for all t. Therefore:

$$E_{t-1}\omega_t^i = e^{\mu_{\omega,t} + \frac{1}{2}\sigma_{\omega,t}^2} = 1 \Rightarrow \mu_{\omega,t} = -\frac{1}{2}\sigma_{\omega,t}^2$$

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[13] The complete set of first order conditions for the household's problem can be found in Appendix D.

The t subscript indicates that $\sigma_{\omega,t}$ is itself the realization of a random variable. The effective capital used in the production process at time t is then given by $\omega_t(i)K_t(i)$.[14]

Labor Demand Schedule

At time t, the firm chooses labor to maximize profits conditional on aggregate and idiosyncratic shocks, $(A_t, \gamma_t, \omega_t(i))$, given the available capital goods purchased in the previous period, $K_t(i)$. Accordingly, labor demand satisfies

$$A_t Y_h(\omega_t(i)K_t(i), X_t h_t(i)) \quad = \quad \frac{W_t}{X_t} \tag{4}$$

where Y_h is the marginal product of labor.

Capital Goods Purchase Decision and Debt Contract

Next, I consider the capital goods purchase decision. At the end of the period t, firms which are solvent, or newly created to replace insolvent firms, purchase capital goods, which can be used in the subsequent period, $t+1$, to produce output. The quantity of capital goods purchased is denoted by $K_{t+1}(i)$, with the subscript denoting the period in which capital good is used. Note that firms need to borrow in the international markets from risk neutral foreign lenders to finance the purchase of capital goods in time t, one period before they are actually used in the production, as it takes one period for the capital to be ready for use in the production process.

The firm finances the purchase of the capital good partly with its own net worth available at the end of period t, $N_t(i)$, and partly by borrowing from risk neutral foreign lenders, $D_t^*(i)$. Then, the capital goods financing constraint takes the form:

$$Q_t K_{t+1}(i) = N_t(i) + D_t^*(i) \tag{5}$$

where Q_t is the price of capital goods. The firms' demand for capital goods depends on the expected marginal return and the expected marginal financing cost. The return to capital is sensitive to both aggregate and idiosyncratic risk. Given the constant returns to scale assumption in the production process, the marginal return on capital goods for firm i can

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[14] Idiosyncratic shock is assumed to follow a mean preserving spread distribution as in Dorofeenko et al. (2008).

be expressed as:

$$R_{K,t+1}(i) = \omega_{t+1}(i) \underbrace{\frac{Z_{K,t+1} + (1-\delta)Q_{t+1}}{Q_t}}_{R_{K,t+1}} \tag{6}$$

where $Z_{K,t+1} = A_{t+1}Y_K\left(K_{t+1}, X_{t+1}h_{t+1}\right)$, Y_K is the marginal product of capital, and R_K is the aggregate component of the return on the investment in capital goods (proved in Appendix E).[15,16]

The marginal cost of purchasing the capital goods to the firm, on the other hand, depends on financial conditions. The idiosyncratic shock, $\omega_{t+1}(i)$, is private information for the firm, implying that a risk neutral foreign lender cannot freely observe the output. Due to the uncertain productivity of the firms, implying risk for the creditors, a risk premium is charged to the firms on their debt. Following BGG, the problem is set as one of costly state verification. This implies that, in order to verify the realized idiosyncratic return, the lender has to pay a cost, consisting of a fraction of those returns, so that the total cost of verification is $\mu\omega_{t+1}(i)R_{K,t+1}Q_tK_{t+1}(i)$, where μ is the real monitoring cost.

The firm chooses capital, $K_{t+1}(i)$, and the associated level of borrowing, $D_t^*(i)$, prior to the realization of the aggregate and idiosyncratic productivity shocks, $(A_{t+1}, \gamma_{t+1}, \omega_{t+1}(i))$, but after the realization of the standard deviation shock, $\sigma_{\omega,t}$. As it will be clear shortly, the latter shock plays an important role in the determination of external finance premium paid at time $t+1$. The firm with an idiosyncratic productivity shock, $\omega_{t+1}(i)$, above a default threshold value, $\bar{\omega}_{t+1}(i)$, pays a gross interest rate, $R_{D,t}^*(i)$, on their loans. The default threshold is set to a level of returns that is just enough to fulfill the debt contract obligations:

$$\bar{\omega}_{t+1}(i)R_{K,t+1}Q_tK_{t+1}(i) = R_{D,t}^*(i)D_t^*(i) \tag{7}$$

The cutoff value $\bar{\omega}_{t+1}(i)$ determines the division of gross earnings from investing in capital goods, $R_{K,t+1}Q_tK_{t+1}(i)$, between borrower and lender. If the idiosyncratic shock is greater

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[15] The realization of the idiosyncratic capital productivity shock at the beginning of period $t+1$ determines the effective amount of physical capital in possession of the firm i, given by $\omega_{t+1}(i)K_{t+1}(i)$. The marginal return to the firm from renting out the capital to be used in the production process is given by $\omega_{t+1}(i)Z_{K,t+1}$. The firm sells the undepreciated capital $(1-\delta)\omega_{t+1}(i)K_{t+1}(i)$ in the market at price Q_{t+1} at the end of period $t+1$. The payoff to the firm per unit of physical capital purchased is thus given by $\omega_{t+1}(i)[Z_{K,t+1} + (1-\delta)Q_{t+1}]$. See Akinci and Queralto (2017) for a more formal description of a similar problem.

[16] As it will be clear shortly when I show the functional forms, the idiosyncratic productivity shock enters the production function with a power α. This assumption is desirable to make the model homogeneous in the term $R_{K,t+1}Q_tK_{t+1}$, where $R_{K,t+1}$ is the aggregate rate of return on capital goods.

than or equal to the default threshold, $\bar{\omega}_{t+1}(i)$, the firm repays the loan and collects the remainder of the profits, equal to $(\omega_{t+1}(i) - \bar{\omega}_{t+1}(i))R_{K,t+1}Q_tK_{t+1}(i)$. This means that if the firm does not default, a lender receives a fixed payment independent of $\omega_{t+1}(i)$. Otherwise, the firm defaults and the foreign lender pays the auditing cost, μ, and collects everything there is to collect, $(1-\mu)\omega_{t+1}(i)R_{K,t+1}Q_tK_{t+1}(i)$.

Define $\Upsilon(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})$ as the expected gross share of the aggregate component of earnings retained by the firm and define $\Gamma(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})$ as the expected gross share of aggregate component of earnings going to the lender such that $\Upsilon(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) + \Gamma(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) = 1$:

$$\begin{aligned}
\Upsilon(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) &\equiv \int\limits_{\bar{\omega}_{t+1}(i)}^{\infty} (\omega_{t+1}(i) - \bar{\omega}_{t+1}(i))dF(\omega_{t+1}(i);\sigma_{\omega,t}) && (8)\\
\Gamma(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) &\equiv \int\limits_{0}^{\bar{\omega}_{t+1}(i)} \omega_{t+1}(i)dF(\omega_{t+1}(i);\sigma_{\omega,t}) + \left[1 - F(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})\right]\bar{\omega}_{t+1}(i) && (9)
\end{aligned}$$

In these equations, $F(.)$ denotes the time-varying cumulative density function of $\omega_{t+1}(i)$ and $F(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})$ is the probability of default. The values of $\bar{\omega}_{t+1}(i)$ and $R^*_{D,t}(i)$ under the standard debt contract are determined by the requirement that risk neutral foreign lenders' expected income flow in $t+1$ is zero for each loan amount.[17] Accordingly, the loan contract must satisfy the zero profit condition of the foreign lender:

$$E_t\Omega(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})R_{K,t+1}Q_tK_{t+1} = R^*_tD^*_t(i) \tag{10}$$

where

$$\begin{aligned}
\Omega(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) &\equiv \Gamma(\bar{\omega}_{t+1}(i);\sigma_{\omega,t}) - \mu G(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})\\
G(\bar{\omega}_{t+1}(i),\sigma_{\omega,t}) &\equiv \int\limits_{0}^{\bar{\omega}_{t+1}(i)} \omega_{t+1}(i)dF(\omega_{t+1}(i);\sigma_{\omega,t})
\end{aligned}$$

and, R^*_t is the financial investors' return from investing in risk-free instruments.[18] Firms, after paying for labor, distribute dividends to households as they are the owners of the firms.

---

[17] Standard debt contract necessitates that the default threshold, $\bar{\omega}_{t+1}$ is state contingent but the contractual interest, $R^*_{D,t}$, is not.

[18] As discussed by BGG, $\Omega(.)$ is increasing in $\bar{\omega}_{t+1}$ given the log-normality assumption. Moreover, given the mean preserving increase in the uncertainty assumption, $\Omega(.)$ is decreasing in $\sigma_{\omega,t}$.

Real dividends are given by:

$$
\begin{aligned}
\Phi^F_{t+1}(i) = &\quad Y_{t+1}(i) - W_{t+1}h_{t+1}(i) - R^*_{D,t}(i)D^*_t(i) - N_{t+1}(i) && (11)\\
= &\quad \omega_{t+1}(i)R_{K,t+1}Q_tK_{t+1}(i) - R^*_{D,t}(i)D^*_t(i) - N_{t+1}(i) && (12)
\end{aligned}
$$

Rearranging equation (12) by using the definition of the default threshold given in equation (7), expected dividends distributed to the households can be expressed as the following:[19]

$$
E_t\Phi^F_{t+1}(i) \;=\; E_t\left(\left[1-\Gamma(\bar{\omega}_{t+1}(i);\sigma_{\omega,t})\right]R_{K,t+1}Q_tK_{t+1}(i) - N_{t+1}(i)\right) \qquad (13)
$$

The problem of the firm at time t is then given by the following:

$$
\max_{\{K_{t+1}(i),\bar{\omega}_{t+1}(i),R^*_{D,t}(i),N_t(i)\}} \Lambda_t\Phi^F_t(i) + \beta E_t\Lambda_{t+1}\Phi^F_{t+1}(i) \qquad (14)
$$

subject to the participation constraint of the foreign lenders, equation (10), and the default threshold definition, equation (7). I denote the Lagrange multiplier for the participation constraint of the lender, equation (10), as $\zeta_t(i)$. The appropriate discount factor is given by Λ_t, where $\Lambda_t = \lambda_t X^{-\sigma}_{t-1}$ is the Lagrange multiplier associated with the households' budget constraint, equation (2).

Firms' optimal decision rules are given by the following three equations:

$$
\begin{aligned}
\frac{R_t}{R^*_t}E_t\Lambda_{t+1} &= E_t\Lambda_{t+1}\rho(\bar{\omega}_{t+1},\sigma_{\omega,t}) && (15)\\
E_t\Lambda_{t+1}\frac{R_{K,t+1}}{R^*_t}\left[1-\Gamma(\bar{\omega}_{t+1};\sigma_{\omega,t})\right] &= E_t\Lambda_{t+1}\rho(\bar{\omega}_{t+1};\sigma_{\omega,t})\frac{N_t}{Q_tK_{t+1}} && (16)\\
E_t\Omega(\bar{\omega}_{t+1};\sigma_{\omega,t})\frac{R_{K,t+1}}{R^*_t}Q_tK_{t+1} &= Q_tK_{t+1} - N_t && (17)
\end{aligned}
$$

where $\rho(\bar{\omega}_{t+1};\sigma_{\omega,t}) = \frac{(1-F(\bar{\omega}_{t+1};\sigma_{\omega,t}))}{(1-F(\bar{\omega}_{t+1};\sigma_{\omega,t})-\mu\bar{\omega}_{t+1}F_{\bar{\omega}}(\bar{\omega}_{t+1};\sigma_{\omega,t}))}$ is the risk premium (proved in Appendix F). Equation (15) is the standard uncovered interest parity relationship linking domestic and foreign interest rates, augmented with an endogenously determined risk premium. Equation (16) defines a key relationship in the firm sector, linking the price of capital goods to the expected *excess* return on investment in those goods (or, the external finance premium), net worth and level of capital goods that is demanded at that price.[20] This equation can be

---

[19] Note that dividend distributed by the surviving firms is $\Phi^F_t(i) = (\omega_t(i) - \bar{\omega}_t(i))R_{K,t}Q_{t-1}K_t(i) - N_t(i)$ and the dividends for insolvent firms is given by $\Phi^F_t(i) = -N_t(i)$.

[20] The external finance premium, $E_t\Lambda_{t+1}R_{K,t+1} > R^*_tE_t\Lambda_{t+1}$, depends inversely on borrower balance

re-written using the definition of leverage, $lev_t = \frac{D_t^*}{Q_t K_{t+1}}$:

$$E_t \Lambda_{t+1} R_{K,t+1} \left[1 - \Gamma(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})\right] \quad = \quad (1 - lev_t) R_t^* E_t \Lambda_{t+1} \rho(\bar{\omega}_{t+1}; \sigma_{\omega,t})$$

As it is clear from these equations, the external finance premium is not the same as the country risk premium, and the difference depends on how leveraged the firms are, $(1 - lev_t)$, and how much of the firms' returns is paid back to the households, $(1 - \Gamma_{t+1})$. Finally, equation (17) is the participation constraint of the foreign lender.

4.2.2 Capital Goods Production Firms

Capital producers produce new capital goods subject to costs of adjusting the capital. Their problem is the following:

$$\max_{K_{t+1}, I_t} E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_t \left[Q_t K_{t+1} - Q_t(1-\delta) K_t - I_t\right] \tag{18}$$

subject to

$$K_{t+1} = (1-\delta) K_t + I_t - \Phi(\frac{K_{t+1}}{K_t}) K_t \tag{19}$$

The price of capital goods is then given by the following:

$$Q_t = 1 + \Phi'\left(\frac{K_{t+1}}{K_t}\right) + \beta E_t \frac{\Lambda_{t+1}}{\Lambda_t}\left[(Q_{t+1} - 1)(1-\delta) + \Phi\left(\frac{K_{t+2}}{K_{t+1}}\right) - \Phi'\left(\frac{K_{t+2}}{K_{t+1}}\right)\frac{K_{t+2}}{K_{t+1}}\right] \tag{20}$$

4.3 Resource Constraint and Balance of Payments

The resource constraint and the balance of payments, respectively, are given by:

$$Y_t \quad = \quad C_t + I_t + NX_t \tag{21}$$

$$NX_t \quad = \quad \Gamma(\bar{\omega}_t; \sigma_{\omega,t-1}) R_{K,t} Q_{t-1} K_t - D_t^* \tag{22}$$

where NX_t is the net exports, $\Gamma(\bar{\omega}_t, \sigma_{\omega,t-1}) R_{K,t-1} Q_{t-1} K_t$ denotes the repayment of the debt and its service by the firms, and D_t^* is the total amount of borrowing at time t by the firms.[21] (Proved in Appendix G.)

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sheets in BGG and related frameworks.

[21] The complete set of equilibrium conditions in stationary form are presented in Appendix H.

5 Functional Forms and Calibration

5.1 Functional Forms

The functional forms of preferences, capital adjustment cost and the production technology are as follows:

$$U(C_t, h_t) = \frac{\left(C_t - \theta \tilde{X}_{t-1} \frac{h_t^{\psi}}{\psi}\right)^{1-\sigma} - 1}{1-\sigma} \tag{23}$$

$$\Phi\left(\frac{K_{t+1}}{K_t}\right) = \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - \gamma\right)^2 \tag{24}$$

$$Y(K_t, h_t) = A_t K_t^{\alpha}\left[X_t h_t\right]^{1-\alpha} \tag{25}$$

The utility function, equation (23), is defined as in Greenwood et al. (1988), which implies non-separability between consumption and leisure. This assumption eliminates the wealth effect on labor supply by making the marginal rate of substitution between consumption and labor independent of consumption. The parameter σ is the coefficient of relative risk aversion, and ψ determines the wage elasticity of labor supply, which is given by $1/(\psi$-1). Equation (24) is the capital adjustment cost function. The parameter γ is the steady state growth rate of permanent technology shock, X_t, and the parameter ϕ introduces the quadratic capital adjustment cost. The production technology, equation (25), takes the Cobb-Douglass form, where A_t is a stationary shock to total factor productivity.

I assume that the exogenous processes for productivity shocks (stationary and nonstationary productivity) and time-varying uncertainty shocks are given, respectively, by

$$log(A_t/A) = \rho_a log(A_{t-1}/A) + \varepsilon_{a,t}; \;\; \varepsilon_{a,t} \sim i.i.d. \;\; N(0, \sigma_a^2) \tag{26}$$

$$log(\gamma_t/\gamma) = \rho_\gamma log(\gamma_{t-1}/\gamma) + \varepsilon_{\gamma,t}; \;\; \varepsilon_{\gamma,t} \sim i.i.d. \;\; N(0, \sigma_\gamma^2) \tag{27}$$

$$log(\sigma_{\omega,t}/\sigma_\omega) = \rho_{\sigma_\omega} log(\sigma_{\omega,t-1}/\sigma_\omega) + \varepsilon_{\sigma_\omega,t}; \;\; \varepsilon_{\sigma_\omega,t} \sim i.i.d. \;\; N(0, \sigma_{\sigma_\omega}^2) \tag{28}$$

5.2 Calibration

The time unit in the model is meant to be one quarter. I assign values to the structural parameters using a combination of calibration and econometric estimation techniques. Table 3 presents the calibrated parameter values and I examine robustness to several of these choices in Section 9.2.

Table 3. Calibrated model parameters.

Parameter	**Concept**	**Value**
σ	Risk aversion	2.00
ψ	Labor elasticity	1.455
$\bar{h}$	Steady-state hours normalization (implies θ)	0.33
α	Capital share	0.32
δ	Capital depreciation rate	0.10
γ	Long run productivity growth	1.005
φ	Degree of slow detrending in the preferences	0.95
R^*	Long run risk-free world interest rate (p.a.)	1.02
β	Discount factor	0.975
μ	Monitoring cost	0.095
$\sigma_{\omega,ss}$	Std. dev. of ω	0.40

The risk aversion parameter is set to 2 and the curvature of labor disutility in the utility function is set to $\psi = 1.455$, which are standard in the open economy RBC literature. I set $\theta = 1.956$ to ensure that in the steady state households allocate about one-third of their time to market work. The capital income share in output is 32 percent, a value commonly used in the literature. The depreciation rate, δ, is chosen such that an average investment ratio implied by the model is in line with the long run averages observed in Argentina, which is a bit higher than 20 percent. Similarly, the steady state productivity growth is chosen to match the long run mean of the GDP growth rate in the data. The implied values for the depreciation rate of 0.1 and the long run trend growth rate of 1.005 are similar to the values used in the literature (e.g. Mendoza (2010) and Garcia-Cicco et al. (2010)). The degree of slow de-trending is set to 0.95, following Akinci and Chahrour (2018).

The annual world risk-free interest rate R^* is set to 2 percent, following several recent studies (e.g. Reifschneider (2016)). For the country risk premium, I used EMBI+ spread for Argentina calculated by J.P. Morgan after 1994 and I used country spread data constructed by Neumeyer and Perri (2005) before 1994. The average annual spread on public sector debt based on available country risk premium data is around 12 percent. This is in line with the average country risk premium estimates reported in Mendoza and Yue (2012) for Argentina. The assumptions on the world interest rate, the steady state growth rate, and the country risk premium imply that the value of the discount factor is 0.975.

Finally, in order to calibrate the parameters governing the degree of financial frictions in the model economy I rely on two targets from Argentine data: (1) The steady state external finance premium that the Argentine corporations pay in the international financial markets (2) the steady state leverage ratio of these corporations. These two targets are calculated from a firm level dataset with annual balance sheet information for Argentine firms (as reported in Dealogic database). The effective premium paid by firms in Argentina, around 7%, is lower on average than the sovereign interest rate premium. This finding is in line with estimates presented in Mendoza and Yue (2012). The steady state leverage ratio of firms is set to 0.50. In comparison, the average leverage ratio of Argentine corporations is 0.49 in the dataset provided by Fernandez and Gulan (2015). These two targets, along with other targets from Argentine data, imply $\mu = 0.095$ and $\sigma_{\omega,ss} = 0.40$.

6 Bayesian Estimation and Identification

I estimate the remaining parameters of the model using Bayesian methods and Argentine data on output growth, consumption growth, investment growth, the trade balance–to-output ratio, and the country risk premium over the period 1983Q1–2001Q3. Specifically, I estimate the parameters defining the stochastic process of the shocks along with the parameter governing the degree of capital adjustment costs. I also estimate nonstructural parameters representing the standard deviations of i.i.d. measurement errors on the observables. Measurement errors are permitted to absorb no more than 25 percent of the standard deviation of the corresponding observable time series.

As it is difficult to quantify prior beliefs for the shock processes, I selected the priors for the autocorrelation and standard deviation of the shocks with the following criteria in mind. For autocorrelation parameters, I adopt beta distributions which have a mean equal to 0.5 and a standard deviation of 0.2, which are quasi-flat priors. All standard deviations of the innovations to the shock processes are assumed to follow an inverse-gamma distribution. The means of stationary and nonstationary technology shocks are both set at 0.02 with a standard deviation of 0.01, and the financial frictions shock has a prior mean of 0.4 and a standard deviation of 0.2. All these priors allow for a quite dispersed range of values.

Table 4 presents key statistics of the prior and posterior distributions. The entire prior and posterior distributions of the parameters along with their respective estimated median values are presented in Appendix I. Several results are worth highlighting: First, when the posterior distributions are compared with the prior distributions, it is evident that all

Table 4. Prior and Posterior Distribution - Baseline Model

	Prior Distribution			Posterior Distribution		
Parameter	Prior	Mean	Std	Median	5%	95%
σ_a	IG	0.02	0.01	0.0108	0.0071	0.0143
ρ_a	B	0.5	0.2	0.87	0.77	0.94
σ_γ	IG	0.02	0.01	0.0133	0.0082	0.0185
ρ_γ	B	0.5	0.2	0.10	0.01	0.24
σ_{σ_ω}	IG	0.40	0.20	0.0645	0.0503	0.0810
ρ_{σ_ω}	B	0.5	0.2	0.97	0.93	0.99
ϕ	G	4	4	5.66	4.02	7.54
Measurement Errors						
Parameter	Prior	Min	Max	Median	5%	95%
$100\sigma_y^{me}$	U	0.01	0.68	0.0106	0.010	0.0127
$100\sigma_c^{me}$	U	0.01	0.79	0.0112	0.010	0.0151
$100\sigma_i^{me}$	U	0.01	1.52	0.1127	0.0710	0.1651
$100\sigma_{tby}^{me}$	U	0.01	0.65	0.0104	0.010	0.0117
$100\sigma_{prem}^{me}$	U	0.01	0.28	0.0103	0.010	0.0114
Log-marginal likelihood					942.0	

Notes: Estimation is based on Argentine data from 1983Q1 to 2001Q3. Posterior statistics are based on a two million MCMC chain from which the first million draws were discarded. For the priors, B, G, IG and U indicate, respectively, the Beta, Gamma, Inverse Gamma and Uniform distributions. The estimated standard deviations for measurement errors are smaller than 25 percent of the standard deviation of the corresponding empirical time series. The Log-Marginal Likelihood was computed using Geweke's modified harmonic mean method.

parameters of the model are well identified. In particular, the parameters of time-varying uncertainty shocks (which is the primary source of exogenous variation in the country risk premium) is well identified, with 95 percent probability intervals of (0.93, 0.99) and (0.05, 0.08) for the autocorrelation coefficient and the standard deviation, respectively. It is also worth highlighting that the estimated volatility of the shock is quite high and the shock is very persistent. Second, the median of nonstationary technology shocks has standard deviation of 0.013 and serial correlation of 0.10, while the corresponding values for stationary technology shocks is 0.011 and 0.87. As it will be evident below, this result suggests that the role of trend shocks is not pronounced under the current specification.

The empirical properties of the trade balance and the country risk premium provide crucial identifying information for different shocks in the baseline model. In order to illustrate this point, Figure 1 shows impulse responses for the trade balance-to-output ratio and the country risk premium to a one-standard deviation innovation to the shock processes in the model for different values of the autocorrelation of the shocks.[22] All other parameters are set at the posterior median values presented in Table 4. The first row of the figure shows the impulse responses to a positive stationary productivity shock, the second row displays the corresponding impulse responses to a positive shock to trend productivity growth, and the last row presents the results for a negative uncertainty shock (implying lower uncertainty).[23]

A positive stationary productivity shock leads to an acyclical or procyclical trade balance unless the autocorrelation coefficient of the shock is very high (in which case the shock resembles a nonstationary technology shock). This pattern is not consistent with emerging economy business cycle facts, implying that properties of the trade balance-to-output ratio cannot be explained by only this shock.

A shock to trend growth rate, on the contrary, leads to a countercyclical trade balance-to-output ratio for any values of its autocorrelation coefficient, a pattern consistent with emerging market data. Absent any information on the country risk premium in the estimation, one would expect that this property of the nonstationary technology shocks causes the estimated model to favor a shock to trend growth over a stationary productivity shock. But the country risk premium predicted by the model with a shock to trend growth is only weakly negatively correlated with output.[24]

Uncertainty shocks, irrespective of the size of the autocorrelation coefficient, can generate countercyclical country risk premium (the transmission mechanism of the shock is explained in the next section). Productivity shocks, in particular the stationary shocks, can account for some fluctuations in the risk premium, and also its modest countercyclicality, but its observed size is not large enough to account for its total volatility. This feature of the model makes it necessary for the estimated model to assign an important role to uncertainty shocks. Below I present a more detailed evaluation of the model as well as the variance decompositions predicted by the baseline model that confirm much of the intuition discussed in this section.

---

[22] The values for the autocorrelation coefficient of the nonstationary technology shock is lower than the corresponding values for other shocks, as this shock is typically estimated to have a low persistent.

[23] The responses of output, consumption and investment to shocks in the model with a relatively high persistence are very similar to the responses of these variable when the shock processes are not persistent.

[24] A higher risk premium may result at the time of an increasing output in response to a nonstationary technology shock if the shock is persistent, a pattern not consistent with the data.

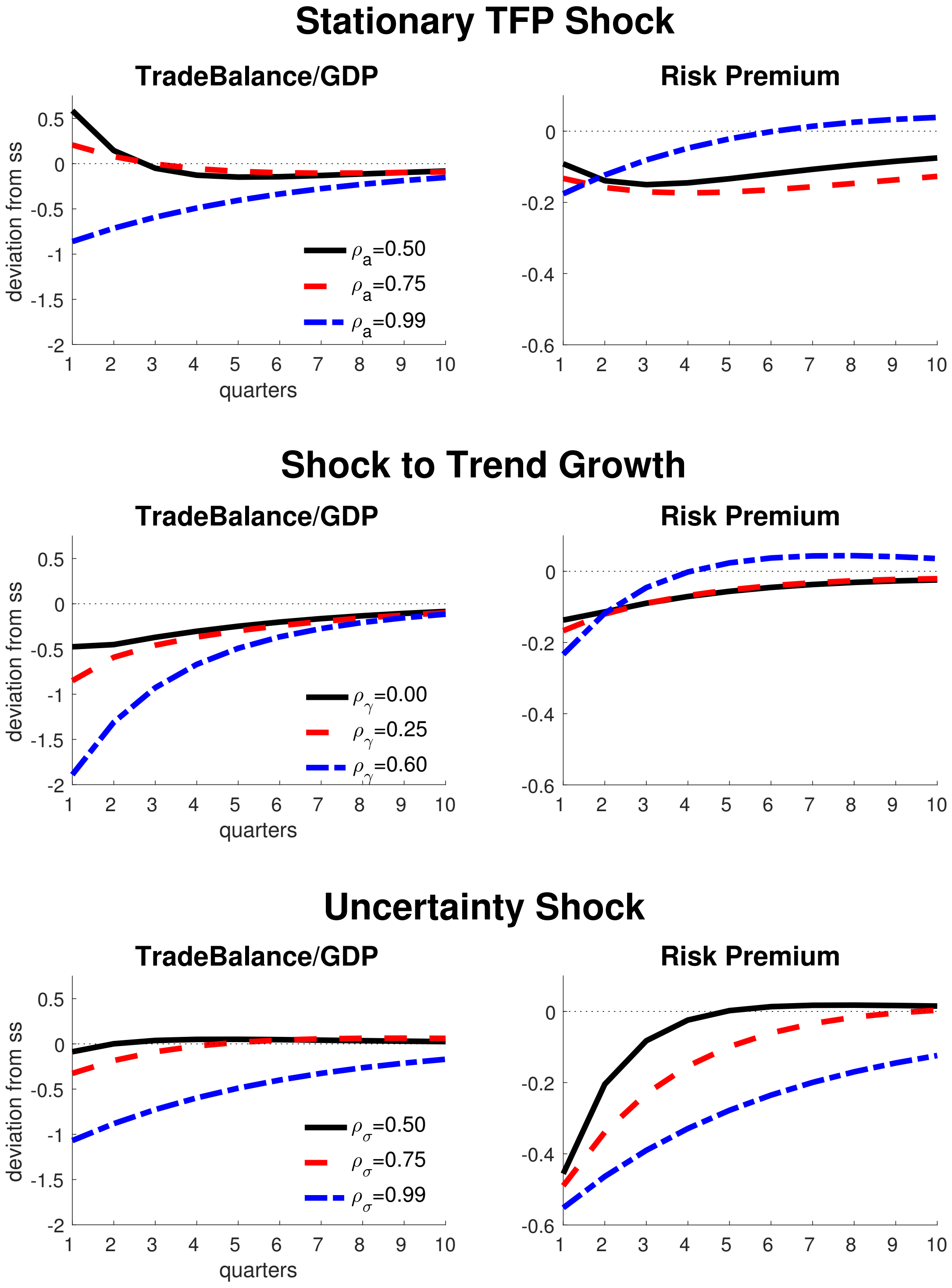

Figure 1. Impulse Responses for different autocorrelation coefficients of shocks

Notes: The first row of the figure shows the impulse responses to a positive stationary productivity shock, the second row displays the corresponding impulse responses to a positive shock to trend productivity growth, and the last row presents the results for a negative uncertainty shock (lower risk).

7 Evaluation of the Baseline Model

Table 5 displays second moments predicted by the baseline model. To facilitate comparison, the table reproduces some of the empirical counterparts from Table 1. The table shows that the model with endogenous default risk successfully generates a countercyclical country interest rate premium and key business cycle moments in Argentine data.

More specifically, the model predicts that the country risk premium negatively co-moves with the growth rate of output as well as with the components of domestic absorption. The correlation between the growth rate of investment and the country risk premium is -0.32 in the data and the model-implied correlation is -0.24. The model also does a remarkable job in matching the negative correlation between consumption growth and the country risk premium, as well the positive correlation between the trade balance and the risk premium. The model captures the fact that in Argentina over the period 1983Q1-2001Q3, as in most other developing countries, consumption growth is more volatile than output growth and the trade balance-to-output ratio is countercyclical.

Finally, the baseline model matches the first-order autocorrelation of the trade balance and the country risk premium reasonably well. This feature of the baseline model constitutes another key difference of the model from a standard open economy RBC model. As is extensively discussed in Garcia-Cicco et al. (2010), given the values of all structural parameters of a small open economy RBC model, there exists a small enough value of the parameter that governs the debt elastic interest rate that ensures stationary up to first order and delivers an autocorrelation function of the trade balance-to-output ratio that is flat and close to unity. In my model, as the indebtedness (as percent of GDP) of the private sector increases (say, for example, due to an adverse technology shock), the risk premium they would face in the international markets increases endogenously, which contributes to generating autocorrelation functions for both the trade balance and the interest rate premium consistent with data.

Table 6 presents the variance decomposition predicted by the baseline model. The following key results regarding the sources of macroeconomic fluctuations in emerging markets are worth highlighting. First, time-varying uncertainty in the firm-specific productivity explains nearly 70 percent of the variance of the trade balance and more than 60 percent of the variance of the country risk premium. The contribution of time-varying uncertainty shocks to investment volatility is sizable; it explains one-fourth of the fluctuations in this variable. However, its contribution to output and consumption volatility is limited. Second, the predicted contributions of nonstationary productivity shocks to explaining the output

Table 5. Second Moments implied by the Baseline Model

Statistics	g^Y	g^C	g^I	*tby*	*prem*
Standard Deviation					
- Baseline Model	2.71	3.11	4.80	2.01	5.44
- Data	2.73	3.15	6.07	2.61	4.46
	(0.42)	(0.47)	(0.78)	(0.26)	(0.71)
Correlation with g^Y					
- Baseline Model		0.98	0.83	-0.34	**-0.18**
- Data		0.94	0.86	-0.19	**-0.25**
		(0.01)	(0.03)	(0.08)	(0.07)
Correlation with *prem*					
- Baseline Model		**-0.19**	**-0.24**	**0.80**	
- Data		**-0.21**	**-0.32**	**0.87**	
		(0.08)	(0.09)	(0.03)	
Serial Correlation					
- Baseline Model	0.08	0.04	-0.03	0.82	0.90
- Data	0.10	0.19	0.39	0.95	0.90
	(0.12)	(0.12)	(0.09)	(0.01)	(0.02)

Notes: Empirical moments are computed at the median of the posterior distribution. The reported statistics belong to the Bayesian estimation of the baseline model on Argentine data with 5 observable time series including output growth, consumption growth, investment growth, the trade balance–to-output ratio and country interest rate premium over the period 1983Q1–2001Q3. Standard errors of sample-moment estimates are shown in parenthesis, and calculated using the Delta method.

Table 6. Variance Decomposition implied by the Baseline Model

Shock	g^Y	g^C	g^I	*tby*	*prem*
Stationary tech.	57.48	48.78	30.87	2.65	27.39
Nonstationary tech.	41.63	48.55	44.09	27.66	9.02
Uncertainty	0.88	2.66	25.04	69.69	63.60

Notes: The estimated contribution of measurement errors (not shown) is negligible for all five variables.

and consumption variations are non-negligible but not dominant. The stationary technology shock explains the majority of fluctuations in these variables. Third, technology shocks contribute to capturing the variations in the country risk premium in this economy (around 40 percent). This result highlights the endogenous nature of the risk premium in emerging countries, echoing the results presented in Akinci (2013).[25]

7.1 Transmission Mechanism of Uncertainty Shocks

Before presenting the responses of the model variables to a shock in uncertainty it will be useful to discuss briefly how an exogenous increase in the cross-sectional dispersion (i.e., higher uncertainty) affects financial variables in partial equilibrium. Figure 2 shows the effect of a 20 percent increase in the standard deviation of the cross-sectional dispersion of firm-specific productivity. The uncertainty shock is a mean-preserving shift in the cross-sectional dispersion of firm's returns. Being idiosyncratic, it is diversable from the perspective of foreign lenders. After an unexpected increase in the uncertainty, foreign lenders, other things equal, bear the cost of more bankruptcies because a fatter left tail of firm's returns falls below the solvency threshold but foreign lenders do not participate in the higher returns of those firms on the fatter right tail. Therefore, if the threshold level of firm-specific productivity was unchanged, there would be more firms with productivity below the threshold level. Since the distribution of the idiosyncratic shock is known at the time the debt contract is made, foreign lenders now understand that there will be fewer firms who will be able pay their debts. Since the lenders should be compensated for the increase in the associated expected monitoring costs, this in turn induces a higher equilibrium level of premium. However, the threshold level of productivity is endogenous, and the general equilibrium effect of an exogenous increase is quantitative in nature.

Figure 3 plots impulse responses for a variety of variables to a one standard deviation innovation to the shocks in the model. All three shocks shown in the figure are favorable shocks, meaning that each shock leads to an increase in output. For example, the dotted blue lines in the the figure show the responses of model variables to a lower uncertainty (or, lower risk).[26] For comparison, the figure also depicts the responses of major macroeconomic variables to a positive stationary technology shock (as shown by the solid blue lines), and to

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[25] I estimate a version of the baseline model with a stochastic process for the world risk-free interest rates. This shock is estimated to have a negligible role in explaining business cycles in Argentina, in line with findings of Akinci (2013). The remaining results presented in this section are largely unchanged.

[26] Note that the model is linear, meaning that a higher uncertainty will generate the same responses of model variables but with an opposite sign.

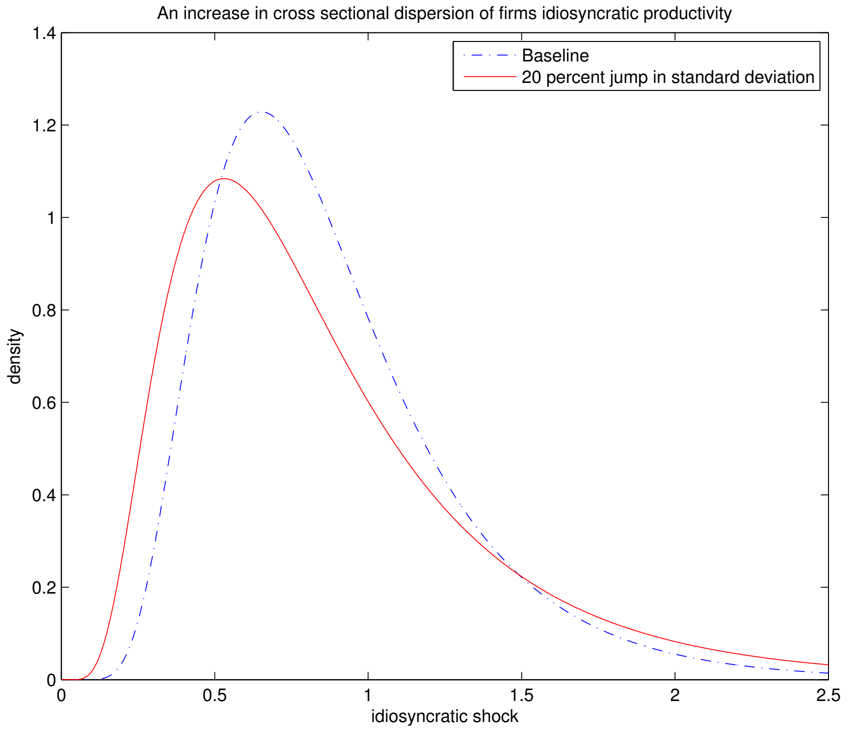

Figure 2. Uncertainty Shock

a positive shock to trend growth (shown by the dashed blue lines).

The figure confirms that uncertainty shocks are positively associated with the country risk premium in general equilibrium. A decrease in the standard deviation of the idiosyncratic productivity of the firm will lead them to expect a lower premium in the future. This is due to the fact that the premium that will be applied at time $t + 1$ is backwardly indexed to the value of the standard deviation of the shock realized today, at t. Upon the lower cost of borrowing, firms will accumulate more debt, and purchase more capital input. Firms will increase their leverage by distributing more dividends to the households, which in turn leads the latter to increase their consumption. The increase in households' demand for domestic goods leads firms to increase their demand for labor, which in turn leads to higher real wages. Higher wages contribute to a rise in households' demand for domestic goods. As a result, output expands. Note that given our preferences, labor supply in the unconstrained economy responds only to the marginal product of labor in the current period. Since capital is predetermined, contemporaneous output response to the uncertainty shock is nil.

In sum, there are two forces moving in the same direction that ultimately lead to a countercyclical risk premium in the model economy. The first one is the cost channel that

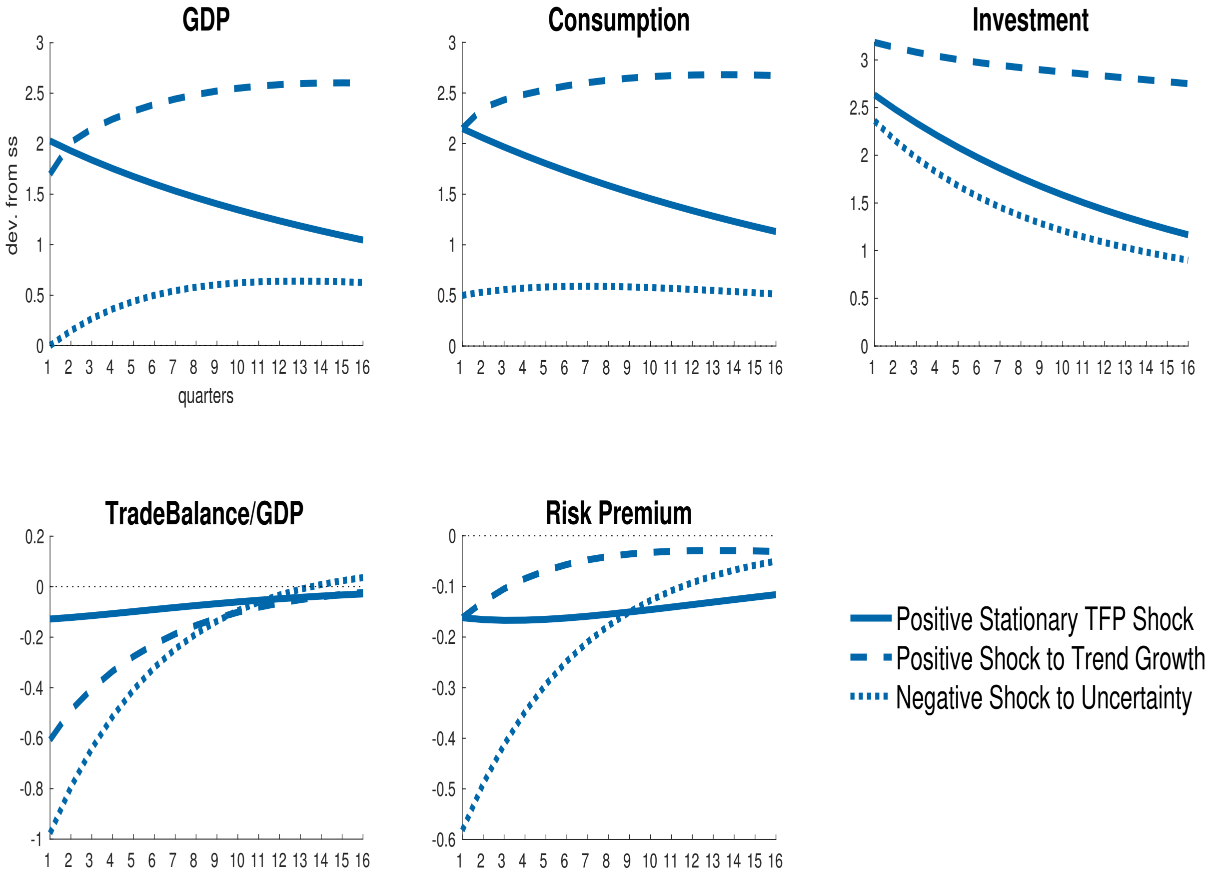

Figure 3. Impulse Responses to all shocks in the model economy

leads to an increased (decreased) financing cost of capital in response to an unexpected positive (negative) shock to uncertainty. The second effect is the demand channel that operates through reduced (increased) dividends distributed to the households and lower (higher) real wages in response to an unexpectedly higher (lower) uncertainty. Both these effects lead to lower (higher) output. Since the risk premium is endogenous in this model, the lower (higher) output feeds onto a higher (lower) risk premium, and the countercyclical country risk premium results in the model economy.

7.2 Inspecting the Role of Endogenous Risk Premium

The endogenous country risk premium contributes to generating higher consumption volatility relative to income volatility in the baseline model. In the standard RBC model, risk averse households decrease their current consumption (usually by less than a decrease in current output) in response to negative stationary TFP shocks.[27] There is an additional channel in my model with an endogenous country risk premium that causes households to decrease consumption by more than the decline predicted by the standard RBC model. An unexpected decrease in productivity leads to a higher risk premium in the baseline model, causing firms to deleverage in the current period (due to the higher cost of borrowing from international markets). In order to deleverage, firms have to reduce the real dividend distributed to the households, which further tightens the budget constraint of the latter. As a result, an increase in the premium becomes a problem for the households in the model economy, causing them to decrease their consumption by more than in the absence of an endogenous country risk premium.[28]

This feature of the baseline model differentiates my framework from other related models that are based on standard BGG frictions. For example, in a contemporaneous work, Fernandez and Gulan (2015) have also introduced corporate default *ala* BGG into an otherwise small open economy RBC model. Their model successfully generates the cyclicality of external finance premium (which is denoted by "efp" in Table 9) faced by firms in the international financial markets by linking it to the dynamics of corporate leverage. However, unlike the baseline model proposed in this paper, the financial stress of the firms (as reflected in the higher premium charged to the firms) does not *directly* translate into a tighter budget constraint for the households who face a riskless interest rate in the international financial markets. This makes a (quasi-) unit root productivity process in their model the only effective channel through which the model can replicate high consumption volatility relative to income volatility.

In order the better highlight this difference between the baseline model and the model with standard BGG frictions, I solve the model proposed in Fernandez and Gulan (2015), and calibrate it to match the long run moments from Argentine data (see section 5 for these

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[27] The model with nonstationary productivity shocks can generate higher consumption volatility relative to income volatility. It happens because the decreasing profile for future expected income levels induces households to reduce consumption beyond the decrease in current output by decumulating the debt they obtain from foreign lenders.

[28] This key result still holds in an extended model presented in Section 9.1, which allows households to borrow directly from the foreign lender, subject to a convex transaction cost.

Table 7. Selected Second Moments (TFP shocks only)
($\rho_a = 0.95$, $g^Y = 2.73$ and $g^I = 6.07$)

	$\sigma_{g^C}/\sigma_{g^Y}$	$\sigma_{tby}/\sigma_{g^Y}$	$\rho_{tby,tby_{-1}}$
Model w/ BGG	0.98	1.87	0.99
Baseline Model	1.16	0.60	0.85
Data	1.15	0.96	0.95

targets).[29] All standard parameters of their model are calibrated as in Table 3, including $\beta = 0.975$, $R^* = 2\%$ (p.a.), $\sigma_{\omega,ss} = 0.40$, and $\mu = 0.095$. The remaining model specific financial parameters are calibrated to achieve the same target for leverage (0.50), external finance premium (7%) and risk premium (12%), as in the baseline model.

In order to facilitate comparisons of the models, I assume that the only source of business cycle fluctuations in both the model with standard BGG frictions and the baseline model are stationary technology shocks (as in Fernandez and Gulan (2015)). One simple exercise to show the importance of endogenous risk premium in generating excessive consumption volatility in the baseline model is to fix the autocorrelation coefficient of the stationary TFP process to a number different than unity (for example, set $\rho_a = 0.95$) in both models. I calibrate the variance of stationary TFP shocks, σ_a, and the capital adjustment cost parameter, ϕ, in each model to match the volatilities of output growth and investment growth in the data. I then compare the performance of the two models for their ability to match volatilities of consumption growth and the trade balance in the data.

Selected second moments predicted by the model with standard BGG frictions and the baseline model are shown in Table 7. Confirming my intuition, the predictions of the model with standard BGG frictions for the consumption volatility are counterfactual: while consumption is more volatile than income in the data, the model predicts the opposite.[30] Moreover, the model predicts that the trade balance is more volatile than its empirical counterpart, and follows a near unit root behavior, which is also counterfactual. By contrast, the baseline model is successful in generating relative consumption volatility seen in the data, and its predictions for the dynamics of the trade balance are closer to the empirical counterparts.

Next, I compare the performance of the models *more formally* after estimating the key parameters of each model using Bayesian methods on Argentine data on output growth, con-

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[29] The complete set of equilibrium conditions of the model presented in Fernandez and Gulan (2015) can be found in the online appendix of their paper.

[30] Fernandez and Gulan (2015) also show that their model predicts consumption volatility being lower than output volatility when ρ_a is set to 0.95 (see Table 13 in their paper).

Table 8. Bayesian Estimation Results for Different Models (TFP shocks only)

	Baseline Model			Model w/ BGG			RBC Model		
Param.	Med.	5%	95%	Med.	5%	95%	Med.	5%	95%
σ_a	0.015	0.012	0.017	0.011	0.009	0.013	0.013	0.011	0.015
ρ_a	0.93	0.91	0.96	0.99	0.982	0.995	0.99	0.989	0.997
ϕ	8.44	5.94	11.30	10.60	7.77	13.96	9.05	7.11	11.23
Log-MLK	721.8			719.4			718.2		

Notes: Estimation is based on Argentine data from 1983Q1 to 2001Q3. Posterior statistics are based on a two million MCMC chain from which the first million draws were discarded. The estimated standard deviations for measurement errors are smaller than 25 percent of the standard deviation of the corresponding empirical time series. The Log-Marginal Likelihood (Log-MLK) was computed using Geweke's modified harmonic mean method.

sumption growth, investment growth, and the trade balance-to-output ratio. I also estimate a standard RBC model for comparison. More precisely, I estimate the autocorrelation and standard deviation of stationary TFP shocks, and the parameter governing the degree of capital adjustment cost in all three models separately after calibrating the standard parameters to match the long run data moments.

The estimation results are presented in Table 8. Note that the RBC model and the model with standard BGG frictions have the autocorrelation coefficient of the stationary TFP shock close to unity, which is needed for these two models to achieve higher consumption volatility than income volatility seen in the data. On the contrary, the autocorrelation coefficient of the stationary TFP process in the baseline model is estimated to be different than unity.

Second moments predicted by the models for output growth, consumption growth, investment growth, the trade balance-to-output ratio, the country risk premium, and the external finance premium are presented in Table 9. The standard RBC model and the model with BGG frictions both predict output volatility being somewhat smaller than its empirical counterpart. But the models can match excessive consumption volatility relative to income volatility, largely owing to the highly persistent productivity processes. The trade balance-to-output ratio predicted by these models is only mildly countercyclical whereas the degree of countercyclicality in the data is high. These models also fail to match the volatility and the autocorrelation function of the trade balance-to-output ratio in the data. The trade balance is more than four times as volatile as in the data and the trade balance-to-output

Table 9. Second Moments implied by Different Models
(TFP Shocks only)

Statistics	g^Y	g^C	g^I	tby	$prem$	efp
Standard Deviation						
- RBC Model	2.38	3.10	4.90	13.73	–	–
- Model w/ BGG	2.62	3.25	4.31	9.17	1.74	0.74
- Baseline model	2.76	3.22	5.23	1.33	3.71	1.80
- Data	2.73	3.15	6.07	2.61	4.46	–
	(0.42)	(0.47)	(0.78)	(0.26)	(0.71)	
Correlation with g^Y						
- RBC Model		0.99	0.98	-0.04	–	–
- Model w/ BGG		0.99	0.99	-0.07	0.04	-0.57
- Baseline model		1.00	0.99	-0.45	-0.18	-0.17
- Data		0.94	0.86	-0.19	-0.25	-0.37
		(0.01)	(0.03)	(0.08)	(0.07)	
Correlation with $prem$						
- RBC Model		–	–	–		–
- Model w/ BGG		0.03	0.02	0.98		0.22
- Baseline model		-0.17	-0.14	0.68		0.99
- Data		-0.21	-0.32	0.87		0.90
		(0.08)	(0.09)	(0.03)		
Serial Correlation						
- RBC Model	0.09	0.04	0.00	1.00	–	–
- Model w/ BGG	0.04	0.00	-0.03	1.00	1.00	0.82
- Baseline model	0.01	0.00	-0.02	0.88	0.97	0.97
- Data	0.10	0.19	0.39	0.95	0.90	0.83
	(0.12)	(0.12)	(0.09)	(0.01)	(0.02)	

Notes: Empirical moments are computed at the median of the posterior distribution. The reported statistics belong to the Bayesian estimation of the model on Argentine data for output growth, consumption growth, investment growth, and the trade balance–to-output ratio over the period 1983Q1–2001Q3. Standard errors of sample-moment estimates are shown in parenthesis, and calculated using the Delta method. Long time series data for the external finance premium for Argentine corporations does not exist, so the empirical moments for the efp, as shown by red in the table, is the average of data from Brazil, Chile, Mexico, Malaysia, and Turkey.

ratio behaves as a near random walk.[31]

The model with standard BGG frictions, as also highlighted in Fernandez and Gulan (2015), predicts that the external finance premium the firms pay is high and countercyclical in emerging economies, in line with the evidence. My baseline model's predictions for both the country risk premium and for the external finance premium are in line with data. More importantly, the baseline model features endogenous model dynamics that help the model to better match the excessive volatility of consumption relative to income (despite the fact that the autocorrelation of the stationary technology shock, ρ_a, is below unity) in emerging economies. Finally, the baseline model better accounts for the empirical properties of the trade balance in the data.

8 Mexican Business Cycles and Uncertainty Shocks

In this section, I estimate the baseline model presented in Section 4 using Mexican data, and discuss whether uncertainty shocks are also relevant for explaining business cycle fluctuations in Mexico. The case of Mexico is of interest to researchers because it is one of the most extensively studied emerging economies in the literature (see, for example, Neumeyer and Perri (2005), Aguiar and Gopinath (2007), and Mendoza (2010) among others). I estimate the parameters σ_a, ρ_a, σ_{μ_X}, ρ_{μ_X}, σ_{σ_ω}, ρ_{σ_ω}, and ϕ of the model using quarterly data on output growth, consumption growth, investment growth, the change in trade balance to output ratio, and country premium for the period 1994Q1-2019Q1.[32] Standard parameters are calibrated as in the Argentine case (see Table 3) except for β, δ, along with the parameters of financial frictions, μ and $\sigma_{\omega_{ss}}$. These parameters are set to 0.985, 0.2, 0.3, and 0.1, respectively, to match the Mexican average annual sovereign interest rate spread of 6 percent, investment-output ratio of 20 percent, steady-state leverage ratio of 0.51 and annual corporate credit spreads of 3 percent.

The Bayesian estimation results are presented in Table 10.The estimated parameters are well-identified. In particular, the autocorrelation coefficient and the standard deviation of the time-varying uncertainty shocks have 95 percent probability intervals of (0.80, 0.84) and

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[31] The result that the autocorrelation function of the trade balance-to-output ratio predicted by the RBC model is flat and close to unity is not a consequence of the presence of near-unit root productivity shocks. It rather reflects the endogenous random walk of consumption typical of small open economies with incomplete asset markets (see, also Garcia-Cicco et al. (2010) for a more detailed discussion).

[32] For Mexico, I use a change in the trade balance which is scaled by GDP to ensure stationarity of the time series used in the estimation.

Table 10. Prior and Posterior Distribution - Mexico

Parameter	Prior Distribution			Posterior Distribution		
	Prior	Mean	Std	Median	5%	95%
σ_a	IG	0.02	0.01	0.0079	0.0062	0.0096
ρ_a	B	0.5	0.2	0.84	0.76	0.90
σ_γ	IG	0.02	0.01	0.0062	0.0042	0.0085
ρ_γ	B	0.5	0.2	0.08	0.02	0.15
σ_{σ_ω}	IG	0.40	0.20	0.0613	0.0600	0.0662
ρ_{σ_ω}	B	0.5	0.2	0.82	0.80	0.84
ϕ	G	1	1	1.46	1.04	1.89

Notes: Estimation is based on Mexican data for the 1993Q4-2019Q1 period. Posterior statistics are based on a two million MCMC chain from which the first million draws were discarded. For the priors, B, G, IG and U indicate, respectively, the Beta, Gamma, Inverse Gamma and Uniform distributions. The estimated standard deviations for measurement errors are smaller than 25 percent of the standard deviation of the corresponding empirical time series.

(0.060, 0.066), respectively. The estimated volatility of the time-varying uncertainty shock is quite high and the shock is persistent.

Table 11 shows second moments predicted by the baseline model at the posterior median along with their empirical counterparts for Mexico. The baseline model does a good job replicating highly volatile and countercyclical premia as well as key business cycle moments. Consumption is more volatile than income and the trade balance-to-output ratio is countercyclical, consistent with the data. The correlation of risk premium with the components of aggregate demand, in particular with investment, predicted by the model matches the data remarkably well. Finally, the serial correlation of the country risk premium is less than unity, in line with data.

Table 12 presents the variance decomposition predicted by the baseline model. The stationary productivity shock emerges as an important shock explaining the output and components of domestic demand in Mexico. Unlike the results in Aguiar and Gopinath (2007), shocks to trend growth in the baseline model play a relatively small role in explaining aggregate fluctuations in Mexico (note that they only explain 4 percent of fluctuations in the premium). The role of shocks to trend growth in explaining the fluctuations in the trade balance is replaced by time-varying uncertainty shocks. As in the case of Argentina, technology shocks contribute to matching the empirical properties of the country risk premium, highlighting the endogenous nature of the risk premium.

Table 11. Second Moments implied by the Model for Mexico

Statistics	g^Y	g^C	g^I	Δtby	$prem$
Standard Deviation					
- Baseline Model	1.63	1.74	3.13	0.82	3.5
- Data	1.59	1.80	4.40	0.78	3.1
	(0.29)	(0.34)	(1.22)	(0.17)	(0.23)
Correlation with g^Y					
- Baseline Model		0.97	0.85	-0.41	**-0.06**
- Data		0.85	0.81	-0.59	**-0.18**
		(0.05)	(0.05)	(0.16)	(0.11)
Correlation with $prem$					
- Baseline Model		**-0.10**	**-0.16**	**0.20**	
- Data		**-0.13**	**-0.16**	**0.27**	
		(0.12)	(0.12)	(0.10)	
Serial Correlation					
- Baseline Model	0.18	0.11	-0.06	-0.18	0.81
- Data	0.17	0.17	0.31	0.04	0.88
	(0.11)	(0.10)	(0.08)	(0.14)	(0.02)

Notes: Empirical moments are computed at the median of the posterior distribution. The reported statistics belong to the Bayesian estimation of the baseline model on Mexican data with 5 observable time series including output growth, consumption growth, investment growth, the change in the trade balance–to-output ratio and country interest rate premium over the period 1994Q1–2009Q1. Standard errors of sample-moment estimates are shown in parenthesis, and calculated using delta method.

Table 12. Variance Decomposition implied by the Model for Mexico

Shock	g^Y	g^C	g^I	Δtby	$prem$
Stationary tech.	74.21	64.65	54.29	14.92	30.99
Nonstationary tech.	24.93	34.03	30.20	42.26	4.22
Uncertainty	0.86	1.33	12.51	42.82	64.78

Notes: The estimated contribution of measurement errors (not shown) is negligible for all five variables.

9 Robustness

In this section, I examine the robustness of my results. First, I investigate whether the results presented for the baseline model regarding the counter-cyclicality of the country risk premium and the importance of uncertainty shocks are robust to the assumption that households cannot directly borrow from the international financial markets. Second, I am interested in assessing whether my conclusion about the importance of uncertainty shocks is robust to the parameter assumptions that I made in my baseline estimation.

9.1 Household participation in international financial markets

In the baseline model the households are assumed not to have access to the international financial markets. This is a reasonable assumption for emerging market countries in which households' foreign exchange markets participation are very limited. Nonetheless, in this section, I allow households to directly borrow from the international markets, which I denote by D^*_{Ht}.[33] Agents, then, seek to maximize the discounted expected future flow of utility,

$$\max_{\{C_t, h_t, B_{t+1}, D^*_{Ht+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, \tilde{X}_{t-1} h_t), \tag{29}$$

subject to the budget constraint

$$C_t + B_t + D^*_{Ht} + f(D^*_{Ht+1}) \quad = \quad \frac{B_{t+1}}{R_t} + \frac{D^*_{Ht+1}}{R^*_t} + W_t h_t + \Phi_t \tag{30}$$

The variable R^*_t denotes the gross world interest rates, and households are assumed to pay a cost, given by $f(D^*_{Ht+1}) = \frac{\kappa}{2}(D^*_{Ht+1})^2$ where *f(.)* is an increasing convex function of the value of household external borrowing. The first order conditions of the household's problem now has an additional optimality condition:

$$\beta E_t \left\{ \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{X_t}{X_{t-1}} \right)^{-\sigma} R^*_t \right\} + f'(D^*_{Ht+1}) \quad = \quad 1$$

The rest of the model, including the firms' optimality conditions, will stay the same as in the baseline model except for a small modification to the balance of payments equations that

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[33] Akinci and Queralto (2019) presents a more detailed description of the model economy in which households are allowed to borrow from foreigners, subject to a transaction cost.

Table 13. Variance Decomposition implied by the Model with HHB

Shock	g^Y	g^C	g^I	tby	$prem$
Stationary tech.	67.88	55.04	40.88	4.14	24.55
Nonstationary tech.	36.39	43.90	41.96	33.56	9.84
Uncertainty	0.74	1.06	17.16	62.29	65.61

Notes: The estimated contribution of measurement errors (not shown) is negligible for all five variables.

will be augmented by household's net borrowing in the international markets, $\frac{D^*_{Ht+1}}{R^*_t} - D^*_{Ht}$.

I estimate the parameter governing the degree of frictions in household's access to international markets, denoted by κ, along with the other parameters in the model. The degree of frictions, κ, is estimated pretty tightly in the data, confirming my intuition that there are frictions in emerging economies in households' access to international financial markets.[34]

Second moments predicted by the model with household's access to international borrowing markets is not shown, but the model matches the empirical regularities of emerging economies very well. In particular, the extended model can successfully generate countercyclical interest rate premia in the Argentine data.[35] Table 13 displays the variance decomposition predicted by the extended model. Time-varying uncertainty shocks are still important for explaining the empirical properties of the trade balance and the risk premium in emerging economies. Therefore, I conclude that the main results presented in the paper are robust to allowing household to have a direct access to the international financial markets.

9.2 Robustness of the Estimation Results

In this section, I assess whether my conclusion that uncertainty shocks play an important role in emerging economies is robust to the assumptions that I made in the baseline estimation. To do this, I consider a range of experiments in which I adjust the value of one of the baseline parameters and re-estimate the economy. Table 14 displays these cases, along with the associated parameter estimates and the value of the marginal likelihood at those points. For reference, the first row of Table 14 presents these values from our baseline estimation.

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[34] The parameter estimates are presented in Table 14 in the following section.

[35] The results are available upon request.

Table 14. Robustness of the Estimation Results

	σ_a	ρ_a	σ_γ	ρ_γ	σ_{σ_ω}	ρ_{σ_ω}	ϕ	κ	Log-ML
Baseline Model	0.011	0.87	0.013	0.10	0.065	0.97	5.66	-	942.0
Model w/ HHB	0.011	0.93	0.012	0.10	0.098	0.97	5.47	0.06	956.4
Baseline Model w/									
$\psi = 1.6$	0.011	0.87	0.014	0.10	0.065	0.97	5.44	-	941.2
$\varphi = 0.0$	0.010	0.88	0.016	0.57	0.068	0.94	5.56	-	948.0
$\rho_{\sigma_\omega} = 0.0$	0.013	0.84	0.014	0.09	0.116	-	5.06	-	935.5
$lev = 0.55$	0.011	0.86	0.012	0.11	0.068	0.96	5.12	-	944.1

Note: Parameter values denoted with a dash (-) indicate parameter is not estimated in corresponding specification. The Log-Marginal Likelihood (Log-ML) was computed using Geweke's modified harmonic mean method.

The second row displays the estimated values for the extended model with household's access to international financial markets. As shown earlier, my results are robust to this extension.

The next row of the table presents estimations of the model in which I consider a higher value for the labor supply elasticity than in the baseline. Note that the Frisch elasticity of labor supply is given by $1/(1-\psi)$ for the curvature of labor disutility. The estimated coefficients for the autocorrelation and standard deviation of the time-varying uncertainty shock are not very sensitive to this parameter. This shock continues to be the main driver of fluctuations in the trade balance and the country risk premium in the model economy.

The next row of the table considers how my results are influenced by the degree of slow adjusting in the preferences, φ. The data slightly prefers the model with immediate detrending, $\varphi = 0$, the standard case considered in Garcia-Cicco et al. (2010). However, the estimates for the autocorrelation and standard deviation of uncertainty shocks remain largely unchanged, implying that this shock is important for business cycle fluctuations in emerging economies.

The following row considers what happens if the autocorrelation coefficient of the uncertainty shock is restricted to be zero. While the estimated standard deviation of the time-varying uncertainty shocks doubles in size, the data prefers the case with a highly persistent process for this shock as in the baseline case.

Finally, I consider what happens when the model is calibrated to a higher value of the steady-state leverage. In the baseline calibration, I only consider the non-financial corporations when calculating the empirical counterpart of the long-run leverage ratio. The average leverage in the data tends to be higher when both the financial and non-financial corporations are considered. Nonetheless, I find that the estimated coefficients for the time-varying productivity shock are robust to targeting a higher value for the steady-state leverage. Altogether, I believe these results indicate that the baseline model's predictions for the importance of uncertainty shock are quite robust to the calibration.

10 Conclusion

This paper proposes and estimates a dynamic equilibrium model of an emerging economy with endogenous default risk premia. Default risk premia arise from financial frictions in firms' access to international markets. I show that the model's quantitative predictions are in line with observed empirical regularities in emerging markets: it predicts high, volatile and countercyclical country risk premia, excessive volatility of consumption relative to output, and strong countercyclicality of the trade balance to output ratio. This result is a significant improvement over the current empirical models of emerging market business cycles, as the interest rate predicted by these models is either acyclical or procyclical.

I investigate the sources of business cycle fluctuations in emerging economies using the estimated model. I find that time-varying uncertainty in firm-specific productivity explains more than half of the variances in the trade balance-to-output ratio and country risk premium. My results also suggest that stationary productivity shocks play an important role in explaining the economic fluctuations in output, consumption and investment. Shocks to a nonstationary component of productivity, on the other hand, are non-negligible but not dominant. Finally, the model predicts that approximately 40 percent of fluctuations in the country borrowing spread is explained by domestic macroeconomic shocks, highlighting the endogenous nature of risk premium in these economies.

References

Aguiar, Mark and Gita Gopinath, "Defaultable debt, interest rates and the current account," *Journal of International Economics*, June 2006, *69* (1), 64–83. 4

_ **and** _ , "Emerging Market Business Cycles: The Cycle Is the Trend," *Journal of Political Economy*, 2007, *115*, 69–102. 1, 2, 8, 3, 8, 4.2.1, B

Akinci, Ozge, "Global financial conditions, country spreads and macroeconomic fluctuations in emerging countries," *Journal of International Economics*, 2013, *91* (2), 358–371. 1, 7, 25

_ **and Albert Queralto**, "Credit Spreads, Financial Crises and Macroprudential Policy," Working Paper Number 802, Federal Reserve Bank of New York Staff Report April 2017. 15

_ **and** _ , "Exchange Rate Dynamics and Monetary Spillovers with Imperfect Financial Markets," Working Paper Number 849, Federal Reserve Bank of New York Staff Report May 2019. 7, 33

_ **and Ryan Chahrour**, "Good news is bad news: Leverage cycles and sudden stops," *Journal of International Economics*, 2018, *114* (C), 362–375. 4.1, 5.2

Bernanke, Ben S., Mark Gertler, and Simon Gilchrist, "Chapter 21 The financial accelerator in a quantitative business cycle framework," in John B. Taylor and Michael Woodford, eds., *John B. Taylor and Michael Woodford, eds.*, Vol. 1, Part 3 of *Handbook of Macroeconomics*, Elsevier, 1999, pp. 1341 – 1393. 1

Chang, Roberto and Andres Fernandez, "On the Sources of Aggregate Fluctuations in Emerging Economies," *International Economic Review*, November 2013, *54* (4), 1265–1293. 3

Christiano, Lawrence J., Mathias Trabandt, and Karl Walentin, "Introducing financial frictions and unemployment into a small open economy model," *Journal of Economic Dynamics and Control*, December 2011, *35* (12), 1999–2041. 1

_ **, Roberto Motto, and Massimo Rostagno**, "Risk Shocks," *American Economic Review*, 2014, *104* (1), 27–65. 1

Chugh, Sanjay K., "Firm risk and leverage-based business cycles," *Review of Economic Dynamics*, 2016, *20*, 111 – 131. 1

Curdia, Vasco, "Monetary Policy under Sudden Stops," *SSRN eLibrary*, 2007. 1, 12

di Giovanni, Julian, Sebnem Kalemli-Ozcan, Mehmet Fatih Ulu, and Yusuf Soner Baskaya, "International Spillovers and Local Credit Cycles," Working Paper 23149, National Bureau of Economic Research February 2017. 1

Dorofeenko, Victor, Gabriel Lee, and Kevin D. Salyer, "Time-Varying Uncertainty and the Credit Channel," *Bulletin of Economic Research, Vol. 60, Issue 4, pp. 375-403*, 2008. 1, 14

Du, Wenxin and Jesse Schreger, "Default risk and risk averse international investors," Working Paper, Harvard University, May 2015. 5

Dueber, Jan-Philipp, "Endogenous Time-Varying Volatility and Emerging Market Business Cycles," Studies in Economics 1811, School of Economics, University of Kent October 2018. 1

Eaton, Jonathan and Mark Gersovitz, "Debt with Potential Repudiation: Theoretical and Empirical Analysis," *Review of Economic Studies*, April 1981, *48* (2), 289–309. 1, 4

Elekdag, Selim, Alejandro Justiniano, and Ivan Tchakarov, "An Estimated Small Open Economy Model of the Financial Accelerator," *IMF Staff Papers*, 2006, *53* (2), 2. 1

Fernandez, Andres and Adam Gulan, "Interest Rates, Leverage, and Business Cycles in Emerging Economies: The Role of Financial Frictions," *American Economic Journal: Macroeconomics*, 2015, *7* (3), 153–88. 1, 5.2, 7.2, 29, 30, 7.2

Fernandez-Villaverde, Jesus, Pablo Guerron-Quintana, Juan F. Rubio-Ramirez, and Martin Uribe, "Risk Matters: The Real Effects of Volatility Shocks," *American Economic Review*, October 2011, *101* (6), 2530–61. 1

Garcia-Cicco, Javier, Roberto Pancrazi, and Martin Uribe, "Real Business Cycles in Emerging Countries?," *American Economic Review*, 2010, *100* (5), 2510–31. 1, 3, 10, 4.1, 5.2, 7, 31, 9.2, B

Gertler, Mark, Simon Gilchrist, and Fabio M. Natalucci, “External Constraints on Monetary Policy and the Financial Accelerator,” *Journal of Money, Credit and Banking*, 03 2007, *39* (2-3), 295–330. 1, 12

Greenwood, Jeremy, Zvi Hercowitz, and Gregory W Huffman, “Investment, Capacity Utilization, and the Real Business Cycle,” *American Economic Review*, June 1988, *78* (3), 402–17. 5.1

Mendoza, Enrique G., “Real Business Cycles in a Small Open Economy,” *The American Economic Review*, 1991, *81* (4), pp. 797–818. 1

_ , “Sudden Stops, Financial Crises, and Leverage,” *American Economic Review*, December 2010, *100* (5), 1941–66. 5.2, 8

_ **and Vivian Z. Yue**, “A General Equilibrium Model of Sovereign Default and Business Cycles,” *Quarterly Journal of Economics*, April 2012, *127* (2), 889–946. 1, 5, 5.2

Miyamoto, Wataru and Thuy Lan Nguyen, “Business Cycles In Small Open Economies: Evidence From Panel Data Between 1900 And 2013,” *International Economic Review*, August 2017, *58*, 1007–1044. 3

Neumeyer, Pablo A. and Fabrizio Perri, “Business cycles in emerging economies: the role of interest rates,” *Journal of Monetary Economics*, March 2005, *52* (2), 345–380. 1, 8, 5.2, 8, B

Reifschneider, David, “Gauging the Ability of the FOMC to Respond to Future Recessions,” 2016. 5.2

Schmitt-Grohe, Stephanie and Martin Uribe, “Closing small open economy models,” *Journal of International Economics*, October 2003, *61* (1), 163–185. 1, B

_ **and** _ , “Pegs and Pain,” Working Paper 16847, National Bureau of Economic Research March 2011. A

Uribe, Martin and Vivian Z. Yue, “Country spreads and emerging countries: Who drives whom?,” *Journal of International Economics*, June 2006, *69* (1), 6–36. 1, B

A Data Description

The dataset includes quarterly data for Argentina between 1983Q1-2001Q3. For the period 1983:Q1 to 1992:Q4, real GDP, real private consumption, real investment, the trade balance and the country interest rate are from Neumeyer and Perri (2005) and posted at www.fperri.net/data/neuperri.xls. The country spread is measured as the difference between the country interest rate from Neumeyer and Perri (2005) and the real U.S. three month Treasury Bill rate. The U.S. real interest rate is measured by the interest rate on three-month US treasury bill minus a measure of US expected inflation. Both U.S. treasury bill rate and U.S. CPI inflation are from St Louis Fred database. The methodology for the construction of time series for the real U.S. interest rate is also from Schmitt-Grohe and Uribe (2011).

For the period 1993:Q1 to 2001:Q3, real GDP, real private consumption, the trade balance are downloaded from Secretara de Politica Economica website.[36] The country spread is measured using data on spreads from J.P.Morgan Emerging Markets Bond Index Plus (EMBI+) downloaded from Global Financial Data. Output, consumption and investment are transformed in per-capita terms using an annual population series from the IMF International Financial Statistics, transformed to quarterly using linear interpolation.

The dataset for Mexico includes quarterly data on real GDP, real private consumption, real investment, the trade balance, and the country risk premium, as measured by the EMBI+, for the 1994Q1-2019Q1 period. All the data, except the risk premium, are downloaded from Haver Analytics database. The EMBI+ data for Mexico is obtained from Bloomberg.

B The Reduced Form Financial Frictions Model

The theoretical framework is the small open economy model presented in Schmitt-Grohe and Uribe (2003) augmented with permanent productivity shocks as in Aguiar and Gopinath (2007). The model is further augmented with domestic preference shocks, country premium shocks and realistic debt elasticity of the country premium as in Garcia-Cicco et al. (2010). The production technology takes the form:

$$Y_t = A_t K_t^{\alpha} (X_t h_t)^{1-\alpha},$$

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[36] http://www.mecon.gov.ar/peconomica/informe/indice.htm.

where Y_t, K_t, and h_t denote output, capital and hours worked in period t, and A_t and X_t represent temporary and permanent productivity shocks, respectively. The productivity shock A_t is assumed to follow a first-order autoregressive process in logs:

$$log(A_{t+1}) \;=\; \rho_a log(A_t) + \varepsilon_{a,t+1};\;\; \varepsilon_{a,t} \sim i.i.d.\;\; N(0, \sigma_a^2)$$

The permanent productivity shock X_t is nonstationary. Let $\gamma_t = \frac{X_t}{X_{t-1}}$ denote the gross growth rate of X_t. I assume that the logarithm of γ_t follows a first-order autoregressive process:

$$log(\gamma_{t+1}/\gamma) \;=\; \rho_\gamma log(\gamma_t/\gamma) + \varepsilon_{\gamma,t+1};\;\;\; \varepsilon_{\gamma,t} \sim i.i.d.\;\; N(0, \sigma_\gamma^2)$$

where γ measures the deterministic gross growth rate of the productivity factor X_t. Households face the following period-by-period budget constraint:

$$\frac{D_{t+1}}{1+R_t} \;=\; D_t - Y_t + C_t + S_t + I_t + \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - \gamma\right)^2 K_t, \tag{31}$$

where D_{t+1} denotes the stock of debt acquired in period t, R_t denotes the domestic interest rate on bonds held between periods t and $t+1$, C_t denotes consumption, I_t denotes gross investment, and the parameter ϕ introduces quadratic capital adjustment costs. The capital stock evolves according to the following law of motion: $K_{t+1} = (1-\delta)K_t + I_t$ where $\delta \in$ [0, 1) denotes the depreciation rate of capital. Consumers are subject to a no–Ponzi scheme constraint. S_t is an exogenous domestic spending shock following an AR(1) processes:

$$log(s_{t+1}/s) = \rho_s log(s_t/s) + \epsilon^s_{t+1}; \qquad \epsilon^s_t \sim N(0, \sigma_s^2)$$

where $s_t \equiv S_t/Y_t$. The household seeks to maximize the utility function

$$E_0 \sum_{t=0}^{\infty} \nu_t \beta^t \frac{\left[C_t - \theta X_{t-1}\frac{h_t^\psi}{\psi}\right]^{1-\sigma} - 1}{1-\sigma},$$

subject to equations (1)-(3) and the no–Ponzi game constraint, taking as given the processes A_t, X_t, and R_t (specified below) and the initial conditions K_0 and D_1. ν_t represents an exogenous and stochastic preference shock following the AR(1) processes

$$log(\nu_{t+1}) = \rho_\nu log(\nu_t) + \epsilon^\nu_{t+1}; \qquad \epsilon^\nu_t \sim N(0, \sigma_\nu^2)$$

The country interest rate takes the form

$$R_t = R^* + \chi \left(e^{\tilde{D}_{t+1}/X_t - \bar{d}} - 1 \right) + e^{\mu_{R,t}-1} - 1$$

where $\mu_{R,t}$ is an exogenous stochastic country premium shock following the AR(1) process

$$log(\mu_{R,t+1}) = \rho_{\mu_R} log(\mu_{R,t}) + \epsilon_{t+1}^{\mu_R}; \qquad \epsilon_t^{\mu_R} \sim N(0, \sigma_{\mu_R}^2).$$

The Model with Working Capital Constraint

In this section, I present the model augmented with an additional source of financial frictions; namely, with working capital loans following Neumeyer and Perri (2005) and Uribe and Yue (2006). Output is produced by means of a production function that takes labor services, h_t and physical capital, K_t as inputs. Given the constant returns to scale assumption, total output, Y_t, in Equation (31) can be written as $Y_t = W_t h_t + R_{K,t} K_t$, where W_t denotes the wage rate and $R_{K,t}$ the rental rate of capital. Firms hire labor and capital services from perfectly competitive markets. The production process is subject to a working-capital constraint that requires firms to borrow in the international markets for transferring a fraction of the resources to the households that provide labor services before the production actually takes place. Therefore, firms borrow $\eta W_t h_t$ units of good at the (gross) domestic interest rate, R_t. We follow Neumeyer and Perri (2005) regarding the timing of the payment of labor input and assume cash-in-advance timing.

In a model with working capital constraints, equilibrium in the labor market is therefore, given by

$$W_t \left[1 + \eta \left(R_t - 1 \right) \right] = (1 - \alpha) \frac{Y_t}{h_t}$$

while the equilibrium in the (physical) capital market takes the standard form: $R_{K,t} = \alpha \frac{Y_t}{K_t}$.

C Estimation of the Model: Argentina, 1983Q1-2001Q3

Table 15. Baseline Calibration Quarterly

Parameter	σ	δ	α	χ	ψ	θ	β	d
Value	2	0.05	0.32	0.001	1.6	2.33	0.975	0.1

Table 16. Prior and Posterior Distributions - Reduced Form Financial Frictions Model (w/ 4 Observables)

	Prior Distribution			Posterior Distribution								
				RBC Model			Reduced Form Financial Frictions Model					
							w/o working capital			w/ working capital		
Parameter	Prior	Mean	Stdev	Median	5%	95%	Median	5%	95%	Median	5%	95%
σ_a	IG	0.010	0.015	0.0066	0.005	0.009	0.0151	0.0126	0.0178	0.0144	0.012	0.017
ρ_a	B	0.5	0.2	0.89	0.82	0.95	0.96	0.93	0.984	0.958	0.93	0.98
σ_γ	IG	0.010	0.015	0.0207	0.0168	0.0252	0.004	0.002	0.008	0.0042	0.0014	0.0089
ρ_γ	B	0.5	0.2	0.672	0.63	0.71	0.56	0.21	0.85	0.51	0.24	0.86
ϕ	G	5	5	9.61	7.2	12.3	8.93	6.19	11.8	10.16	7.62	14.00
σ_ν	IG	0.10	0.15	-	-	-	0.075	0.0472	0.1209	0.0960	0.06	0.20
ρ_ν	B	0.5	0.2	-	-	-	0.86	0.66	0.98	0.91	0.81	0.99
σ_s	IG	0.010	0.015	-	-	-	0.0064	0.0015	0.0185	0.007	0.001	0.023
ρ_s	B	0.5	0.2	-	-	-	0.49	0.12	0.87	0.50	0.13	0.88
σ_{μ_R}	IG	0.010	0.015	-	-	-	0.0041	0.0026	0.006	0.0049	0.003	0.007
ρ_{μ_R}	B	0.5	0.2	-	-	-	0.97	0.95	0.99	0.974	0.95	0.99
χ	IG	0.7	0.7	-	-	-	0.129	0.073	0.207	0.161	0.09	0.27
η	B	0.5	0.1	-	-	-	-	-	-	0.5228	0.33	0.70
Measurement Errors												
$100\sigma_y^{me}$	IG	0.27	0.27	0.17	0.06	0.39	0.31	0.08	0.50	0.28	0.08	0.48
$100\sigma_c^{me}$	IG	0.31	0.31	0.88	0.73	1.05	0.25	0.07	0.52	0.23	0.07	0.47
$100\sigma_i^{me}$	IG	0.60	0.60	2.91	2.67	3.02	1.17	0.21	1.89	0.49	0.13	1.18
$100\sigma_{tby}^{me}$	IG	0.26	0.26	0.12	0.05	0.21	0.18	0.07	0.29	0.22	0.10	1033
Log-marginal likelihood					806.3			798.3			803.0	

Notes: Estimation is based on Argentine data from 1983Q1 to 2001Q3. Posterior statistics are based on a two million MCMC chain from which the first million draws were discarded. For the priors, B, G and IG indicate, respectively, the Beta, Gamma and Inverse Gamma distributions. The Log-Marginal Likelihood was computed using Geweke's modified harmonic mean method.

Table 17. Prior and Posterior Distributions - Reduced Form Financial Frictions Model (w/ 5 Observables)

	Prior Distribution			Posterior Distribution					
				Reduced Form Financial Frictions Model					
				w/o working capital			w/ working capital		
Parameter	Prior	Mean	Stdev	Median	5%	95%	Median	5%	95%
σ_a	IG	0.010	0.015	0.0128	0.0084	0.0171	0.011	0.0076	0.0153
ρ_a	B	0.5	0.2	0.89	0.82	0.95	0.88	0.80	0.94
σ_γ	IG	0.010	0.015	0.0152	0.0081	0.0219	0.016	0.009	0.022
ρ_γ	B	0.5	0.2	0.78	0.67	0.92	0.76	0.65	0.91
ϕ	G	5	5	10.94	8.72	14.11	10.64	8.2	13.0
σ_ν	IG	0.10	0.15	0.06	0.03	0.11	0.06	0.03	0.11
ρ_ν	B	0.5	0.2	0.73	0.37	0.98	0.70	0.37	0.98
σ_s	IG	0.010	0.015	0.0064	0.0016	0.0187	0.0064	0.0015	0.0190
ρ_s	B	0.5	0.2	0.51	0.13	0.87	0.50	0.13	0.87
σ_{μ_R}	IG	0.010	0.015	0.0035	0.0028	0.0044	0.0034	0.0026	0.0043
ρ_{μ_R}	B	0.5	0.2	0.98	0.94	0.99	0.98	0.95	0.99
χ	IG	0.7	0.7	0.147	0.097	0.20	0.154	0.10	0.21
η	B	0.5	0.1	-	-	-	0.497	0.31	0.68
				Measurement Errors					
$100\sigma_y^{me}$	IG	0.27	0.27	0.21	0.06	0.45	0.24	0.07	0.53
$100\sigma_c^{me}$	IG	0.31	0.31	0.43	0.10	0.70	0.48	0.11	0.76
$100\sigma_i^{me}$	IG	0.60	0.60	2.42	1.77	3.02	2.52	2.00	3.02
$100\sigma_{tby}^{me}$	IG	0.26	0.26	0.18	0.07	0.30	0.18	0.07	0.31
$100\sigma_{prem}^{me}$	IG	0.13	0.13	0.37	0.28	0.48	0.37	0.27	0.48
Log-marginal likelihood					1065.4			1066.2	

Notes: Estimation is based on Argentine data from 1983Q1 to 2001Q3. Posterior statistics are based on a two million MCMC chain from which the first million draws were discarded. For the priors, B, G and IG indicate, respectively, the Beta, Gamma and Inverse Gamma distributions. The Log-Marginal Likelihood was computed using Gewekes modified harmonic mean method.

D Household's Optimality Conditions

Let the Lagrange multiplier on the household's budget constraint in equation (2) be given by $\lambda_t X_{t-1}^{-\sigma}$. After imposing our functional form for preferences, Lagrangian of the problem can be written as:

$$\mathcal{L} = \max_{\{C_t, h_t, B_{t+1}\}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t - \theta \tilde{X}_{t-1} \frac{h_t^{\psi}}{\psi} \right)^{1-\sigma} - 1}{1-\sigma} + \lambda_t X_{t-1}^{-\sigma} \left(\frac{B_{t+1}}{R_t} + W_t h_t + \Phi_t - C_t - B_t \right) \right]$$

The first order conditions of the household's problem are

$$\begin{aligned} \left(\frac{C_t}{X_{t-1}} - \theta \frac{\tilde{X}_{t-1}}{X_{t-1}} \frac{h_t^{\psi}}{\psi} \right)^{-\sigma} &= \lambda_t \\ \theta \tilde{X}_{t-1} h_t^{\psi-1} &= W_t \\ \beta E_t \left\{ \lambda_{t+1} \left(\frac{X_t}{X_{t-1}} \right)^{-\sigma} R_t \right\} &= \lambda_t \end{aligned}$$

E Return on Capital Goods

Given the constant return to scale assumption for the production function, the marginal return on capital goods can be written as:

$$Z_{K,t}(i) = \alpha A_t \left(\omega_t(i) \right)^{\alpha} \left(\frac{X_t h_t(i)}{K_t(i)} \right)^{1-\alpha}$$

Using labor demand schedule, equation (4), one can write the effective labor-capital ratio as a function of aggregate variables and idiosyncratic productivity shock:

$$\frac{X_t h_t(i)}{K_t(i)} = \left(\frac{(1-\alpha) A_t X_t}{W_t} \right)^{\frac{1}{\alpha}} \omega_t(i)$$

Substituting the effective labor-capital ratio into the return on capital equation:

$$\begin{aligned} Z_{K,t}(i) &= \alpha A_t \left(\omega_t(i) \right)^{\alpha} \left(\left(\frac{(1-\alpha) A_t X_t}{W_t} \right)^{\frac{1}{\alpha}} \omega_t(i) \right)^{1-\alpha} \\ &= \omega_t(i) \underbrace{\alpha A_t^{\frac{1}{\alpha}} \left(\frac{W_t / X_t}{1-\alpha} \right)^{-\frac{1-\alpha}{\alpha}}}_{Z_{K,t}} \end{aligned}$$

F Firm's Profit Maximization Problem

Firms maximize their discounted sum of real dividends distributed to households:

$$\max_{K_t(i), R^*_{D,t}(i), N_t(i)} E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_t \Phi^F_t(i)$$

where $E_{t-1}\Phi^F_t(i) = E_{t-1}\left(\left[1 - \Gamma(\bar{\omega}_t(i); \sigma_{\omega,t-1})\right] R_{K,t} Q_{t-1} K_t(i) - N_t(i)\right)$ subject to foreign lenders participation constraint, equation (10), the definition of default threshold, equation (7).

Imposing the definition of default threshold, equation (7), and letting ζ^i_t denote the Lagrange multiplier for the participation constraint, equation (10), the Lagrangian of the firm's problem can then be written as follows:

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta^t \Lambda_t \left(\left[1 - \Gamma\left(\frac{R^*_{D,t-1}(i)[Q_{t-1}K_t(i) - N_{t-1}(i)]}{R_{K,t}Q_{t-1}K_t(i)}; \sigma_{\omega,t-1} \right) \right] R_{K,t}Q_{t-1}K_t(i) - N_t(i) \right) +$$

$$E_0 \sum_{t=0}^{\infty} \beta^t \zeta_t(i) \left(E_t \left[\Omega\left(\frac{R^*_{D,t}(i)[Q_t K_{t+1}(i) - N_t(i)]}{R_{K,t+1}Q_t K_{t+1}(i)}; \sigma_{\omega,t} \right) R_{K,t+1}Q_t K_{t+1}(i) \right] - R^*_t [Q_t K_{t+1}(i) - N_t(i)] \right)$$

First order conditions with respect to $K_{t+1}(i)$, $R^*_{D,t}(i)$ and $N_t(i)$, respectively, are:

$$\begin{aligned} &\beta E_t \Lambda_{t+1} \left[1 - \Gamma(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})\right] R_{K,t+1} Q_t - \frac{R^*_{D,t}(i) N_t(i)}{K_{t+1}(i)} \beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \\ &= -\zeta_t(i) E_t \Omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) R_{K,t+1} Q_t + \zeta_t(i) R^*_t Q_t - \zeta_t(i) \frac{R^*_{D,t}(i) N_t(i)}{K_{t+1}(i)} E_t \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) \end{aligned} \tag{32}$$

$$\zeta_t(i) = \frac{\beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t})} \tag{33}$$

$$\Lambda_t = \beta R^*_{D,t} E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) - \Lambda_{t+1} \zeta_t(i) R^*_{D,t}(i) E_t \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) + \Lambda_{t+1} \zeta_t(i) R^*_t \tag{34}$$

Replacing equation (33) into (34), I get the following condition:

$$\Lambda_t \quad = \quad \frac{\beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})} R^*_t$$

Defining $\rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \equiv \frac{\Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})}$ and imposing Λ_t from the household's problem

$(\Lambda_t = \beta R_t E_t \Lambda_{t+1})$, where $\Lambda_{t+1} = \lambda_{t+1} X_t^{-\sigma})$, I get:

$$R_t^* E_t \Lambda_{t+1} \rho(\bar{\omega}_{t+1}(i), \sigma_{\omega,t}) \quad = \quad R_t E_t \Lambda_{t+1}$$

Rearranging equation (32) after imposing the definition of ζ_t^i and $\rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})$:

$$\begin{aligned} &\beta E_t \Lambda_{t+1} \left[1 - \Gamma(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})\right] \frac{R_{K,t+1}}{R_t^*} \\ &= \beta E_t \Lambda_{t+1} \rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \left(1 - E_t \Omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \frac{R_{K,t+1}}{R_t^*}\right) \end{aligned}$$

Finally, using the foreign lender's participation constraint $E_t \left\{ \Omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \frac{R_{K,t+1}}{R_t^*} Q_t K_{t+1} \right\} = Q_t K_{t+1}(i) - N_t(i)$, one get the following optimality condition:

$$E_t \Lambda_{t+1} \frac{R_{K,t+1}}{R_t^*} \left[1 - \Gamma(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})\right] \quad = \quad E_t \Lambda_{t+1} \rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) \frac{N_t}{Q_t K_{t+1}}$$

Note that one can re-write $\rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})$ in terms of default probabilities by taking the derivative of $\Gamma(.)$ and $\Omega(.)$ functions with respect to default threshold, $\bar{\omega}$. It can be shown that $\Gamma_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) = 1 - F(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})$ and $\Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) = 1 - F(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) - \mu \bar{\omega}_{t+1}(i) F_\omega(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})$.[37] Then, I have:

$$\rho(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) = \frac{1 - F(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})}{E_t \left(1 - F(\bar{\omega}_{t+1}(i); \sigma_{\omega,t}) - \mu \bar{\omega}_{t+1}(i) F_{\bar{\omega}}(\bar{\omega}_{t+1}(i); \sigma_{\omega,t})\right)}$$

Because the idiosyncratic shock is independent from all other shocks and across time, and identical across firms, then all firms will make the same decisions in face of the expectations about the future. This implies that the above relationships can all be expressed in aggregate terms.

G Resource Constraint

The aggregate profits by final goods, Φ_t^F, and capital goods producing firms, Φ_t^C, are given, respectively, by:

$$E_{t-1} \Phi_t^F \quad = \quad (1 - \Gamma(\bar{\omega}_t; \sigma_{\omega,t-1})) R_{K,t} Q_{t-1} K_t - N_t$$

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[37] $F(.)$ denotes cdf and $F_\omega(.)$ denotes the derivative of cdf of the idiosnycratic shock, $\omega(i)$ wrt $\bar{\omega}$.

$$\Phi_t^C \quad = \quad Q_t K_{t+1} - \left(K_{t+1} + \Phi\left(\frac{K_{t+1}}{K_t}\right) K_t \right)$$

Combining these profits with the intertemporal budget constraint of the household, equation (30), and using the constant returns to scale assumption in production function along with the firms' balance sheet identity, equation (5), one obtains (note that domestic bonds exist in zero supply in equilibrium):

$$\begin{aligned}
C_t &= W_t h_t + (1-\Gamma(\bar{\omega}_t;\sigma_{\omega,t-1}))R_{K,t}Q_{t-1}K_t - N_t + Q_t K_{t+1} - \left(K_{t+1} + \Phi\left(\frac{K_{t+1}}{K_t}\right) K_t \right) \\
C_t &= \underbrace{W_t h_t + R_{K,t}Q_{t-1}K_t}_{Y_t} - \Gamma(\bar{\omega}_t;\sigma_{\omega,t-1})R_{K,t}Q_{t-1}K_t + \underbrace{(Q_t K_{t+1} - N_t)}_{D_t^*} - \underbrace{\left(K_{t+1} + \Phi\left(\frac{K_{t+1}}{K_t}\right) K_t \right)}_{I_t} \\
C_t &= Y_t - \Gamma(\bar{\omega}_t;\sigma_{\omega,t-1})R_{K,t}Q_{t-1}K_t + D_t^* - I_t
\end{aligned}$$

Using this expression, we can derive the resource constraint and the balance of payments equation for the economy as the following:

$$\begin{aligned}
Y_t &= C_t + I_t + NX_t \\
NX_t &= \Gamma(\bar{\omega}_t;\sigma_{\omega,t-1})R_{K,t}Q_{t-1}K_t - D_t^*
\end{aligned}$$

H Stationary Equilibrium Conditions

Let $z_t \equiv Z_t/X_{t-1}$, for $Z_t \in \{C_t, K_t, W_t, Y_t, I_t, NX_t, B_t^*, N_t, LEV_t\}$, and $\Lambda_t = \lambda_t X_{t-1}^{-\sigma}$. Then the stationary first order conditions of the economy, excluding those of the exogenous shock processes, are the following:

$$\lambda_t = \left(c_t - \theta \tilde{\gamma}_{t-1}^{\frac{\varphi}{\varphi-1}} \frac{h_t^{\psi}}{\psi} \right)^{-\sigma} \tag{35}$$

$$w_t = \theta \tilde{\gamma}_{t-1}^{\frac{\varphi}{\varphi-1}} h_t^{\psi-1} \tag{36}$$

$$\lambda_t = \beta E_t \left\{ \lambda_{t+1} \gamma_t^{-\sigma} R_t \right\} \tag{37}$$

$$w_t = (1-\alpha)\frac{y_t}{h_t} \tag{38}$$

$$R_{K,t} = \frac{\alpha y_t/k_t + (1-\delta)Q_t}{Q_{t-1}} \tag{39}$$

$$y_t = A_t k_t^{\alpha} \left(\gamma_t h_t\right)^{1-\alpha} \tag{40}$$

$$i_t = \gamma_t k_{t+1} - (1-\delta)k_t + \frac{\phi}{2}\left(\gamma_t \frac{k_{t+1}}{k_t} - \gamma\right)^2 k_t \tag{41}$$

$$y_t = c_t + i_t + nx_t \tag{42}$$

$$nx_t = \Gamma(\bar{\omega}_t; \sigma_{\omega,t-1}) R_{K,t} Q_{t-1} k_t - d_t^* \tag{43}$$

$$lev_t = \frac{d_t^*}{Q_t \gamma_t k_{t+1}} \tag{44}$$

$$n_t = (1 - lev_t) Q_t \gamma_t k_{t+1} \tag{45}$$

$$\rho_t = \frac{\Gamma_{\omega}(\bar{\omega}_t; \sigma_{\omega,t-1})}{E_{t-1}\Omega_{\omega}(\bar{\omega}_t; \sigma_{\omega,t-1})} \tag{46}$$

$$lev_t = E_t \Omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) \frac{R_{K,t+1}}{R_t^*} \tag{47}$$

$$\bar{\omega}_t = \frac{R_{D,t-1}^*}{R_{K,t}} lev_{t-1} \tag{48}$$

$$Q_t = 1 + \phi\left(\gamma_t \frac{k_{t+1}}{k_t} - \gamma\right) + \beta E_t \frac{\lambda_{t+1}\gamma_t^{-\sigma}}{\lambda_t}\left[(Q_{t+1}-1)(1-\delta) + \frac{\phi}{2}\left(\frac{\gamma_{t+1}k_{t+2}}{k_{t+1}} - \gamma\right)^2 k_{t+1}\right] \tag{49}$$

$$-\beta E_t \frac{\lambda_{t+1}\gamma_t^{-\sigma}}{\lambda_t}\left[\phi\left(\frac{\gamma_{t+1}k_{t+2}}{k_{t+1}} - \gamma\right)\frac{\gamma_{t+1}k_{t+2}}{k_{t+1}}\right] \tag{50}$$

$$E_t \lambda_{t+1} \rho_{t+1} = \frac{E_t \lambda_{t+1} \frac{R_{K,t+1}}{R_t^*}\left[1 - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t})\right]}{(1 - lev_t)} \tag{51}$$

$$E_t \lambda_{t+1} \rho_{t+1} = \frac{R_t}{R_t^*} E_t \lambda_{t+1} \tag{52}$$

where $\tilde{\gamma}_t = \tilde{\gamma}_{t-1}^{\varphi} \gamma_t^{1-\varphi}$. In these equations $lev_t \equiv \frac{D_t^*}{Q_t K_{t+1}}$ denotes the aggregate leverage of the firm, and $\rho_t \equiv \rho(\bar{\omega}_t(i); \sigma_{\omega,t-1})$ as defined section (4.2.1).

I Bayesian Estimation Results: Baseline Model Argentina, 1983Q1 - 2001Q3

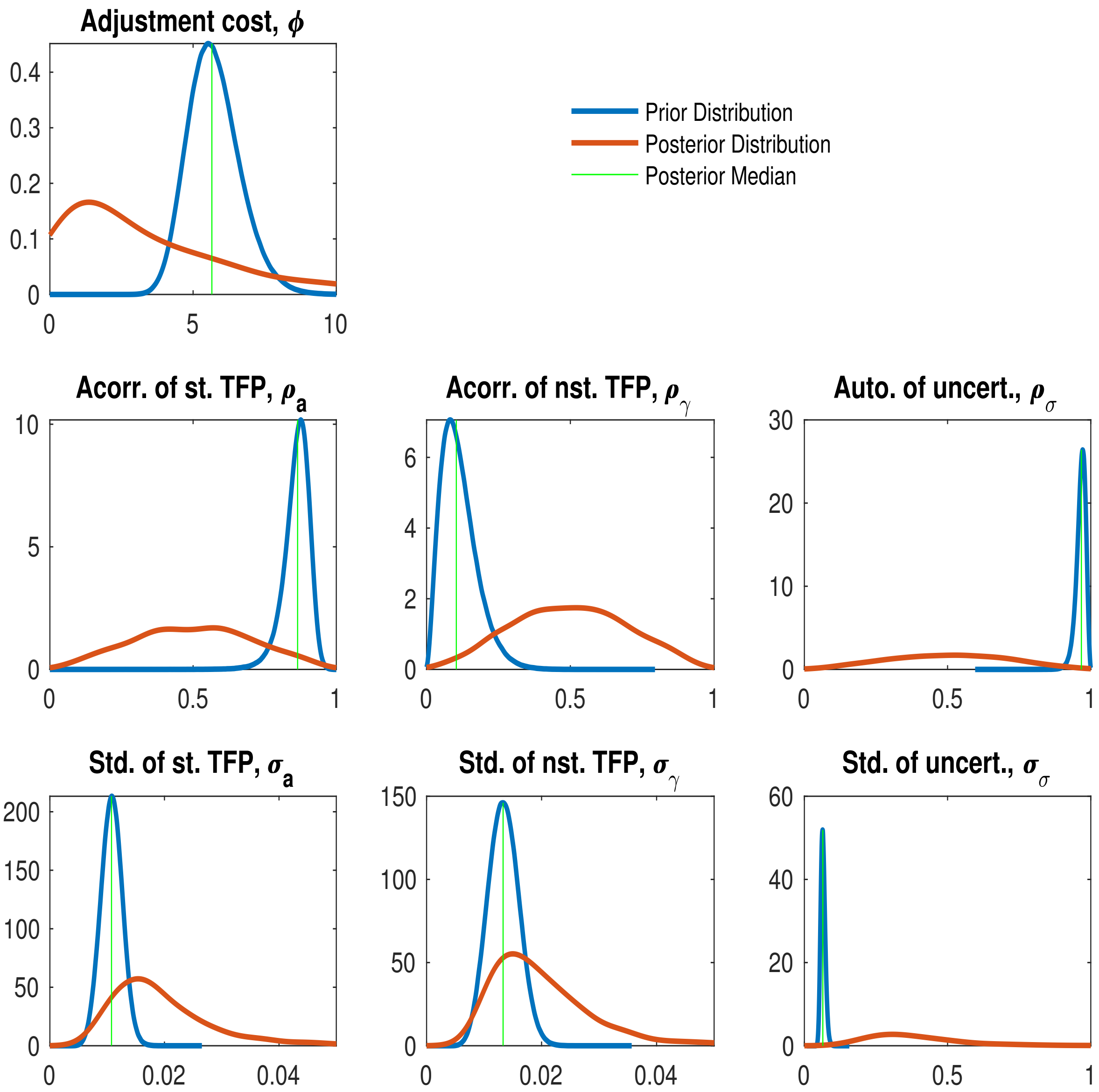

Figure 4. Prior and Posterior Distribution - Baseline Model