

Financial Frictions and Macroeconomic Fluctuations in Emerging Economies

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Abstract

Estimated dynamic models of business cycles in emerging markets deliver counterfactual predictions for the country risk premium. In particular, the country interest rate predicted by these models is acyclical or procyclical, whereas it is countercyclical in the data. This paper proposes and estimates a small open economy model of the emerging-market business cycle in which a time-varying country risk premium emerges endogenously through a variant of the financial accelerator mechanism as in Bernanke, Gertler, and Gilchrist (1999). In the proposed model, a firm's borrowing rate adjusts countercyclically as the productivity default threshold depends on the state of the macroeconomy. I econometrically estimate the proposed model and find that it can account for the volatility and the countercyclicality of country risk premium as well as for other key emerging market business cycle moments. Time varying uncertainty in firm specific productivity contributes to delivering a countercyclical default rate and explains more than 70 percent of the variances in the trade balance and in the country risk premium. Finally, I find the predicted contribution of nonstationary productivity shocks in explaining output variations falls between the high estimate reported by Aguiar and Gopinath (2007) and the low estimates reported by García-Cicco, Pancrazi, and Uribe (2010).

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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 and persistence of the trade balance to output ratio and (3) high, volatile, and countercyclical country risk premia. Existing estimated models of business cycles in emerging markets place significant emphasis on explaining observed movements in output, consumption and the trade balance, but much less emphasis on 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. 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, Gertler, and Gilchrist (1999). In the model, due to a costly state verification problem, external funds will be more expensive than internal funds. Assuming that domestic households are the owners of the leveraged firms which might default on their debt, both country interest rate and the rate at which firms borrow 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 foreign lenders 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 higher consumption volatility relative to income volatility, and countercyclical trade balance-to-output ratio in the model economy. The first result arises because 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. The second result occurs because the total

consumption of households varies more in a model with endogenous spreads in response to productivity shocks. Firms tend to reduce the leverage when the economy is hit by adverse productivity shock. They do so by decreasing the real dividends distributed to the household, which tightens their budget constraints. As a result of this, 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 augmented the data series that is 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 fed with a variety of shocks, such as stationary and nonstationary shocks to total factor productivity, consumption preferences shocks, government spending shocks and financial shocks. 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 intermediate goods to be used in the production process through a combination of their own resources and borrowing from international 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. \(2008\)](#) and [Christiano et al. \(2009\)](#). The former extended the Carlstrom and Fuerst agency cost model of business cycles by including time-varying uncertainty in the technology shocks that affect capital production and then calibrated the model for the U.S. economy. The latter augmented the financial accelerator model as in Bernanke, Gertler, and Gilchrist (1999) with the time varying uncertainty shock and estimated the model for the U.S. economy and Euro area. Finally, [Christiano et al. \(2007\)](#) incorporated the time varying uncertainty shock into a small open economy, and then estimated the model on Swedish data. In all these papers, the financial frictions introduced into the model are related to domestic financial markets and the models are estimated for developed economies.¹

¹Similar to [Dorofeenko et al. \(2008\)](#) and [Christiano et al. \(2009\)](#), time varying uncertainty shock introduced in this paper is a mean preserving shift in the cross-sectional dispersion of returns from investing in intermediate inputs.

Incorporating time varying uncertainty shock into an emerging market business cycle model is appealing for three reasons. First, it helps to account for the countercyclical risk premium and other key emerging market business cycle moments in the model. In response to an increase in the standard deviation of the idiosyncratic productivity shock, foreign lenders will charge a higher risk premium on their lending to an emerging economy because they have to bear the cost of more bankruptcies after a positive shock. Raising the risk premium is the only way they can shed this risk. With the higher cost of borrowing, firms reduce the amount of intermediate inputs used in the production because intermediate inputs are now more expensive to finance. Besides, 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. At the end, output decreases and a countercyclical interest rate emerges. Second, this shock is important in delivering a high and volatile country risk premium, which is shown to be a good business cycle leading indicator in emerging economies (see, for example, [Neumeyer and Perri \(2005\)](#)). Finally, time varying uncertainty shock in the model with financial frictions replaces some of the role of the nonstationary technology shock, which is shown to be the single most important shock for the emerging economy in the context of frictionless real business cycle models.

I investigated the sources of business cycle fluctuations in emerging economies using the estimated model. I find that shocks to a nonstationary component of productivity explains 50 percent of the unconditional variances of output and consumption. This estimate falls between the estimates in [Aguiar and Gopinath \(2007\)](#) (80 percent) and in [García-Cicco, Pancrazi, and Uribe \(2010\)](#) (5 percent). Time varying uncertainty in the firm specific productivity explains more than 70 percent of the variance of trade balance-to-output ratio and country risk premium.

I show that incorporating the endogenous risk premium and the inclusion of the country risk premium data in the estimation modifies inferences about the sources of macroeconomic fluctuations in emerging markets. Without the financial frictions and the country risk premium data, the nonstationary technology shock is the main source of aggregate fluctuations. In response to a positive and persistent shock to productivity growth, current output increases on impact and is expected to continue to grow in the future. This increasing profile for future expected income levels induces households to consume beyond the increase in current output by increasing the debt they obtain

from foreign lenders. This results in a countercyclical trade balance-to-output ratio and higher consumption volatility relative to income volatility. However, the estimated frictionless model implies excessive volatility of trade balance to output ratio.

With reduced form financial frictions and the neglecting of the information on the country risk premium, the data assigns a negligible role to the nonstationary technology shock. Its role is replaced by the stationary technology shock, the consumption preferences shock and the exogenous country risk premium shock. When the economy is hit by a higher consumption preference shock, everyone suddenly wants to consume more, which is partly financed by borrowing in the international markets. A higher demand for funds will in turn lead to a higher interest rates. The exogenous increase in the country risk premium will lead to a higher country interest rate by assumption in the reduced form financial frictions model. Once the model is forced to use information on country risk premium, some of the explanatory power of the consumption preference shock and the country risk premium shock is lost. The estimated standard deviation and the serial correlation of the stationary technology shock also decrease. The role of the nonstationary technology shock increases so that the model, especially the consumption euler equation, fits the data better. However, the estimated reduced form financial frictions model predicts acyclical or procyclical country interest rate. The endogenous risk premium model proposed in this paper (with country interest rate data used in the estimation) predicts that part of the role of the nonstationary shock in the frictionless model is taken up by the time varying uncertainty shock and the model successfully accounts for the interest rate cyclicity and other key moments of emerging market data.

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 real business cycle model presented in [Mendoza \(1991\)](#) and [Schmitt-Grohe and Uribe \(2003\)](#). The first contributions in emerging-market business-cycle literature (see, for example, [Neumeyer and Perri \(2005\)](#) and [Uribe and Yue \(2006\)](#)) augmented the canonical model with two different types of financial friction: an induced process for the country risk premium and the working capital constraint. These papers treat country risk premium in a reduced form without explicitly incorporating a microfounded default mechanism. They also assume that working capital loans pay the total cost of labor in full, which implies that the share of working capital loans in the gross domestic product is very high while

empirical evidence suggests it is a significantly smaller share.²

In a more recent paper, [Aguiar and Gopinath \(2007\)](#) argue that introducing shocks to trend output in an otherwise standard small open economy real business cycle model can account for the key features of economic fluctuations in emerging market economies. I show in this paper that the model can account for excess volatility of consumption, but this comes at the cost of a high implied volatility of the trade balance to output ratio (about four times higher than the data). This result suggests that it is not reasonable to assume frictionless financial markets. The estimated model also predicts that the trade balance-to-output ratio and the country interest rates exhibit near random walk behavior. However, the empirical autocorrelation function of these variables takes a value slightly higher than 0.90 at order one and then declines quickly toward zero, resembling a variable with a stationary autoregressive behavior.

[García-Cicco, Pancrazi, and Uribe \(2010\)](#), motivated by the failure of frictionless real business cycle models augmented by trend shocks to productivity, estimated an encompassing model for an emerging economy with both trend shocks and financial frictions. The estimated model generates higher consumption volatility relative to income volatility and countercyclical trade balance-to-output ratio. However, the model cannot explain the interest rate driving its results. Financial market imperfections are introduced into the model in a reduced form by econometrically estimating the value of the parameter governing the debt elasticity of the country premium. I show in this paper that the model proposed by [García-Cicco, Pancrazi, and Uribe \(2010\)](#) predicts a procyclical interest rate, while it is strongly countercyclical in the data. [Chang and Fernandez \(2010\)](#) also estimate a reduced form financial 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.

The recent work by [Mendoza and Yue \(2011\)](#) incorporated a slightly modified version of the default risk model of [Eaton and Gersovitz \(1981\)](#) into an otherwise standard real business cycle model. Their model is successful in replicating the countercyclical spreads and two key stylized facts of emerging market business cycles: countercyclical net exports and consumption variability that

² As also argued in [Oviedo \(2005\)](#) and [Mendoza and Yue \(2011\)](#), the implied share of working capital loans in the gross domestic product is approximately 67 percent while [Mendoza and Yue \(2011\)](#) report that it is 6 percent of the gross domestic product in Argentina and [Schmitt-Grohe and Uribe \(2007\)](#) estimate that it is 9.3 percent annually for the U.S.

exceeds income volatility (but the model underestimates both relative to the data). However, their results crucially depend on the assumption that defaults on public and private foreign obligations occur simultaneously. They assume that government can divert the firms' repayment when it defaults on its own debt so that foreign lenders arbitrage interest rate on sovereign debt and the firms' working capital loans. Moreover, the only source of uncertainty in this model is shocks to the stationary component of total factor productivity. [Aguiar and Gopinath \(2006\)](#) in a quantitative model of sovereign default based on the classic setup of [Eaton and Gersovitz \(1981\)](#) show that the stationary productivity shock is not consistent with countercyclical spreads. They argue that permanent productivity shocks successfully generate the cyclicity 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.

Finally, my work is 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. [Gertler et al. \(2007\)](#), [Elekdag et al. \(2006\)](#), [Curdia \(2007\)](#) among others study the role of monetary and exchange rate policy in the presence of financial frictions *ala* [Bernanke et al. \(1999\)](#). The financial shock introduced in these models leads to a sudden stop of capital inflows to an emerging economy. In [Gertler et al. \(2007\)](#) and [Elekdag et al. \(2006\)](#), financial frictions are introduced into the physical capital markets and an exogenous increase in world interest rate causes the sudden stops. In [Curdia \(2007\)](#), similar to the setup employed in this paper, financial frictions apply to the intermediate inputs purchase decisions and the sudden stop is modeled as a change in the perceptions of foreign lenders that brings about an increase in the cost of borrowing.

The remainder of the paper is organized as follows: Section 2 outlines the real business cycle model of an emerging economy with an endogenous default premium through a variant of the financial accelerator model of Bernanke, Gertler, and Gilchrist (1999). Section 3 analyzes empirical regularities of business cycles in Argentina. Section 4 describes the econometric estimation of the model using Bayesian methods and Argentine data. Section 5 estimates the reduced form financial frictions model as in [García-Cicco, Pancrazi, and Uribe \(2010\)](#) and the frictionless real business cycle model as in [Aguiar and Gopinath \(2007\)](#) for Argentina. The purpose of this section is to evaluate the existing models in the literature in terms of their ability to produce countercyclical interest rates and other stylized facts. Section 6 concludes.

2 The Model

The model is a canonical small open economy real business cycle model augmented with financial frictions *ala* [Bernanke et al. \(1999\)](#). It consists of households, firms and the foreign sector. The households consume, invest in physical capital (subject to quadratic adjustment cost), and provide labor and capital for the production firms. The households are the shareholders of the firms that have access to the international markets. The domestic goods are produced via constant returns to scale technology that requires labor, capital and intermediate inputs. The firms rent labor and capital from households in a perfectly competitive market. However, it takes one period for the intermediate input to be ready for use in the production process. Therefore, I assume that firms borrow in the international markets from risk neutral foreign lenders to finance the purchase of the intermediate inputs. The mix of intermediate inputs is determined by a standard constant elasticity of substitution aggregator that combines domestically produced intermediate inputs with the imported intermediate inputs.

2.1 Households

Our economy is populated by a continuum of identical consumers. The household's preferences are defined by per capita consumption, C_t , and per capita labor effort, h_t , and are described by the utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \nu_t U(C_t, h_t), \quad (1)$$

where

$$U(C, h) = \frac{\left(C_t - \psi^{-1} X_{t-1} h_t^\psi\right)^{1-\sigma} - 1}{1 - \sigma}, \quad (2)$$

E_t denotes the mathematical expectation operator conditional on information available at time t , $\beta \in (0, 1)$ represents a subjective discount factor, the parameter σ is the coefficient of relative risk aversion, and ψ determines the wage elasticity of labor supply, which is given by $1/(\psi-1)$. Utility 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 variable ν_t is an intertemporal preference shock with the law of motion:

$$\log(\nu_{t+1}/\nu) = \rho_\nu \log(\nu_t/\nu) + \varepsilon_{\nu,t+1}; \quad \varepsilon_{\nu,t} \sim i.i.d. \quad N(0, \sigma_\nu^2) \quad (3)$$

This intertemporal shock allows us to capture changes in aggregate demand in a simple way. Empirically, it helps the intertemporal euler equation of consumption to fit the data. The household is assumed to own physical capital, K_t , which accumulates according to the following law of motion

$$I_t = K_{t+1} - (1 - \delta)K_t, \quad (4)$$

where I_t denotes investment and δ is the rate of depreciation of physical capital.

The household's period-by-period budget constraint is given by:

$$C_t + K_{t+1} - (1 - \delta)K_t + B_t^d = \frac{B_{t+1}^d}{R_t} + W_t h_t + R_{k,t} K_t - \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + \Phi_t^f + \Phi_t^m \quad (5)$$

where μ_X is the steady state growth rate of permanent technology shock, X . In each period $t \geq 0$, consumers have access to domestic one period bond, B_{t+1}^d , the net supply of which is zero in equilibrium. The variable R_t denotes the gross real interest rate of this one period domestic bond in period t . W_t is the household's real wage rate, $R_{k,t}$ is the real return on capital, Φ_t^f and Φ_t^m are transfers from the final and intermediate goods firms, respectively. The parameter φ introduces the quadratic capital adjustment cost. In addition, consumers are subject to a borrowing constraint that prevents them from engaging in Ponzi financing.

Consumers choose contingent plans $\{C_t, h_t, B_{t+1}^d, K_{t+1}\}$ to maximize (1) subject to capital accumulation equation, (4), their budget constraint, (5), and the no-Ponzi-game constraint, taking as given the processes $W_t, R_{k,t}, R_t, X_t$ and the initial conditions D_0, K_0 . I let the multiplier on the budget constraint (5) be $\lambda_t X_{t-1}^{-\sigma}$.³

³First order conditions for household's optimization problem is presented in Appendix 7.1.

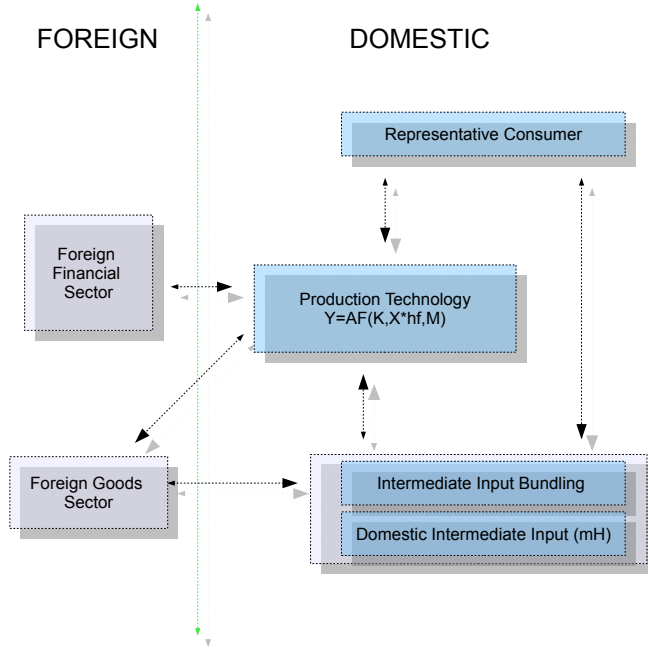


Figure 1: Flowchart of the Model

2.2 Firms

2.2.1 Final Goods Production Firms

Firms operate as price takers in a competitive market. They hire labor, h_t^f , and rent capital, K_t from households and purchase intermediate goods, M_t , that are required for production but take one period to be processed and used. The production technology takes the form:

$$Y_t^i = A_t [K_t^i]^\alpha [X_t h_t^{f,i}]^\gamma [\omega_t^i M_{t-1}^i]^\eta \quad (6)$$

where A_t is a stationary shock to total factor productivity following the AR(1) processes

$$\log(A_{t+1}/A) = \rho_a \log(A_t/A) + \varepsilon_{a,t+1}; \quad \varepsilon_{a,t} \sim i.i.d. \quad N(0, \sigma_a^2) \quad (7)$$

The productivity shock X_t is nonstationary. Let

$$\mu_{X,t} = \frac{X_t}{X_{t-1}}$$

denote the gross growth rate of X_t . I assume that the logarithm of $\mu_{X,t}$ follows a first-order autoregressive process of the form

$$\log(\mu_{X,t+1}/\mu_X) = \rho_\mu \log(\mu_{X,t}/\mu_X) + \varepsilon_{\mu_X,t+1}; \quad \varepsilon_{\mu_X,t} \sim i.i.d. N(0, \sigma_{\mu_X}^2) \quad (8)$$

In addition, I assume that the purchased intermediate goods are shifted by a productivity shock, ω_t^i that is i.i.d. across firms and time. The shock is assumed to be lognormally 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:

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

The evolution of the standard deviation is such that

$$\log(\sigma_{\omega,t}/\sigma_\omega) = \rho_{\sigma_\omega} \log(\sigma_{\omega,t-1}/\sigma_\omega) + \varepsilon_{\sigma_\omega,t}; \quad \varepsilon_{\sigma_\omega,t} \sim i.i.d. N(0, \sigma_{\sigma_\omega}^2) \quad (9)$$

The t subscript indicates that $\sigma_{\omega,t}$ is itself the realization of a random variable. I assume that technology is subject to constant returns to scale, $\alpha + \gamma + \eta = 1$. Firms produce a (tradable) good sold at a world-determined price (normalized to unity without loss of generality).⁴

Labor and Capital Demand Schedules

At time t , the firm chooses labor and capital to maximize profits conditional on $(A_t, \mu_{x,t}, \nu_t, \omega_t^i)$, given the available intermediate goods purchased in the previous period, M_{t-1}^i . Accordingly, labor and capital demand satisfies

$$\gamma \frac{Y_t^i}{h_t^{f,i}} = W_t \quad (10)$$

$$\alpha \frac{Y_t^i}{K_t^i} = R_{k,t} \quad (11)$$

⁴I assume that idiosyncratic shock is following a mean preserving spread distribution as in [Dorofeenko et al. \(2008\)](#). Moreover, idiosyncratic productivity shock enters the production function with a power η . This assumption is desirable to make the model homogeneous in the term $R_{m,t+1} p_{m,t} M_t$ where $R_{m,t+1}$ is the aggregate rate of return on intermediate goods (see the proof in [Appendix 7.3](#) for the desirability of this assumption).

Intermediate Input Purchase Decision and Standard Debt Contract

Next, I consider the intermediate input purchase decision. At the end of the period t , firms which are solvent, or newly created to replace insolvent firms, purchase intermediate inputs which can be used in the subsequent period $t + 1$ to produce output. The quantity of intermediate input purchased is denoted by M_t^i with the subscript denoting the period in which the intermediate input is purchased. The firm finances the purchase of the intermediate input 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, B_t^i . Then, the intermediate input financing constraint takes the form:

$$p_{m,t}M_t^i = N_t^i + B_t^i \quad (12)$$

where $p_{m,t}$ denotes the price of the intermediate good. The firms' demand for intermediate input depends on the expected marginal return and the expected marginal financing cost. The return to intermediate input is sensitive to both aggregate and idiosyncratic risk. The (gross) marginal return to intermediate input for firm i is the next period's ex-post output net of labor and capital costs, normalized by the period t market value of the intermediate input:

$$R_{m,t+1}^i = \frac{Y_{t+1}^i - W_{t+1}h_{t+1}^{f,i} - R_{k,t+1}K_{t+1}^i}{p_{m,t}M_t^i} \quad (13)$$

$$= \frac{Y_{t+1}^i - \gamma Y_{t+1}^i - \alpha Y_{t+1}^i}{p_{m,t}M_t^i} \quad (14)$$

$$= \frac{\eta Y_{t+1}^i}{p_{m,t}M_t^i} \quad (15)$$

Given the constant returns to scale assumption for the production function, the return on intermediate inputs can be expressed as

$$R_{m,t+1}^i = \omega_{t+1}^i \left(\frac{\eta \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha}{\eta}}}{p_{m,t}} \right) \equiv \omega_{t+1}^i R_{m,t+1} \quad (16)$$

where $R_{m,t+1}$ is the aggregate component of the return on the investment in intermediate inputs.

(Proved in the Appendix 7.3.)

Since $E_t[\omega_{t+1}^i] = 1$ for all $t \geq 0$ (the mean of ω_{t+1}^i across firms is unity), I can express the expected marginal return simply as

$$\begin{aligned} E_t \{R_{m,t+1}^i\} &= E_t \{\omega_{t+1}^i R_{m,t+1}\} \\ &= E_t \{\omega_{t+1}^i\} E_t \{R_{m,t+1}\} \\ &= E_t \{R_{m,t+1}\} \end{aligned}$$

The marginal cost of the intermediate input, on the other hand, depends on financial conditions. The idiosyncratic shock ω_{t+1}^i is private information for the firm, implying that a risk neutral foreign lender cannot freely observe the gross output. The risk free opportunity cost for the foreigner lenders is the international real interest rate, R_t^* . However, due to the uncertain productivity of the firms, implying risk for the creditors, a risk premium is charged to the firms on their debt. The foreign lenders are risk neutral. Following [Bernanke et al. \(1999\)](#), 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 $\mu \omega_{t+1}^i R_{m,t+1} p_{m,t} M_t^i$ where μ is the real monitoring cost.⁵

The firm chooses intermediate input, M_t^i , and the associated level of borrowing, B_t^i , prior to the realization of the idiosyncratic and aggregate technology shocks, $(A_{t+1}, \mu_{x,t+1}, \nu_{t+1}, \omega_{t+1}^i)$ but after the realization of the standard deviation shock, $\sigma_{\omega,t}$, which is affecting the distribution of idiosyncratic productivity shock, $F(\omega_{t+1}^i; \sigma_{\omega,t})$; hence, the external finance premium paid at time $t + 1$. The firm with an idiosyncratic productivity shock, ω_{t+1}^i , above an endogenously determined default threshold value, $\bar{\omega}_{t+1}^i$, pays a gross interest rate, $R_{B,t}^i$, on their loans. The default threshold is set to a level of returns that is just enough to fulfill the debt contract obligations:

$$\bar{\omega}_{t+1}^i R_{m,t+1} p_{m,t} M_t^i = R_{B,t}^i B_t^i \tag{17}$$

⁵If there was no costly state verification problem, say ω_{t+1}^i is common knowledge, the total cost of funding would be equal to the amount of borrowing multiplied by the (gross) interest paid on the funds borrowed, $R_t B_t$. [Neumeyer and Perri \(2005\)](#) assume that a large mass of international investors is willing to lend to the emerging economy any amount at a rate R_t . Loans to the domestic economy are risky assets because they assume that there can be default on payments to foreigners. But their model does not provide microfoundations to explain the default decision; hence, the sources of high and time varying risk premium seen in the data. They rather assume that private domestic lenders always pay their obligation in full but in each period there is a probability that the local government will confiscate all the interest payments going from local borrowers to the foreign lenders.

Given the constant returns to scale assumption, the cutoff value $\bar{\omega}_{t+1}^i$ determines the division of gross earnings from investing in intermediate inputs, $R_{m,t+1}p_{m,t}M_t^i$, between borrower and lender. If the idiosyncratic shock is greater than or equal to the default threshold, $\bar{\omega}_{t+1}^i$, i.e., the firm is solvent, the firm repays the loan and collects the remainder of the profits, equal to $(\omega_{t+1}^i - \bar{\omega}_{t+1}^i)R_{m,t+1}p_{m,t}M_t^i$. This means that if the firm does not default, a lender receives a fixed payment independent of ω_{t+1}^i . Otherwise, the firm defaults and the foreign lender receives nothing and pays the auditing cost, μ and collects everything there is to collect, $(1 - \mu)\omega_{t+1}^i R_{m,t+1}p_{m,t}M_t^i$. 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:

$$\Upsilon(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv \int_{\bar{\omega}_{t+1}^i}^{\infty} (\omega_{t+1}^i - \bar{\omega}_{t+1}^i) dF(\omega_{t+1}^i; \sigma_{\omega,t}) \quad (18)$$

$$\Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv \int_0^{\bar{\omega}_{t+1}^i} \omega_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) + \int_{\bar{\omega}_{t+1}^i}^{\infty} \bar{\omega}_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) \quad (19)$$

$$\equiv \int_0^{\bar{\omega}_{t+1}^i} \omega_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) + \left[1 - \int_0^{\bar{\omega}_{t+1}^i} dF(\omega_{t+1}^i; \sigma_{\omega,t}) \right] \bar{\omega}_{t+1}^i \quad (20)$$

$$\equiv \int_0^{\bar{\omega}_{t+1}^i} \omega_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) + [1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] \bar{\omega}_{t+1}^i \quad (21)$$

where $F_t(\cdot)$ denotes the time varying cumulative density function of ω_{t+1}^i and $F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})$ is the probability of default. Because $E_t[\omega_{t+1}^i] = 1$, I have that

$$\Upsilon(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) + \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv 1$$

Rearranging the above given expression, I have

$$\Upsilon(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv 1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \quad (22)$$

where $0 < \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t-1}) < 1$.

The values of $\bar{\omega}_{t+1}^i$ and $R_{B,t}^i$ 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.⁶

Accordingly, the loan contract must satisfy the zero profit condition of the foreign lender:

$$E_t \left\{ [1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] R_{B,t}^i B_t^i + (1 - \mu) \int_0^{\bar{\omega}_{t+1}^i} \omega_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t \right\} = R_t^* B_t^i \quad (23)$$

where $[1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})]$ is one minus the probability of the default for the firm (i.e., the survival probability of the firm), R_t^* is the financial investors' return from investing in risk-free financial instruments.

Combining equation defining the expected gross share of aggregate component of earnings going to the lender, equation (19), and the balance sheet identity, equation (12), with the participation constraint, equation (23), yields the following expression:⁷

$$E_t \{ \Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t \} = R_t^* B_t^i \quad (24)$$

where

$$\Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) - \mu G(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \quad (25)$$

and

$$G(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \equiv \int_0^{\bar{\omega}_{t+1}^i} \omega_{t+1}^i dF(\omega_{t+1}^i; \sigma_{\omega,t}) \quad (26)$$

Firms, after paying for labor and capital inputs, distribute the remaining output to households, as they are the owners of the firms. Real dividends distributed to households are given by the following expression:

$$\Phi_{t+1}^{f,i} = Y_{t+1}^i - W_{t+1} h_{t+1}^{f,i} - R_{k,t+1} K_{t+1}^i - R_{B,t}^i B_t^i - N_{t+1}^i \quad (27)$$

⁶Standard debt contract necessitates that the default threshold, $\bar{\omega}_{t+1}$ is state contingent but the contractual interest, $R_{B,t}$ is not.

⁷As discussed by BGG, $\Omega(\cdot)$ is increasing in $\bar{\omega}_{t+1}$ given the log-normality assumption. Moreover, given the mean preserving increase in the uncertainty assumption, $\Omega(\cdot)$ is decreasing in $\sigma_{\omega,t}$.

Using the constant returns to scale assumption, I can write dividends as the following:⁸

$$\Phi_{t+1}^{f,i} = \omega_{t+1}^i R_{m,t+1} p_{m,t} M_t^i - R_{B,t}^i B_t^i - N_{t+1}^i \quad (28)$$

Rearranging equation (28) by using the definition of the default threshold, (17), I get the following expression for real dividends distributed to households:

$$\Phi_{t+1}^{f,i} = \left[\int_{\bar{\omega}_{t+1}^i}^{\infty} (\omega_{t+1}^i - \bar{\omega}_{t+1}^i) dF(\omega_{t+1}^i; \sigma_{\omega,t}) \right] R_{m,t+1} p_{m,t} M_t^i - N_{t+1}^i \quad (29)$$

$$= [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] R_{m,t+1} p_{m,t} M_t^i - N_{t+1}^i \quad (30)$$

Given the standard debt contract, the expected dividends to be distributed to households may be expressed as

$$E_t \Phi_{t+1}^{f,i} = E_t \{ [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] R_{m,t+1} p_{m,t} M_t^i - N_{t+1}^i \} \quad (31)$$

The formal investment and contracting problem then reduces to choosing M_t^i and a schedule for $\bar{\omega}_{t+1}^i$ (as a function of realized values of $R_{m,t+1}$) to maximize (31) subject to the participation constraint of the foreign lender,(24).

After the firm has chosen M_t^i and $\bar{\omega}_{t+1}^i$, the firm's net worth, N_t^i is determined. I assume that a new firm is immediately created for the insolvent firm with a level of net worth, N_t^i , which is the only variable characterizing the firm at time t .

Formally, the problem of the firm at the end of time t is then given as follows:

$$\max_{\{M_t^i, \bar{\omega}_{t+1}^i, R_{B,t}^i, N_t^i\}} \Lambda_t \Phi_t^{f,i} + \beta E_t \Lambda_{t+1} \Phi_{t+1}^{f,i} \quad (32)$$

subject to the participation constraint of the foreign lenders, (24) and the default threshold definition, (17), with respect to M_t^i , $\bar{\omega}_{t+1}^i$, $R_{B,t}^i$ and N_t^i .⁹

⁸Under the constant returns to scale assumption, I have the following relationship between the output and production factors: $Y_{t+1}^i = W_{t+1} h_{t+1}^i + R_{k,t+1} K_{t+1}^i + \omega_{t+1}^i R_{m,t+1} p_{m,t} M_t^i$

⁹Expected dividend for the surviving firms is $\Phi_t^{f,i} = (\omega_t^i - \bar{\omega}_t^i) R_{m,t} p_{m,t-1} M_{t-1}^i - N_t^i$ and for the newly created firms it is given by $\Phi_t^{f,i} = -N_t^i$

I eliminate the second constraint by substituting the default threshold by $\bar{\omega}_t^i = \frac{R_{B,t-1}^i(p_{m,t-1}M_{t-1}^i - N_{t-1}^i)}{R_{m,t}p_{m,t-1}M_{t-1}^i}$. I denote the lagrange multiplier for the participation constraint of the lender (24) as φ_t^i . The appropriate discount factor is given by Λ_t where $\Lambda_t = \lambda_t X_{t-1}^{-\sigma}$ is the lagrange multiplier associated with the households' budget constraint (5). The firm's problem is discussed in detail in the Appendix (7.4).

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

$$E_t \lambda_{t+1} \frac{R_{m,t+1}}{R_t^*} [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] = E_t \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \frac{N_t}{p_{m,t} M_t^i} \quad (33)$$

$$\frac{R_t}{R_t^*} E_t \lambda_{t+1} = E_t \{ \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i, \sigma_{\omega,t}) \} \quad (34)$$

$$E_t \Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \frac{R_{m,t+1}}{R_t^*} p_{m,t} M_t^i = [p_{m,t} M_t^i - N_t^i] \quad (35)$$

where $\rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) = \frac{(1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}))}{(1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) - \mu \bar{\omega}_{t+1}^i F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}))}$

(Proved in the Appendix 7.4.)

Equation (33) implicitly defines a key relationship in the firm sector, linking the price of intermediate inputs to the expected return on investment in those intermediate inputs, relative to the risk free rate, net worth and level of intermediate inputs that is demanded at that price. Therefore, this expression is also written as:

$$p_{m,t} M_t = \frac{E_t \rho(\bar{\omega}_{t+1}^i, \sigma_{\omega,t+1})}{E_t \frac{R_{m,t+1}}{R_t^*} (1 - \Gamma(\bar{\omega}_{t+1}^i, \sigma_{\omega,t+1}))} N_t = \chi \left(\frac{R_{m,t+1}}{R_t^*}, \bar{\omega}_{t+1}^i, \sigma_{\omega,t+1} \right) N_t$$

which relates purchases of intermediate inputs to the level of net worth and the external finance premium, $R_{m,t+1}/R_t^*$.

The equation characterizing the evolution of net worth, equation (34), takes the form of a usual uncovered interest parity relationship linking domestic and foreign interest rates, added by a risk premium term, $\rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})$. The last equation, equation (35), is the participation constraint of the foreign lender.

2.2.2 Intermediate Goods Production Firms

I assume that intermediate goods, owned by households, are produced by a separate sector in a competitive market. Total intermediate good is assumed to be given by a constant elasticity of substitution aggregate of domestic and imported intermediate goods (M_t^H and M_t^F , respectively):

$$M_t = \left[\nu^{\frac{1}{\rho i}} (M_t^H)^{\frac{\rho i - 1}{\rho i}} + (1 - \nu)^{\frac{1}{\rho i}} (M_t^F)^{\frac{\rho i - 1}{\rho i}} \right]^{\frac{\rho i}{\rho i - 1}} \quad (36)$$

where ρi is the elasticity of substitution between domestic and imported intermediate goods. The relative price of domestic intermediate input, p_t^H is taken as given by the intermediate good producers. The world price of imported intermediate inputs, p_t^F , is exogenous and taken as given by the small open economy. The price index for intermediate goods and the breakdown into domestic and foreign components are, respectively, expressed as

$$p_{m,t} = \left(\nu (p_t^H)^{1 - \rho i} + (1 - \nu) (p_t^F)^{1 - \rho i} \right)^{\frac{1}{1 - \rho i}} \quad (37)$$

$$M_t^H = \nu M_t \left(\frac{p_t^H}{p_{m,t}} \right)^{-\rho i} \quad (38)$$

$$M_t^F = (1 - \nu) M_t \left(\frac{p_t^F}{p_{m,t}} \right)^{-\rho i} \quad (39)$$

Domestic intermediate goods are produced using labor, h_t^m with the following linear production technology: $M_t^H = X_{t-1} h_t^m$. The profit maximization problem gives us the following optimality condition: $p_t^H = W_t / X_{t-1}$.

2.3 Market Clearing Conditions

Labor Market: $h_t = h_t^f + h_t^m$

Goods Market Equilibrium:

$$Y_t + p_t^H M_t^H = C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + p_{m,t} M_t + N X_t \quad (40)$$

(Proved in the Appendix 7.5)

Balance of Payments:

$$0 = NX_t - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t}) R_{m,t} p_{m,t-1} M_{t-1} + B_t$$

where NX_t is the net exports, $\Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t}) R_{m,t} p_{m,t-1} M_{t-1}$ denotes the repayment of the debt and its service by the firms; B_t is the total amount of borrowing at time t by the firms.

3 Business Cycles in Argentina: 1983Q1-2001Q3

I am going to estimate and evaluate the predictions of the model with the endogenous risk premium for Argentina. The reason for choosing Argentina as a case study is two-fold. First, Argentina is one of two countries (the other is Mexico) frequently used in the quantitative real business cycle literature. Since one of the main objectives of this paper is to evaluate the predictions of the model for the interest rates as well as other traditional moments, the use of Argentine data facilitates comparison of the model's results to the existent literature. Second, the interest rate series for Argentina starts in 1983 while for other emerging markets (for example, Mexico) it starts in 1994. I argue that one must use the interest rate data as one of the observables in the estimation to better identify the parameters of the model characterizing the international financial frictions. However, I exclude the post 2001 period from the 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. Given that one of the objectives of this paper is to join to the discussion of the role of permanent technology shocks in emerging markets, estimating the model between 1983Q1 and 2001Q1 is also desirable because it facilitates the comparison of the model's results with the existent literature which uses quarterly data from 1980s until the beginning of 2000s (see, for example, [Aguiar and Gopinath \(2007\)](#)).

Table 1 presents second moments and the corresponding GMM estimated standard error for g^Y , g^C , g^I , tby and country interest rate. Notably, per-capita consumption growth in Argentina is significantly more volatile than per-capita output growth. Gross investment growth is highly volatile. The trade balance to-output ratio is about as volatile as output growth. The volatility of the (annualized) interest rates at which Argentina borrowed in the international markets in this

period is quite high. The observed correlation between the trade balance-to-output ratio and output growth and between the country interest rate and output growth, is negative and significantly different from zero.

Table 1: Argentina 1983Q1-2001Q3: Summary Statistics

Statistics	g^Y	g^C	g^I	tby	R
Standard Deviation	2.72 (0.42)	3.13 (0.47)	6.03 (0.78)	2.6 (0.26)	5.38 (0.7)
Correlation with g^Y	1.00 -	0.94 (0.008)	0.86 (0.03)	-0.18 (0.07)	-0.25 (0.08)
Correlation with tby	-0.18 (0.07)	-0.15 (0.07)	-0.24 (0.08)	1.00 -	0.90 (0.02)
Correlation with R	-0.25 (0.08)	-0.20 (0.08)	-0.35 (0.09)	0.90 (0.02)	1.00 -
Serial Correlation	0.10 (0.12)	0.18 (0.12)	0.39 (0.09)	0.95 (0.008)	0.93 (0.01)

Notes: 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. R is the interest rate faced by Argentina in the international financial markets. I constructed the real interest rate for Argentina as in [Schmitt-Grohe and Uribe \(2011\)](#). Standard errors are shown in parentheses.

4 Estimation and Evaluation of the Model with Microfounded Financial Frictions

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 2 presents the calibrated parameter values. The risk aversion parameter is set to 2 and the quarterly world risk-free interest rate R^* is set to 1 percent, which are standard values in quantitative business cycle studies. The curvature of labor disutility in the utility function is set to $\psi = 1.6$, which implies a Frisch wage elasticity of labor supply of $1/(\psi - 1) = 1.7$. This is the value frequently used in calibrated versions of small open economy models (e.g. [Mendoza \(1991\)](#) and [Schmitt-Grohe and Uribe \(2003\)](#)).

The share of intermediate goods in gross output M is set to 0.43, which corresponds to the average ratio of intermediate goods to gross production calculated using annual data for Argentina for the period 1993-2005 from the United Nations database. Given M , I set $\alpha = 0.17$ so that the capital income share in value added of the final goods sector matches the standard 30 percent. These

factor shares imply a labor share in gross output of final goods $\gamma = 0.40$, which yields a labor share in value added of 0.7 in line with the standard 70 percent labor share. I assume linear production technology using only labor in the production of domestic intermediate goods. The values ν and ρi as well as factor income shares are taken from [Mendoza and Yue \(2011\)](#).

Table 2: Baseline Calibration

Parameter	Description	Value	Target Statistics
σ	Inverse of IES	2	Standard RBC value
ψ	Elasticity of L_s , $1/(\psi - 1)$	1.6	Labor supply elasticity of 1.7
δ	Depreciation rate of capital	0.2	Average investment ratio of about 17 percent
α	Capital income share	0.17	Standard Capital Share, 30 percent
γ	Labor income share	0.40	Standard Labor Share, 70 percent
η	Intermed. input income share	0.43	Mendoza and Yue (2011)
μ_x	Long-run productivity growth	1.005	GPU (2010)
R^*	Gross risk free foreign interest rate	1%	Standard RBC Value
β	Discount Factor	0.975	Steady state annual spread, 10%
ρi	Home good bias in intermed. goods	0.65	Mendoza and Yue (2011)
ν	Weight of domestic inputs	0.73	Mendoza and Yue (2011)
μ	Monitoring cost	0.075	μ and σ_ω implied by $d^{ss} = 47\%$,
$\sigma_{\omega,ss}$	Std. dev. of the log-normal dist. of ω	0.45	$prem = 10\%$ and C.spread=7%
$p_{z,ss}$	World price of intermed. inputs	1.028	Mendoza(2010) for Mexico

For the 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 spread on public sector debt is about 10 percent annually and the private sector pays an average spread of 7 percent annually in Argentina. The case of Argentina is exceptional in the sense that the effective financing cost of firms is lower on average than the sovereign interest rates (see [Figure 4](#) in Appendix).¹⁰The assumptions on the foreign interest rate, the steady state growth rate and risk premium imply that the value of the discount factor is about 0.975. In order to calibrate the financial frictions of the economy, the steady state leverage ratio of the Argentine firms, d , is set to 47 percent. Using firm level data set with annual balance sheet information for Argentine firms, I report a median debt-to-assets ratio of 47 percent for firms in Argentina (see [Figure 5](#) in Appendix [7.6](#)). The values for μ and $\sigma_{\omega,ss}$, important parameters characterizing the financial frictions in the economy, are obtained in the process of calibrating the leverage ratio, the country spread and a firm-level debt. The implied values are 0.075 for μ and 0.45 for $\sigma_{\omega,ss}$.

¹⁰[Mendoza and Yue \(2011\)](#) compares these numbers for 15 emerging markets and report that except Argentina, China and Russia, the effective financing cost of firms is higher on average than the sovereign interest rates.

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 country risk premium over the period 1983Q1–2001Q3. Specifically, I estimate ten parameters defining the stochastic process of the shocks, and the parameter governing the degree of capital adjustment costs, ϕ . I also estimate five 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.

Table 3: Prior and Posterior Distribution

Parameter	Prior Distribution			Posterior Distribution		
	Prior	Mean	Std	Financial Frictions Model Median	5%	95%
σ_a	IG	0.010	0.015	0.012	0.008	0.018
ρ_a	B	0.5	0.2	0.625	0.44	0.81
σ_{μ_X}	IG	0.010	0.015	0.034	0.023	0.045
ρ_{μ_X}	B	0.5	0.2	0.21	0.11	0.34
σ_v	IG	0.10	0.15	0.0404	0.015	0.10
ρ_v	B	0.5	0.2	0.732	0.24	0.97
σ_s	IG	0.010	0.015	0.004	0.001	0.009
ρ_s	B	0.5	0.2	0.58	0.14	0.85
ϕ	G	5	5	2.7473	1.72	4.78
σ_{σ_ω}	IG	0.30	0.42	0.1654	0.11	0.21
ρ_{σ_ω}	B	0.5	0.2	0.9858	0.97	0.99

Notes: Estimation is based on Argentine data from 1980Q3 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 and are omitted from the table for brevity.

4.1 Evaluating Model Fit

As it is difficult to quantify prior beliefs for the shock processes, I selected the priors for the autocorrelation and standard deviation of the exogenous shocks with the following criteria in mind. First, all standard deviations of the innovations to the shock processes are assumed to follow an inverse-gamma distribution with five degrees of freedom. For autocorrelation parameters, I adopt beta distributions which have a mean equal to 0.5 and a standard deviation of 0.2. These priors allow for a quite dispersed range of values. Table 3 presents key statistics of the prior and posterior distributions, along with the 5 percent and 95 percent intervals. I highlight the following features: First, when the posterior distributions are compared with the prior distributions, it is evident that

all parameters of the model, except for those related to the stochastic process for the government spending shock, are well identified. In particular, the posterior distributions of the parameters σ_{μ_X} and ρ_{μ_X} defining the nonstationary productivity shock are quite tight, with 95 percent probability intervals of (0.023, 0.045) and (0.11, 0.34), respectively. Second, the median of σ_{μ_X} takes the value 0.034 while the median of the standard deviation of nonstationary technology shocks, σ_a is 0.012. As will be evident when I present the variance decomposition results, this suggests that the role of trend shocks is more pronounced under the present specification. Third, the estimated volatility of the time varying uncertainty shocks, σ_{σ_ω} , is quite high in Argentina and the shock is very persistent.

Table 4: Second Moments: Model vs Data

Statistics	g^Y	g^C	g^I	tby	$prem$
Standard Deviation					
- Model	2.74	3.01	4.90	1.5	6.1
- Data	2.72	3.13	6.03	2.6	4.43
Correlation with g^Y					
- Model	1.00	0.92	0.71	-0.3	-0.15
- Data	1.00	0.94	0.86	-0.18	-0.24
Serial Correlation					
- Model	0.17	0.11	-0.05	0.50	0.82
- Data	0.10	0.19	0.39	0.95	0.92

Table 4 displays second moments predicted by the model with endogenous financial frictions. 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 generate countercyclical interest rates and key business cycle moments. 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 trade balance -to output ratio is countercyclical.

Table 5 presents the variance decomposition predicted by the model with financial frictions. I want to highlight four important results regarding the sources of macroeconomic fluctuations in emerging markets. First, time varying uncertainty in the firm specific productivity explains more than 70 per cent of the variances of the trade balance and of the country risk premium. However, its contribution to output and consumption volatility is limited.

Table 5: Variance Decomposition

Shock	g^Y	g^C	g^I	tby	$prem$
Stationary Technology, σ_a	41.74	32.42	25.44	6.20	12.96
Nonstationary Technology, σ_{μ_x}	51.33	56.78	35.34	21.23	9.88
Uncertainty, σ_{σ_ω}	6.62	8.43	36.4	71.41	72.87
Perence, σ_ν	0.33	2.36	2.80	1.15	4.27

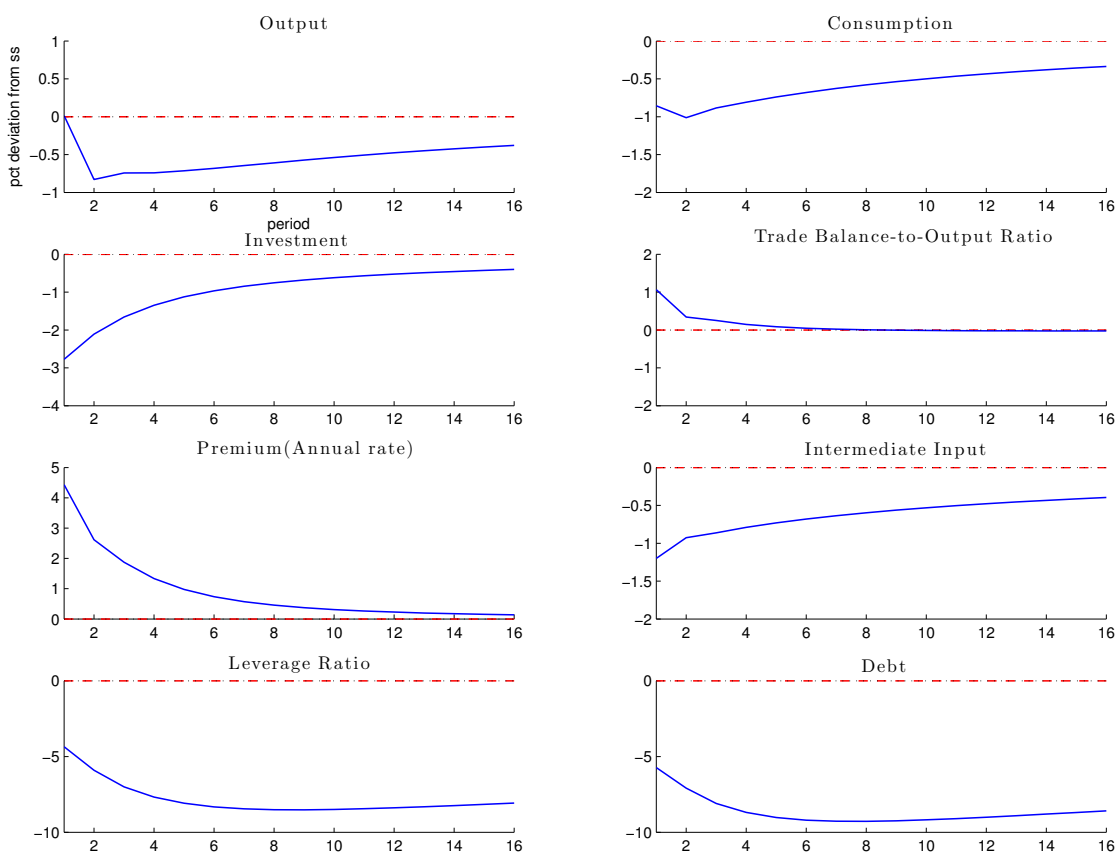
Notes: The estimated contribution of all five measurement errors and the government spending shock (not shown) is negligible for all five variables.

Second, the predicted contribution of nonstationary productivity shocks to explaining output variations falls between the high estimate (80 percent) reported by [Aguiar and Gopinath \(2007\)](#) and the low estimates (5 percent) reported by [Garcia-Cicco et al. \(2010\)](#). Unlike [Garcia-Cicco et al. \(2010\)](#), shocks to nonstationary productivity are well identified in this model. Therefore, I argue that introducing microfounded financial frictions and disciplining the estimation with the data on country risk premium significantly helps the model to identify between trend and stationary technology shocks. Third, preference shocks identified in [Garcia-Cicco et al. \(2010\)](#) as the significant source of fluctuations for consumption are negligible. The endogenous nature of the country risk premium accompanied with shocks to trend productivity are sufficient for the model to match the consumption process seen in the data. Disturbances in productivity, whether permanent or temporary, contribute to the explanation of the country risk premium in this economy. Finally, I find that domestic spending shocks are estimated to have a negligible role in explaining business cycles.

Figure 2 plots the impulse response of selected macroeconomic variables in the model to a one standard deviation shock to Uncertainty. The transmission mechanism of the shock, as shown by those figures, can be broadly described as follows. Increase in the standard deviation of the idiosyncratic productivity of the firm will lead them to expect higher premium in the future. It 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 higher cost of borrowing firms will reduce the amount of debt they are obtaining. In addition to that firms will also reduce the amount of intermediate inputs used in the production because they are now more expensive to finance. In order to reduce their leverage firms have to reduce the dividend distributed to the households. This leads them to reduce consumption expenditure. Investment also falls through a nonarbitrage condition between the returns to physical capital and to investing in the stocks of

the firm. As the consumption decreases, households' demand for domestic goods decreases. This leads firms to reduce their demand for labor. Combined with the decline in the purchases of the intermediate inputs, output contracts in the economy. In sum, in response to unexpected shock to uncertainty, both higher cost effect (financing intermediate inputs are more costly now) and lower demand effect contribute to the decline in the output in the economy.

Figure 2: Impulse Responses to Uncertainty Shock



5 Estimation and Evaluation of the Reduced Form Financial Frictions Model

This section estimates and evaluates the performance of the reduced form financial frictions model proposed by [Garcia-Cicco et al. \(2010\)](#) in terms of its ability to match the statistical properties of the interest rates and other keys moments of the emerging market data. To this end, I augment the [Garcia-Cicco et al. \(2010\)](#) model with working capital loans and then estimate the two versions of the model: with and without the country interest rates in the estimation. Here I discuss only the calibration and estimation of the model for Argentina between 1983Q1-2001Q3. For the details of the model, the reader should refer to [Garcia-Cicco et al. \(2010\)](#).

Table 6: Calibration

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

The time unit in the model is meant to be one quarter. Table 6 presents the calibrated parameter values. I set the parameter \bar{d} to induce a small steady-state trade balance– to-output ratio of about 0.41 percent, as observed on average in Argentina over the period 1983Q1–2001Q3. The value assigned to the depreciation rate δ implies an average investment ratio of about 17 percent, which is in line with the average value observed in Argentina between 1983Q1–2001Q3. The value assumed for the discount factor β implies a relatively high average real interest rate of 10 percent per annum, which is consistent with the interest rate observed in Argentina over the period 1983Q1–2001Q3. I set the parameter α , which determines the average capital income share, at 0.32, a value commonly used in the related literature. I set $\theta = 2.33$, to ensure that in the steady state households allocate about one-third of their time to market work. The parameter γ , defining the curvature of the period utility function, takes the value 2, which is standard in related business-cycle studies. Finally, ω is calibrated at 1.6, which implies a labor-supply elasticity of 1.7. Gross long-run growth rate of the economy is set to $\mu_X = 1.005$.

I estimate the remaining parameters of the model using Bayesian methods and Argentine data on output growth, consumption growth, investment growth, and the trade balance–to-output ratio

over the period 1983Q1–2001Q3. Specifically, I estimate five structural parameters, namely, the four parameters defining the stochastic process of the productivity shocks, σ_A , ρ_A , σ_{μ_X} , and ρ_{μ_X} and the parameter governing the degree of capital adjustment costs, ϕ . I also estimate four nonstructural parameters representing the standard deviations of i.i.d. measurement errors on the observables. Table 7 presents key statistics of the prior and posterior distributions when the model is estimated with exactly same four time series used in Garcia-Cicco et al. (2010) (left column) and when the model is estimated with 5 observables including interest rate into the observable set (right column).

Table 7: Prior and Posterior Distributions - GPU(2010) Model

Parameter	Posterior Distribution					
	GPU w/ 4 observables			GPU w/ 5 observables		
	5%	Median	95%	5%	Median	95%
σ_{μ_X}	0.0010	0.0042	0.01	0.010	0.0159	0.022
ρ_{μ_X}	0.21	0.51	0.86	0.65	0.764	0.90
σ_A	0.012	0.0144	0.017	0.0076	0.0113	0.0153
ρ_A	0.93	0.96	0.98	0.8	0.88	0.94
ϕ	7.62	10.16	14.0	8.2	10.64	13.0
σ_ν	0.06	0.096	0.20	0.03	0.055	0.10
ρ_ν	0.81	0.914	0.99	0.37	0.69	0.98
σ_s	0.002	0.007	0.0230	0.0015	0.0064	0.0191
ρ_s	0.13	0.51	0.88	0.13	0.50	0.87
σ_{μ_R}	0.003	0.0049	0.007	0.0027	0.0034	0.0043
ρ_{μ_R}	0.95	0.974	0.99	0.95	0.98	0.99
ψ	0.09	0.161	0.27	0.10	0.154	0.21
η	0.33	0.5228	0.70	0.31	0.49	0.68

Notes: Estimation is based on Argentine data from 1980Q3 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 and omitted from the table for brevity.

Table 8 displays second moments predicted by the model with financial frictions. The table shows both RBC model augmented with trend shock and reduced form financial frictions model perform similarly in explaining observed movements in output and consumption. Reduced form financial frictions model significantly improves along matching the statistical properties of trade-balance-to output ratio. However, both models perform poorly in matching the interest rate process seen in the data. In particular, the interest rate predicted by these models is either acyclical or procyclical while it is countercyclical in the data.

Table 8: Second Moments: Data vs Model

Statistics	g^Y	g^C	g^I	tby	R
Standard Deviation					
- RBC model	2.79	3.07	5.37	10.2	0.72
- GPU model w/ 4 obs	2.62	3.04	5.36	1.67	4.36
- GPU model w/ 5 obs	2.90	3.17	5.16	1.55	4.03
- Data	2.72	3.13	6.03	2.6	5.38
Correlation with g^Y					
- RBC model	1.00	0.99	0.94	-0.07	0.04
- GPU model w/ 4 obs	1.00	0.92	0.70	-0.04	-0.01
- GPU model w/ 5 obs	1.00	0.94	0.83	-0.13	0.10
- Data	1.00	0.94	0.86	-0.18	-0.25

Finally, Table 9 presents the variance decomposition predicted by the model with frictionless RBC and financial frictions. The most remarkable result that emerges from this exercise is that there is significant disagreement in the literature regarding the contribution of nonstationary productivity shocks to business cycles.

Table 9: Variance Decomposition Predicted by GPU Model

Shock	g^Y	g^C	g^I	tby	R
Stationary Technology, σ_a					
- RBC model	17.7	9.1	2.6	4.4	4.2
- GPU Model with 4 observables	94.8	78.8	42.3	3.9	18.2
- GPU Model with 5 observables	48.5	34.1	21.3	7.6	10.9
Nonstationary Technology, σ_{μ_x}					
- RBC model	82.3	90.9	97.4	95.6	95.8
- GPU Model with 4 observables	3.9	2.6	1.7	0.5	0.6
- GPU Model with 5 observables	51.1	53.8	53.0	29.5	50.5
Preference, σ_ν					
- RBC model	-	-	-	-	-
- GPU Model with 4 observables	0.47	11.7	9.7	13.4	22.1
- GPU Model with 5 observables	0.05	9.0	2.5	11.9	4.1
Risk Premium, σ_{μ_R}					
- RBC model	-	-	-	-	-
- GPU Model with 5 observables	0.74	6.85	46.2	82.0	59.1
- GPU Model with 5 observables	0.27	3.03	23.2	50.8	34.4

Incorporating the endogenous risk premium and the inclusion of the country risk premium data in the estimation modify inferences about the sources of macroeconomic fluctuations in emerging markets. Without the financial frictions and the country risk premium data, nonstationary technology shock is the main source of aggregate fluctuations. In response to a positive and persistent shock

to productivity growth, current output increases on impact and is expected to continue to grow in the future. This increasing profile for future expected income levels induces households to consume beyond the increase in current output by increasing the debt they obtain from foreign lenders. This result in countercyclical trade balance-to-output ratio and higher consumption volatility relative to income volatility. However, estimated frictionless model implies excessive volatility of trade balance to output ratio.

With reduced form financial frictions and the neglecting of the information on the country risk premium, the data assigns a negligible role to the nonstationary technology shock. Its role is replaced by the stationary technology shock, the consumption preferences shock and the exogenous country risk premium shock. When the economy is hit by a higher consumption preference shock, everyone suddenly wants to consume more, which is partly financed by borrowing in the international markets. A higher demand for funds will in turn lead to a higher interest rates. The exogenous increase in the country risk premium will lead to a higher country interest rate by assumption in the reduced form financial frictions model. Once the model is forced to use information on country risk premium, much of the explanatory power of the consumption preference shock and the country risk premium shock is lost. The estimated standard deviation and the serial correlation of the stationary technology shock also decrease. The role of the nonstationary technology shock increases so that the consumption euler equation fits the data better. However, the estimated reduced form financial frictions model predicts acyclical or procyclical country interest rate. The endogenous risk premium model proposed in this paper (with country interest rate data used in the estimation) predicts that part of the role of the nonstationary shock in the frictionless model is taken up by the time varying uncertainty shock and the model successfully accounts for the interest rate cyclicity seen in the data.

The reduced form financial frictions model in this paper is estimated using quarterly Argentine data. However, [Garcia-Cicco et al. \(2010\)](#) argue that a drawback of existing studies is the use of short samples to identify permanent shifts in productivity. In order to overcome this difficulty, they used more than one century of Argentine and Mexican data to estimate the structural parameters of a small-open economy real business cycle model. I showed in the [Appendix 7.7](#) that inclusion of country interest rate data into their set of observables in the empirical analysis modifies inferences. To be more specific, the nonstationary technology becomes more important.

6 Conclusion

This paper proposed and estimated 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 showed that its quantitative predictions are in line with observed empirical regularities in emerging markets: the model predicts high, volatile and countercyclical country risk premia; excessive volatility of consumption relative to output and strong countercyclicity of the trade balance to output ratio. This result is significant improvement over the current models of emerging market business cycles, as the interest rate predicted by these models is either acyclical or procyclical.

I investigated the sources of business cycle fluctuations in emerging economies using the estimated model. I find that shocks to nonstationary component of the productivity explain a 50 percent of the unconditional variances of output and consumption, which fall between the number presented in [Aguiar and Gopinath \(2007\)](#) (80 percent) and in [Garcia-Cicco et al. \(2010\)](#) (5 percent). Time varying uncertainty in the firm specific productivity explains more than 70 percent of the variance of trade balance-to-output ratio and country risk premium. Finally, the model predicts that approximately 30 percent of fluctuations in the borrowing spread is explained by domestic macroeconomic shocks.

7 Appendix

7.1 Optimality Conditions of the Household's Problem

The first order conditions of the household's problem are:

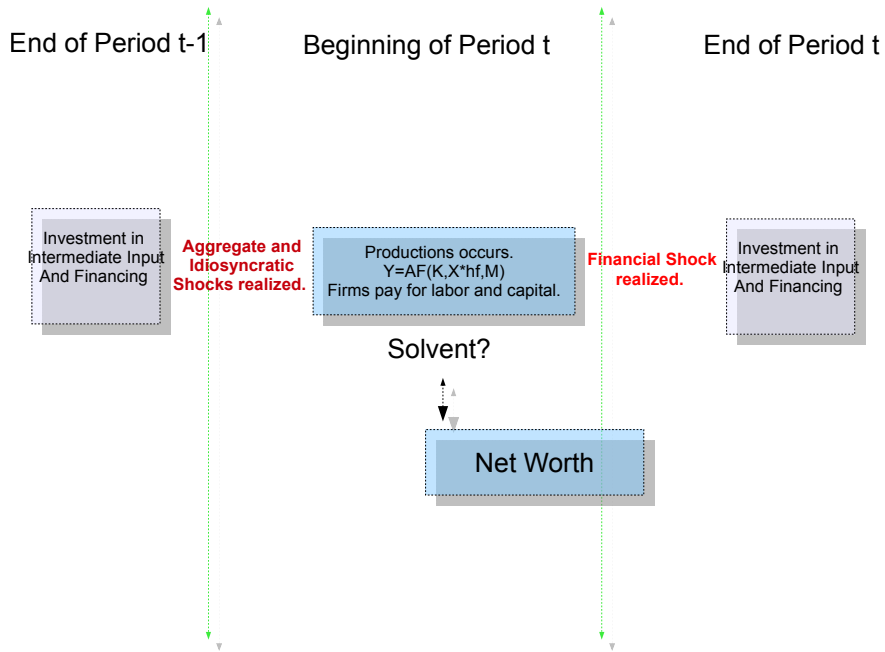
$$\begin{aligned}
 \phi_t \left(\frac{C_t}{X_{t-1}} - \theta \psi^{-1} h_t^\psi \right)^{-\sigma} &= \lambda_t \\
 \frac{\beta}{\mu_{x,t}^\sigma} R_t E_t \{ \lambda_{t+1} \} &= \lambda_t \\
 \left(\frac{C_t}{X_{t-1}} - \theta \psi^{-1} h_t^\psi \right)^{-\sigma} (\theta h_t^{\psi-1}) &= \lambda_t \frac{W_t}{X_{t-1}} \\
 \frac{\beta}{\mu_{x,t}^\sigma} E_t \lambda_{t+1} \left\{ R_{k,t+1} + 1 - \delta_{t+1} + \varphi \left(\frac{K_{t+2}}{K_{t+1}} \right) \left(\frac{K_{t+2}}{K_{t+1}} - \mu_x \right) - \frac{\varphi}{2} \left(\frac{K_{t+2}}{K_{t+1}} - \mu_x \right)^2 \right\} &= \lambda_t \left[1 + \varphi \left(\frac{K_{t+1}}{K_t} - \mu_x \right) \right]
 \end{aligned}$$

7.2 Sequence of Events for Firm's Problem

1. Firm starts the period t with the intermediate inputs purchased in the previous period, M_{t-1} ; and financial contract with the foreign lenders, $B_{t-1}, R_{B,t-1} \bar{\omega}_t$.
2. The exogenous state vector of aggregate and idiosyncratic productivity shocks, $(A_t, \mu_{x,t}, \nu_t, \omega_t^i)$, is realized. Perfectly competitive firm observes real wages, W_t and real return on capital, $R_{k,t}$. Given the available intermediate inputs, M_{t-1} , purchased in the previous period and becoming productive at time t , $(\omega_t^i M_{t-1})$, the firm hires labor and rents capital (h_t, K_t) from households, produces and sells output, Y_t , conditional on the realization of shocks. The firm pays for labor and capital inputs hired from households. The solvent firm pays its previous debt, $R_{B,t-1} B_{t-1}$ and retains N_t units of net worth. If the firm is not solvent, the foreign lender takes the residual profit after paying the monitoring cost, μ . I assume that exactly the same number of firms is created to replace insolvent firms, with a level of net worth, N_t , transferred from the households. The firm's net worth, N_t is the only variable characterizing the firm at time t and nothing else about its history is relevant.
3. The standard deviation of the idiosyncratic productivity of the firm at time $t+1$ (ω_{t+1}^i) , $\sigma_{\omega,t}$, is revealed at the end of period t right before the investment decisions are made. The firm makes investment and financing decision, $(M_t, B_t, R_{B,t}, \bar{\omega}_{t+1})$, conditional on the realization

of the shock, $\sigma_{\omega,t}$ for a given level of net worth, N_t . The firm finances the purchase of the intermediate input partly with its own net worth available at the end of period t , N_t , and partly by borrowing from risk neutral foreign lenders, B_t ; i.e, the firm borrows the difference between the value of its net worth, N_t and the expenditure in the intermediate inputs, $p_{m,t}M_t$. The balance sheet of the firm is then given as $B_t = p_{m,t}M_t - N_t$. The standard debt contract is defined by the contractual interest rate, $R_{B,t}$ and state contingent cutoff level of productivity for the entrepreneurs' productivity shock, $\bar{\omega}_{t+1}$. The firm then chooses N_t to maximize the expected future profits.¹¹

Figure 3: Timing of the Events



¹¹The shock $\sigma_{\omega,t}$ has an impact on the external finance premium paid at time $t + 1$. Also, note that cumulative distribution function (cdf) of idiosyncratic shock ω_{t+1}^i , $F(\omega_{t+1}^i; \sigma_{\omega,t})$ is time variant and subject to uncertainty shock.

7.3 Derivations for Return on Intermediate Input Equation

Given the CRS assumption, $\gamma + \alpha + \eta = 1$, the return on intermediate input, (14), can be written as:

$$R_{m,t+1}^i = \frac{\eta A_{t+1} \left(\frac{K_{t+1}^i}{M_t^i} \right)^\alpha \left(\frac{X_{t+1} h_{t+1}^{f,i}}{M_t^i} \right)^\gamma (\omega_{t+1}^i)^\eta}{p_{m,t}} \quad (41)$$

Defining $\tilde{h}_{t+1}^i = \frac{X_{t+1} h_{t+1}^{f,i}}{M_t^i}$ and $\tilde{k}_{t+1}^i = \frac{K_{t+1}^i}{M_t^i}$ and rewriting (41), I then get the following expression for return on intermediate inputs,

$$R_{m,t+1}^i = \frac{\eta A_{t+1} \left(\tilde{k}_{t+1}^i \right)^\alpha \left(\tilde{h}_{t+1}^i \right)^\gamma (\omega_{t+1}^i)^\eta}{p_{m,t}} \quad (42)$$

By using labor and capital demand equations, (10) and (11) respectively, I can express \tilde{h}_{t+1}^i and \tilde{k}_{t+1}^i as a function of aggregate variables common to all firms and idiosyncratic productivity shock as the following:

From labor demand equation, (10),

$$\tilde{h}_{t+1}^i = \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\gamma}} \left(\tilde{k}_{t+1}^i \right)^{\frac{\alpha}{1-\gamma}} \quad (43)$$

From capital demand equation, (11),

$$\tilde{k}_{t+1}^i = \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1}{1-\alpha}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\alpha}} \left(\tilde{h}_{t+1}^i \right)^{\frac{\gamma}{1-\alpha}} \quad (44)$$

Substituting (43) into (44), I get the following expression for \tilde{k}_{t+1}^i :

$$\begin{aligned}
\tilde{k}_{t+1}^i &= \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1}{1-\alpha}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\alpha}} \left(\left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\gamma}} (\tilde{k}_{t+1}^i)^{\frac{\alpha}{1-\gamma}} \right)^{\frac{\gamma}{1-\alpha}} \\
\tilde{k}_{t+1}^i &= \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1}{1-\alpha}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{(1-\gamma)(1-\alpha)}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\alpha} + \frac{\gamma}{(1-\gamma)(1-\alpha)}} (\tilde{k}_{t+1}^i)^{\frac{\alpha\gamma}{(1-\gamma)(1-\alpha)}} \\
(\tilde{k}_{t+1}^i)^{\frac{\gamma}{(1-\gamma)(1-\alpha)}} &= \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1}{1-\alpha}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{(1-\gamma)(1-\alpha)}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{(1-\alpha)(1-\gamma)}} \\
(\tilde{k}_{t+1}^i) &= \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1-\gamma}{\eta}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{\eta}} \\
\tilde{k}_{t+1}^i &= \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1-\gamma}{\eta}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} \omega_{t+1}^i
\end{aligned}$$

By using \tilde{k}_{t+1}^i equation just derived, I can express the \tilde{h}_{t+1}^i as the following:

$$\begin{aligned}
\tilde{h}_{t+1}^i &= \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma}} ((\omega_{t+1}^i)^\eta)^{\frac{1}{1-\gamma}} \left(\left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1-\gamma}{\eta}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} \omega_{t+1}^i \right)^{\frac{\alpha}{1-\gamma}} \\
\tilde{h}_{t+1}^i &= \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma} + \frac{\gamma\alpha}{\eta(1-\gamma)}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha}{\eta}} (\omega_{t+1}^i)^{\frac{\eta}{1-\gamma} + \frac{\alpha}{(1-\gamma)}} \\
\tilde{h}_{t+1}^i &= \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma} + \frac{\gamma\alpha}{\eta(1-\gamma)}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha}{\eta}} \omega_{t+1}^i
\end{aligned}$$

I will now substitute the derived values for \tilde{h}_{t+1}^i and \tilde{k}_{t+1}^i into (42),

$$\begin{aligned}
R_{m,t+1}^i &= \frac{\eta (\omega_{t+1}^i)^\eta \left(\left(\frac{\gamma}{W_{t+1}} \right)^{\frac{1}{1-\gamma} + \frac{\gamma\alpha}{\eta(1-\gamma)}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha}{\eta}} \omega_{t+1}^i \right)^\gamma \left(\left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{1-\gamma}{\eta}} \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} \omega_{t+1}^i \right)^\alpha}{p_{m,t}} \\
R_{m,t+1}^i &= \omega_{t+1}^i \left(\frac{\eta \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{1-\gamma} + \frac{\gamma^2\alpha}{\eta(1-\gamma)} + \frac{\alpha\gamma}{\eta}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha\gamma}{\eta} + \frac{\alpha(1-\gamma)}{\eta}}}{p_{m,t}} \right) \\
R_{m,t+1}^i &= \omega_{t+1}^i \left(\frac{\eta \left(\frac{\gamma}{W_{t+1}} \right)^{\frac{\gamma}{\eta}} \left(\frac{\alpha}{R_{k,t+1}} \right)^{\frac{\alpha}{\eta}}}{p_{m,t}} \right) \\
R_{m,t+1}^i &= \omega_{t+1}^i R_{m,t+1}
\end{aligned}$$

7.4 Solving Firm's Profit Maximization Problem

This section solves the firm's profit maximization problem.

The solvent and insolvent firms choose M_t^i (intermediate inputs), $\bar{\omega}_{t+1}^i$ (default threshold), N_t^i (net worth) and $R_{B,t}^i$ (loan rate) to maximize

$$\Lambda_t [(\omega_t^i - \bar{\omega}_t^i)R_{m,t}p_{m,t-1}M_{t-1}^i - N_t^i] + \beta E_t \Lambda_{t+1} \{[1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})]R_{m,t+1}p_{m,t}M_t^i - N_{t+1}^i\}$$

OR

$$\Lambda_t [-N_t^i] + \beta E_t \Lambda_{t+1} \{[1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})]R_{m,t+1}p_{m,t}Z_t^i - N_{t+1}^i\}$$

respectively, subject to

$$\begin{aligned} E_t \{ \Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i \} &= R_t^* [p_{m,t} M_t^i - N_t^i] \\ \bar{\omega}_{t+1}^i R_{m,t+1} p_{m,t} M_t^i &= R_{B,t}^i [p_{m,t} M_t^i - N_t^i] \end{aligned}$$

I will eliminate the second constraint by substituting $\bar{\omega}_t^i$ with $\frac{R_{B,t-1}^i [p_{m,t-1} M_{t-1}^i - N_{t-1}^i]}{R_{m,t} p_{m,t-1} M_{t-1}^i}$ and $\bar{\omega}_{t+1}^i$ with $\frac{R_{B,t}^i [p_{m,t} M_t^i - N_t^i]}{R_{m,t+1} p_{m,t} M_t^i}$. Note that the contract is “Standard Debt Contract,” which means that the default threshold, $\bar{\omega}_{t+1}^i$ is state contingent but the contractual interest rate, $R_{B,t}^i$ is not. I denote the lagrange multiplier for the participation constraint, (24), by φ_t^i .

The lagrangian of the problem can then be written as follows:

$$\begin{aligned} \mathcal{L} &= \Lambda_t [\textit{irrelevant} - N_t^i] + \beta E_t \Lambda_{t+1} \left\{ [1 - \Gamma \left(\frac{R_{B,t}^i [p_{m,t} M_t^i - N_t^i]}{R_{m,t+1} p_{m,t} M_t^i}; \sigma_{\omega,t} \right)] R_{m,t+1} p_{m,t} M_t^i - N_{t+1}^i \right\} \\ &+ \varphi_t^i E_t \left\{ \Omega \left(\frac{R_{B,t}^i [p_{m,t} M_t^i - N_t^i]}{R_{m,t+1} p_{m,t} M_t^i}; \sigma_{\omega,t} \right) R_{m,t+1} p_{m,t} M_t^i - R_t^* [p_{m,t} M_t^i - N_t^i] \right\} \end{aligned}$$

First order conditions of the problem with respect to M_t^i , $R_{B,t}^i$ and N_t^i , respectively are as follows:

M_t :

$$\begin{aligned} 0 &= \beta E_t \Lambda_{t+1} \{ [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] R_{m,t+1} p_{m,t} - \Gamma_{\omega}(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t(\cdot) \} \\ &+ \varphi_t^i E_t \{ \Omega_{\omega}(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t(\cdot) \} \end{aligned}$$

where $(\cdot) = \left(\frac{R_{B,t} p_{m,t} (R_{m,t+1} p_{m,t} M_t^i) - R_{B,t} [p_{m,t} M_t^i - N_t^i] (R_{m,t+1} p_{m,t})}{(R_{m,t+1} p_{m,t} M_t^i)^2} \right)$

$R_{B,t}$:

$$0 = -\beta_t E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i \left(\frac{[p_{m,t} M_t^i - N_t^i]}{(R_{m,t+1} p_{m,t} M_t^i)} \right) + \varphi_t^i E_t \left\{ \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i \left(\frac{[p_{m,t} M_t^i - N_t^i]}{(R_{m,t+1} p_{m,t} M_t^i)} \right) \right\}$$

N_t :

$$0 = -\Lambda_t + \beta E_t \Lambda_{t+1} \left\{ \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i \left(\frac{R_{B,t+1}^i}{(R_{m,t+1} p_{m,t} M_t^i)} \right) \right\} - \varphi_t^i E_t \left(\Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i \left(\frac{R_{B,t+1}^i}{(R_{m,t+1} p_{m,t} M_t^i)} \right) + R_t^* \right)$$

Rearranging, first order conditions can be written as

Z_t :

$$0 = \beta E_t \Lambda_{t+1} \left\{ [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] R_{m,t+1} p_{m,t} - \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \left(\frac{R_{B,t}^i N_t^i}{M_t^i} \right) \right\} + \varphi_t^i E_t \left\{ (\Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} - R_t^* p_{m,t}) + \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) \left(\frac{R_{B,t}^i N_t^i}{M_t^i} \right) \right\}$$

$$R_{B,t}: 0 = -\beta E_t \Lambda_{t+1} \left\{ \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) [p_{m,t} M_t^i - N_t^i] \right\} + \varphi_t^i E_t \left\{ \Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) [p_{m,t} M_t^i - N_t^i] \right\}$$

$$N_t: 0 = -\Lambda_t + \beta E_t \Lambda_{t+1} \left\{ \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{B,t}^i \right\} - \varphi_t^i E_t \left(\Omega_\omega(\bar{\omega}_{t+1}; \sigma_{\omega,t}) R_{B,t}^i + R_t^* \right)$$

From the first order condition wrt $R_{B,t}^i$, I can write the lagrange mutliplier of the participation constraint φ_t^i , as the following

$$\varphi_t^i = \frac{\beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})} \quad (45)$$

Using the definition of φ_t^i , I can re-write the first order condition wrt N_t^i and get the following equation:

$$0 = -\Lambda_t + \beta E_t \Lambda_{t+1} \left\{ \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{B,t}^i \right\} - \frac{\beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})} E_t \Omega_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{B,t}^i + \frac{\beta E_t \Lambda_{t+1} \Gamma_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})}{E_t \Omega_\omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})} R_t^*$$

Rearranging it further, I get:

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

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:

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

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

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:

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

Finally, I rearrange the first order condition wrt M_t^i after imposing the definition of φ_t^i and I get the following equation:

$$E_t \lambda_{t+1} R_{m,t+1} [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] p_{m,t} M_t^i + E_t \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) [E_t \Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) R_{m,t+1} p_{m,t} M_t^i - R_t^* p_{m,t} M_t^i] = 0$$

Using the foreign lender's participation constraint, this equation can be further simplified to:

$$E_t \lambda_{t+1} \frac{R_{m,t+1}}{R_t^*} [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] = E_t \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \frac{N_t}{p_{m,t} M_t}$$

Optimality conditions of the firm's problem under the Standard Debt Contract are then given by the following equations:

$$\begin{aligned} E_t \lambda_{t+1} \frac{R_{m,t+1}}{R_t^*} [1 - \Gamma(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})] &= E_t \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \frac{N_t}{p_{m,t} M_t^i} \\ \frac{R_t}{R_t^*} E_t \lambda_{t+1} &= E_t \{ \lambda_{t+1} \rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \} \\ E_t \Omega(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) \frac{R_{m,t+1}}{R_t^*} p_{m,t} M_t^i &= [p_{m,t} M_t^i - N_t^i] \end{aligned}$$

for $t = 0, 1, 2, \dots, \infty$ for equations, (33) and (34), and for $t = -1, 0, 1, 2, \dots, \infty$ for equation (35). I can re-write $\rho(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})$ in terms of default probabilities by taking the derivative of $\Gamma(\cdot)$ and $\Omega(\cdot)$ 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 $\Omega_{\omega}(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) = 1 - F(\bar{\omega}_{t+1}^i; \sigma_{\omega,t}) - \mu \bar{\omega}_{t+1}^i F_{\omega}(\bar{\omega}_{t+1}^i; \sigma_{\omega,t})$.¹² Then, I have:

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

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. That is so because, ex-ante, all firms are identical. The only variable that will differ across firms is the amount of dividend actually distributed to the shareholders, which will absorb all of the idiosyncratic shock. This implies that the above relationships can all be expressed in aggregate terms.

7.5 Deriving Resource Constraint

$$C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + B_t^d - \frac{B_{t+1}^d}{R_t} = W_t h_t + R_{k,t} K_t + \Phi_t^f + \Phi_t^m$$

¹² $F(\cdot)$ denotes cdf and $F_{\omega}(\cdot)$ denotes the derivative of cdf of the idiosyncratic shock, ω^i wrt $\bar{\omega}$.

Using the aggregate (real) profits distributed to households,

$$\Phi_t^f = (1 - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t}))R_{m,t}p_{m,t-1}M_{t-1} - N_t$$

and the CRS assumption, I simplify the intertemporal budget constraint of the household as follows:

$$\begin{aligned} C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t &= W_t h_t^f + W_t h_t^m + R_{k,t} K_t + \{(1 - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t}))R_{m,t}p_{m,t-1}M_{t-1} - N_t\} + \Phi_t^m \\ &= Y_t - R_{m,t}p_{m,t-1}M_{t-1} + (1 - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t}))R_{m,t}p_{m,t-1}M_{t-1} - N_t + W_t h_t^m + \Phi_t^m \\ &= Y_t - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t})R_{m,t}p_{m,t-1}M_{t-1} - N_t + p_t^H M_t^H \end{aligned}$$

I rearrange and finally impose balance of payments identity to get the resource constraints of the economy (note that $B_{t+1}^d = 0$ for t – domestic bonds exist in zero supply in equilibrium):

$$\begin{aligned} C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t &= Y_t - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t})R_{m,t}p_{m,t-1}M_{t-1} - N_t + p_t^H M_t^H \\ C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + p_{m,t}M_t &= Y_t - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t})R_{m,t}p_{m,t-1}M_{t-1} + (p_{m,t}M_t - N_t) + p_t^H M_t^H \\ C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + p_{m,t}M_t + NX_t &= Y_t + NX_t - \Gamma(\bar{\omega}_{t+1}; \sigma_{\omega,t})R_{m,t}p_{m,t-1}M_{t-1} + B_t + p_t^H M_t^H \\ C_t + I_t + \frac{\varphi}{2} \left(\frac{K_{t+1}}{K_t} - \mu_X \right)^2 K_t + p_{m,t}M_t + NX_t &= Y_t + p_t^H M_t^H \end{aligned}$$

7.6 Empirical Regularities in Emerging Markets: The Case of Argentina

Figure 4: Firm Borrowing Spread in Argentina: Annualized 1994Q1-20010Q4

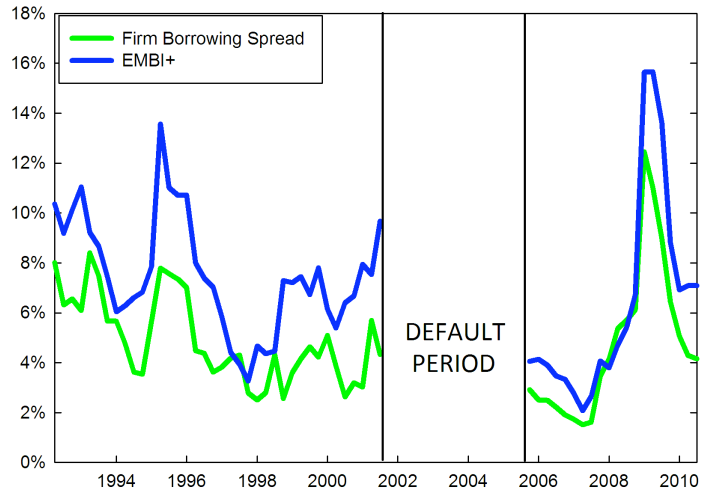
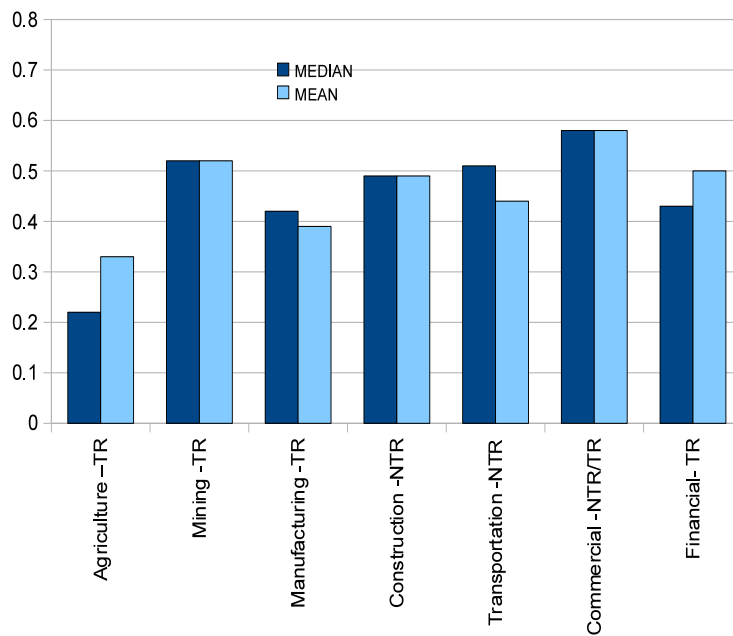


Figure 5: Leverage Ratio of Argentine Firms in Different Sectors 1993-2009



7.7 GPU (2010) Estimation Results with Annual Data for Argentina 1900-2005

Table 10: Calibration Annual

Parameter	γ	δ	α	ω	θ	β	d
Value	2	0.1255	0.32	1.6	2.24	0.9224	0.007

Table 11: Estimation Results: Argentina 1900-2005

Parameter	Posterior Distribution							
	Prior Distribution		Financial Frictions Model 4 observables			Financial Frictions Model 5 observables		
	Min	Max	Median	5%	95%	Median	5%	95%
$\mu_{X,ss}$	1	1.03	1.01	1.003	1.017	1.0054	1.00	1.013
σ_{μ_X}	0	0.2	0.0071	0.000	0.027	0.036	0.01	0.06
ρ_{μ_X}	-0.99	0.99	0.35	-0.66	0.83	0.44	0.11	0.74
σ_A	0	0.2	0.033	0.028	0.038	0.0229	0.008	0.0334
ρ_A	-0.99	0.99	0.87	0.79	0.93	0.83	0.53	0.99
ϕ	0	8	4.6	3	6.5	1.8	1.2	2.3
σ_ν	0	1	0.51	0.37	0.8	0.31	0.11	0.75
ρ_ν	-0.99	0.99	0.86	0.74	0.93	0.68	0.48	0.87
σ_s	0	0.2	0.015	0.001	0.05	0.016	0.00	0.05
ρ_s	-0.99	0.99	0.29	-0.73	0.92	0.16	-0.69	0.99
σ_{μ_R}	0	0.2	0.056	0.034	0.08	0.016	0.011	0.021
ρ_{μ_R}	-0.99	0.99	0.91	0.83	0.97	0.90	0.82	0.98
ψ	0	5	2.8	1.3	4.6	0.32	0.1	0.6

Notes: Estimation is based on Argentine data on per capita output, consumption and investment growth and the trade balance-to-output ratio from 1990 to 2005. In the five observables case, interest rate data is included in the estimation (from 1900 to 2001). 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 and omitted from the table for brevity.

Table 12: Variance Decomposition

Shock	g^Y	g^C	g^I	tby	R
Stationary Technology, σ_a					
- 4 observables	84.2	51.3	15.9	1.3	4.2
- 5 observables (w/ R)	44.1	23.8	16.7	4.2	8.1
Nonstationary Technology, σ_{μ_X}					
- 4 observables	7.4	4.3	1.5	0.4	0.09
- 5 observables (w/ R)	51	29.0	23.9	4.9	6.3
Preference, σ_ν					
- 4 observables	5.5	39.1	20.2	19.3	39.9
- 5 observables (w/ R)	0.7	45	3.1	32.4	19.7
Risk Premium, σ_{μ_R}					
- 4 observables	2.9	5.2	62.4	78.9	55.8
- 5 observables (w/ R)	3.7	1.8	56.1	58.3	65.9

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