

# Interest Rates, Leverage, and Business Cycles in Emerging Economies:

## The Role of Financial Frictions

### Online Appendix

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#### A Data

##### A.1 Emerging Economies, National Accounts and Interest Rates

Our list of emerging economies is Argentina, Brazil, Ecuador, Korea, Malaysia, Mexico, Peru, Philippines, South Africa, Thailand, Turkey as well as Chile and Colombia. The latter two countries replaced Israel and the Slovak Republic due to data limitations (relative to Aguiar and Gopinath (2007)). The panel dataset contains information on National Accounts components and EMBI/CEMBI spreads. CEMBI index, which is the Emerging Market Corporate Bond Industrial Spread Over Benchmark Index, contains information on corporations, and it tracks only the liquid, tradable portion of the Emerging Markets USD corporate bond market.

The sources of National Accounts data are the International Monetary Fund's International Financial Statistics. The source of EMBI and CEMBI is Bloomberg.

In all tables and calibrations in this paper, we use output series net of government expenditure, in order to make it consistent with our model. Since EMBI/CEMBI data is reported at different and higher than quarterly frequencies, we took appropriate simple averages. All variables except EMBI/CEMBI were seasonally adjusted using the X-12 filter in Eviews and log-detrended using the HP filter.

National accounts data were computed by deflating the nominal series using the GDP deflator-based inflation.

We broadly follow Neumeier and Perri (2005) in constructing real country interest rates. In particular, they were obtained by subtracting the expected U.S. CPI inflation from the nominal rate. Expected inflation

rate was computed as the average inflation in the current and three preceding months.

Table 1 documents that virtually all emerging countries exhibit a very high comovement between sovereign and corporate measures of risk, with correlations between EMBI and CEMBI spreads ranging between 0.80 and 0.99. This strong comovement provides an empirical validation for our model to be presented below in which risk premia emanate from default in the private rather than the public sector.

Table 1: Correlations between *EMBI* and *CEMBI* spreads in emerging economies.

Country <sup>a</sup>	Period	$\rho(\text{EMBI}, \text{CEMBI})^b$
Brazil	4Q 2003–4Q 2011	0.96 (0.02) <sup>c</sup>
Chile	3Q 2009–4Q 2011	0.99 (0.00)
Colombia	4Q 2007–4Q 2011	0.96 (0.01)
Korea	3Q 2002–2Q 2004	0.98 (0.06)
Malaysia	4Q 2001–4Q 2011	0.98 (0.00)
Mexico	4Q 2001–4Q 2011	0.80 (0.06)
Peru	3Q 2005–4Q 2011	0.95 (0.01)
Philippines	4Q 2009–3Q 2010	0.99 (0.00)
South Africa	4Q 2009–4Q 2011	0.82 (0.10)
Turkey	3Q 2010–4Q 2011	0.88 (0.05)

<sup>a</sup> All series were logged and then HP filtered. Moments and their corresponding standard errors were computed using GMM. <sup>b</sup>  $\rho$  denotes correlation coefficient. <sup>c</sup> Standard errors are reported in brackets.

## A.2 Developed countries, national accounts and interest rates

For developed economies we extend the Neumeier and Perri (2005) dataset in both the number of countries and the period covered. Our extended set matches that of Aguiar and Gopinath (2007). In particular, the developed economies considered are Australia, Austria, Belgium, Canada, Denmark, Finland, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden and Switzerland. We also extend coverage until 3Q 2010. The data for the national accounts come from the Organization for Economic Cooperation and Development (OECD), quarterly national accounts section. We tested the data for any significant seasonal component. Whenever necessary, the data was then deseasonalized using the U.S. Census Bureau X-12 quarterly multiplicative seasonal adjustment method<sup>1</sup>. The OECD reports this series either with a base year or with chained prices. For Belgium, Denmark, Finland, Netherlands, Portugal, Spain and Sweden, we spliced the base year and chained series since neither was available at full length.

<sup>1</sup>Seasonal adjustments were made for the national accounts of Belgium, Finland, Portugal and Sweden.

Table 2: Volatility of main macro variables in emerging economies.

Country <sup>a</sup>	$\sigma(Y)^b$	$\sigma(C)/\sigma(Y)$	$\sigma(I)/\sigma(Y)$	$\sigma(TB)$	$\sigma(R)$
Argentina	4.88 <sup>c</sup> (0.70)	1.24 (0.11)	3.35 (0.51)	3.10 (0.81)	2.20 (0.32)
Brazil	2.36 (0.39)	0.94 (0.11)	3.43 (0.68)	1.04 (0.15)	0.60 (0.10)
Chile	2.29 (0.28)	1.25 (0.23)	3.71 (0.61)	3.83 (0.80)	0.30 (0.05)
Colombia	2.52 (0.53)	0.99 (0.10)	4.55 (0.40)	1.90 (0.37)	0.37 (0.03)
Ecuador	2.34 (0.25)	2.16 (0.36)	8.41 (1.52)	5.71 (0.93)	1.60 (0.31)
Korea	3.52 (0.71)	1.54 (0.12)	3.46 (0.31)	4.15 (1.03)	0.31 (0.07)
Malaysia	3.01 (0.43)	1.47 (0.24)	5.29 (0.40)	4.93 (1.04)	0.39 (0.06)
Mexico	2.85 (0.33)	1.31 (0.18)	2.80 (0.29)	1.59 (0.40)	0.55 (0.12)
Peru	2.21 (0.35)	1.20 (0.16)	4.35 (0.33)	2.24 (0.43)	0.34 (0.04)
Philippines	2.82 (0.40)	0.74 (0.08)	2.82 (0.47)	3.71 (0.66)	0.31 (0.04)
South Africa	1.87 (0.34)	0.93 (0.08)	3.42 (0.40)	1.37 (0.11)	0.32 (0.04)
Thailand	3.20 (0.75)	1.07 (0.10)	4.46 (0.37)	4.23 (0.97)	0.27 (0.05)
Turkey	4.34 (0.44)	0.99 (0.05)	3.77 (0.28)	2.40 (0.30)	0.37 (0.03)

<sup>a</sup> All series were logged (except for *TB*), and then HP filtered. Moments and their corresponding standard errors were computed using GMM. <sup>b</sup>  $\sigma$  denotes standard deviation. <sup>c</sup> Standard deviations are expressed in %. Standard errors are reported in brackets.

Table 3: Correlations of main macro variables with output in emerging economies.

Country <sup>a</sup>	$\rho(TB, Y)^b$	$\rho(C, Y)$	$\rho(I, Y)$	$\rho(R, Y)$
Argentina	-0.66 (0.09) <sup>c</sup>	0.91 (0.02)	0.83 (0.07)	-0.56 (0.12)
Brazil	-0.02 (0.17)	0.73 (0.11)	0.58 (0.15)	-0.36 (0.14)
Chile	0.32 (0.18)	-0.02 (0.17)	0.41 (0.15)	0.04 (0.28)
Colombia	-0.60 (0.16)	0.83 (0.08)	0.81 (0.08)	-0.23 (0.14)
Ecuador	-0.32 (0.24)	0.39 (0.21)	0.63 (0.09)	-0.43 (0.14)
Korea	-0.82 (0.07)	0.90 (0.05)	0.91 (0.02)	-0.67 (0.16)
Malaysia	-0.46 (0.21)	0.49 (0.22)	0.76 (0.07)	-0.52 (0.19)
Mexico	-0.56 (0.15)	0.77 (0.06)	0.79 (0.06)	-0.47 (0.17)
Peru	-0.26 (0.17)	0.30 (0.13)	0.87 (0.05)	-0.34 (0.22)
Philippines	-0.15 (0.16)	0.85 (0.04)	0.22 (0.17)	-0.07 (0.21)
South Africa	-0.22 (0.20)	0.82 (0.07)	0.67 (0.14)	0.07 (0.23)
Thailand	-0.42 (0.20)	0.81 (0.05)	0.75 (0.12)	-0.57 (0.09)
Turkey	-0.48 (0.20)	0.86 (0.05)	0.82 (0.07)	-0.23 (0.18)

<sup>a</sup> All series were logged (except for *TB*), and then HP filtered. Moments and their corresponding standard errors were computed using GMM. <sup>b</sup>  $\rho$  denotes correlation coefficient. <sup>c</sup> Standard errors are reported in brackets.

Consumption is households' final consumption. Whenever household consumption was not available <sup>2</sup>, we used private final consumption, which additionally includes final consumption of non-profit institutions. Investment is gross fixed capital formation. Government spending is government final consumption. Exports are goods and services exports. Imports are goods and services imports. Net exports is constructed as the difference between exports and imports. Gross Domestic Product (GDP) is constructed as the sum of consumption, investment and net exports, so we exclude government spending from GDP.

Following Neumeyer and Perri (2005) we computed the interest rates using data on 90-day corporate commercial papers, call money rates, or interbank lending rates. The data comes from the OECD database, Main Economic Indicators section (except for Switzerland where the source is Global Financial Data). For Australia and New Zealand the interest rate is the 90-day bank bill. For Austria we used the 90-day VIBOR. For Belgium, Denmark, Portugal and Spain it is the 90-day interbank rate. For Canada the nominal interest rate series we used is the 90-day corporate commercial paper. For Finland the interest rate is the 90-day HELIBOR. For Netherlands, from 3Q 1983 to 4Q 1985, we used the nominal interest rate reported by Neumeyer and Perri (2005) and spliced it with the 90-day AIBOR from 1Q 1986 to 2Q 2008. Due to strange behavior of the series after, we dropped the data for Netherlands from 3Q 2008 on. For Norway we used the 90-day NIBOR. The nominal interest rate for Sweden is the rate on 90-day treasuries and for Switzerland it is the 3-month LIBOR.

To calculate the real national accounts we deflated the series using the GDP Deflator (Australia, Austria, Canada and Norway) or the Consumer Price Index (Belgium, Denmark, Finland, Netherlands, New Zealand, Portugal, Spain, Sweden and Switzerland).

The real rate was obtained by subtracting the expected U.S. CPI inflation rate from the nominal interest rate. The expected inflation in period  $t$  was computed as the average of annual inflation in the current and the three preceding months. Finally, the real interest rate is reported in gross terms.

### A.3 Leverage Dataset

The firm-level leverage dataset consists of firms available in the Bloomberg database, for the twelve emerging economies considered, except for Ecuador for which no data was found. We used the data for common stocks and preference stocks with any trading status. We used the data for firms of all non-financial sectors, in particular: basic materials, consumer goods, consumer services, health care, industrials, oil and gas, technology, telecommunications. We then also separately downloaded data for financial firms which include, among others, banks. We only used firms for which the primary exchange listing is the same as the country of domicile. The timing is quarterly, from 3Q 1995 until 1Q 2013. Figure 1 illustrates data availability, i.e.

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<sup>2</sup>Household consumption was not available for Australia, Canada, Netherlands, Portugal and Switzerland.

the number of firms used for a given country. In the graph, each country's observations are measured on both axes. As the number of observations for a country increases beyond 150, the axis switches from the right one to the left one. For the early dates (esp. before 2000), the final series are based frequently only on a few firms and are strongly affected by new firms entering the sample. Therefore they have to be treated with much caution. Series downloaded are: SHORT\_AND\_LONG\_TERM\_DEBT, CUR\_MKT\_CAP, as well as TOT\_DEBT\_TO\_TOT\_ASSETS. Leverage is then defined as

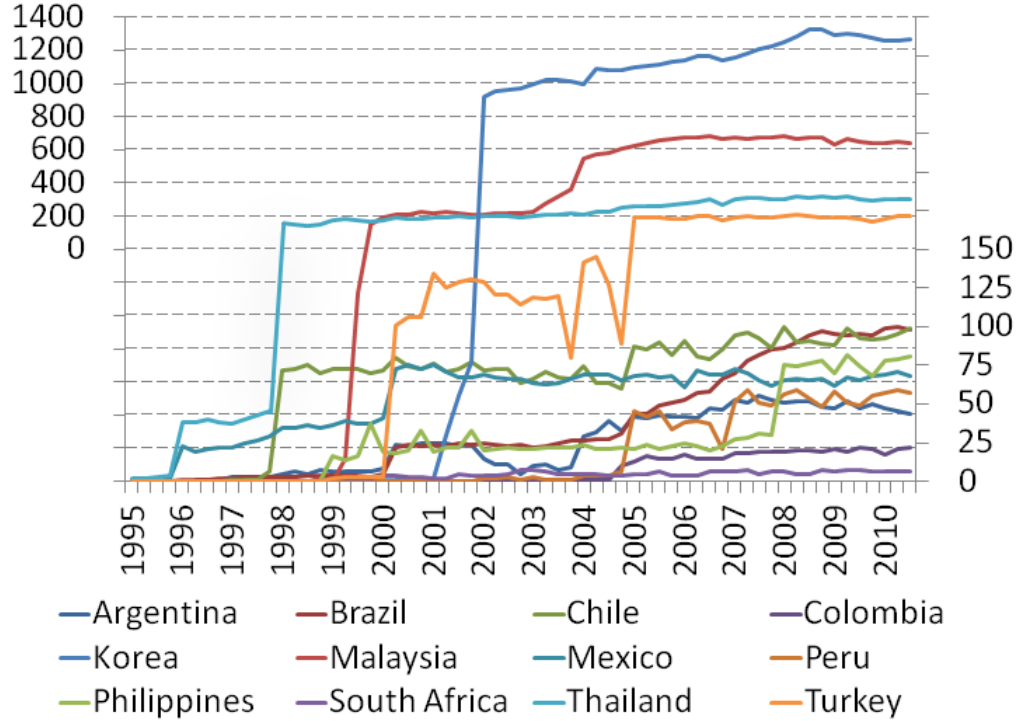


Figure 1: Number of non-financial firms used for the computation of leverage.

$$Lev_{i,t} = \frac{Equity_{i,t} + Debt_{i,t}}{Debt_{i,t}} \quad (A.1)$$

where  $i$  is the country and  $t$  is the quarter. Market leverage proxy is computed using market capitalization (CUR\_MKT\_CAP) as proxy for equity as well as (SHORT\_AND\_LONG\_TERM\_DEBT) as book value of debt. Aggregate leverage for a given year in a given country is then computed as a weighted average, where the weights are the relative market capitalizations of firms, relative to total market capitalization in the given country for that year. In particular, in each period we sum market capitalizations across all (available) firms of a given country.

$$Lev_t = \sum_{i=1}^{N(t)} \frac{Equity_{i,t}}{\sum_{i=1}^{N(t)} Equity_{i,t}} Lev_{i,t}$$

The data is filtered according to the following criteria: A) For market leverage, we take only data where

both market capitalization and debt are available for a particular firm in a particular period. B) In statistical filtering, for each country (considering all periods jointly) we discard the lowest and highest 2.5% of the firm-specific leverage levels. C) In cases where 1 or at most 2 observations for the leverage were missing within the series, we performed linear interpolation. If the gaps were larger, we truncated the leverage series. D) The final filtered leverage series were HP filtered with smoothing parameter 1600.

## A.4 Dividend Dataset

The data for dividends comes from Bloomberg. We use the dividends paid series (ARD\_DIVIDEND\_PD). The data extracted is annual (1995-2012), which has no bearing on our analysis given that we work with ratios. As with leverage, no data for Ecuador was available. The dividend to equity ratio (*DER*) is defined as the ratio of dividends paid in a given period over current market capitalization. This corresponds to the value

$$DPR_t = \frac{C_t^e}{V_t} = \frac{(1 - \phi)V_t}{V_t} = 1 - \phi$$

We extract the firm-level data from Bloomberg following the same criteria as with leverage (points 1.-4.). For each country we obtain an unbalanced panel of  $N$  firms and  $T = 18$  years. For each country separately, we stack the data and drop observations which lie below the lowest 2.5 percentile and above the 97.5 percentile, hence working with the middle 95% of the empirical distributions. Country-wide dividend to equity ratios reported in the paper are simple averages of the filtered observations. The total average is a simple average across 12 countries.

## B Model in levels

Budget constraint

$$\tilde{C}_t - \tilde{D}_{t+1} = \tilde{W}_t H_t - \Psi_t R^* \tilde{D}_t \tag{B.1}$$

Risk premium

$$\Psi_t = \left\{ \tilde{\Psi} + \tilde{\Psi} \left[ \exp \left( \frac{\tilde{D}_t^A}{\tilde{X}_t} - d \right) - 1 \right] \right\} \tag{B.2}$$

Labor supply for GHH preferences

$$\tau \tilde{X}_t H_t^{\gamma-1} = \tilde{W}_t \tag{B.3}$$

Marginal utility of consumption for GHH preferences

$$\tilde{\lambda}_t = \left( \tilde{C}_t - \tau \tilde{X}_t \frac{H_t^\gamma}{\gamma} \right)^{-\sigma} \tag{B.4}$$

Euler with foreign bonds

$$\tilde{\lambda}_t = \beta E_t \Psi_{t+1} R^* \tilde{\lambda}_{t+1} \tag{B.5}$$

Production function

$$\tilde{Y}_t = A_t \tilde{K}_t^\alpha \left( \tilde{X}_t L_t \right)^{1-\alpha} \quad (\text{B.6})$$

Labor aggregation

$$L_t = (H_t^e)^\Omega H_t^{1-\Omega} \quad (\text{B.7})$$

Entrepreneurial labor demand

$$(1-\alpha) \Omega \frac{\tilde{Y}_t}{H_t^e} = \tilde{W}_t^e \quad (\text{B.8})$$

Labor demand

$$(1-\alpha)(1-\Omega) \frac{\tilde{Y}_t}{H_t} = \tilde{W}_t \quad (\text{B.9})$$

Investment funds

$$Q_t \tilde{K}_{i,t+1} = \tilde{N}_{i,t+1} + \tilde{B}_{i,t+1} \quad (\text{B.10})$$

Return on capital *ex post*

$$R_{i,t}^K = \frac{\alpha \frac{\tilde{Y}_{i,t}}{\tilde{K}_{i,t}} + Q_t (1-\delta)}{Q_{t-1}} \quad (\text{B.11})$$

Interest rates

$$E_t \left\{ \frac{R_{t+1}^K}{R^*} \right\} = E_t \left\{ \left( \frac{1}{\Gamma(\bar{\omega}_{t+1}) - \mu G(\bar{\omega}_{t+1})} \right) \left( \frac{\tilde{B}_{t+1}}{Q_t \tilde{K}_{t+1}} \right) \right\} \quad (\text{B.12})$$

Evolution of net worth

$$\tilde{N}_{t+1} = v_t \phi \tilde{V}_t + \tilde{W}_t^e \quad (\text{B.13})$$

Value of firms

$$\tilde{V}_t = R_t^K Q_{t-1} \tilde{K}_t - \left( R^* + \frac{\mu \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega R_t^K Q_{t-1} \tilde{K}_t}{Q_{t-1} \tilde{K}_t - \tilde{N}_t} \right) (Q_{t-1} \tilde{K}_t - \tilde{N}_t) \quad (\text{B.14})$$

Entrepreneurial consumption

$$\tilde{C}_t^e = (1-\phi) \tilde{V}_t \quad (\text{B.15})$$

Motion of capital

$$\tilde{K}_{t+1} = (1-\delta) \tilde{K}_t + \tilde{I}_t - \frac{\varphi}{2} \left( \frac{\tilde{K}_{t+1}}{\tilde{K}_t} - g \right)^2 \tilde{K}_t \quad (\text{B.16})$$

Market clearing

$$\tilde{Y}_t = \tilde{C}_t + \tilde{C}_t^e + \tilde{I}_t + \tilde{N} X_t + \mu \int_0^{\bar{\omega}_t} \omega f(\omega) d\omega R_t^K Q_{t-1} \tilde{K}_t \quad (\text{B.17})$$

Home technology shock

$$\ln A_t = \rho_A \ln A_{t-1} + (1-\rho_A) \ln A + \epsilon_{A,t} \quad (\text{B.18})$$



Optimal omega

$$E_{t-1} \left\{ [1 - \Gamma(\bar{\omega}_t)] \frac{R_t^K}{R^*} + \frac{\Gamma_{\bar{\omega}}(\bar{\omega}_t)}{\Gamma_{\bar{\omega}}(\bar{\omega}_t) - \mu G_{\bar{\omega}}(\bar{\omega}_t)} \left[ \frac{R_t^K}{R^*} (\Gamma(\bar{\omega}_t) - \mu G(\bar{\omega}_t)) - 1 \right] \right\} = 0 \quad (\text{B.19})$$

Price of capital

$$E_t \left\{ (1 - \delta) Q_{t+1} - (1 - \delta) - \varphi \left( \frac{\tilde{K}_{t+2}}{\tilde{K}_{t+1}} - g \right) \frac{\tilde{K}_{t+2}}{\tilde{K}_{t+1}} + \frac{\varphi}{2} \left( \frac{\tilde{K}_{t+2}}{\tilde{K}_{t+1}} - g \right)^2 \right\} \quad (\text{B.20})$$

## C Steady state

First, normalize  $H_t^e \equiv 1 \forall t$  (labor supply of entrepreneurs). Secondly, set  $A = 1$  (technology),  $H = 0.33$  (labor supply) as well as  $R^* = 1.002$  (quarterly foreign interest rate).

The optimal  $\bar{\omega}$  is found by maximizing the return of the entrepreneurs subject to the zero-profit condition of the lenders:

$$\max_{\bar{\omega}, K, \lambda} [1 - \Gamma(\bar{\omega})] R^K Q K - \lambda \{ R^* (QK - N) - [\Gamma(\bar{\omega}) - \mu G(\bar{\omega})] R^K Q K \}$$

with  $Q = 1$ . The first order conditions are:

$$\frac{\partial}{\partial \bar{\omega}} : -\Gamma_{\bar{\omega}}(\bar{\omega}) R^K Q K + \lambda [\Gamma_{\bar{\omega}}(\bar{\omega}) - \mu G_{\bar{\omega}}(\bar{\omega})] R^K Q K = 0$$

$$\frac{\partial}{\partial K} : [1 - \Gamma(\bar{\omega})] R^K Q - \lambda \{ R^* Q - [\Gamma(\bar{\omega}) - \mu G(\bar{\omega})] R^K Q \} = 0$$

$$\frac{\partial}{\partial \lambda} : R^* (QK - N) - [\Gamma(\bar{\omega}) - \mu G(\bar{\omega})] R^K Q K = 0$$

The solution yields:

$$\lambda(\bar{\omega}) = \frac{\Gamma_{\bar{\omega}}(\bar{\omega})}{\Gamma_{\bar{\omega}}(\bar{\omega}) - \mu G_{\bar{\omega}}(\bar{\omega})}$$

$$s(\bar{\omega}) \equiv \frac{\lambda(\bar{\omega})}{1 - \Gamma(\bar{\omega}) + \lambda[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})]} = \frac{R^K}{R^*}$$

and

$$k(\bar{\omega}) \equiv \frac{1 - \Gamma(\bar{\omega}) + \lambda[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})]}{1 - \Gamma(\bar{\omega})} = \frac{QK}{N}$$

The second order conditions which guarantee a maximum are given by the following inequality condition for the bordered hessian:

$$\det H = \begin{vmatrix} 0 & -(\Gamma_{\bar{\omega}} - \mu G_{\bar{\omega}}) R^K K & R^* - (\Gamma - \mu G) R^K \\ -(\Gamma_{\bar{\omega}} - \mu G_{\bar{\omega}}) R^K K & -\Gamma_{\bar{\omega}^2} R^K K + \lambda(\Gamma_{\bar{\omega}^2} - \mu G_{\bar{\omega}^2}) R^K K & -\Gamma_{\bar{\omega}} R^K + \lambda(\Gamma_{\bar{\omega}} - \mu G_{\bar{\omega}}) R^K \\ R^* - (\Gamma - \mu G) R^K & -\Gamma_{\bar{\omega}} R^K + \lambda(\Gamma_{\bar{\omega}} - \mu G_{\bar{\omega}}) R^K & 0 \end{vmatrix} > 0$$

At this point, we have all the necessary parameter values to solve for optimal cutoff  $\bar{\omega}$ . We follow Gertler, Gilchrist and Natalucci (2007), correcting for the fact that we have a deterministic trend and borrowing directly from abroad at  $R^*$ . Specifically, take NSSS versions of equations B.11, B.8 combined with B.13 as well as B.14 combined with the zero-profit condition of lenders to get:

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

Now, we obtain

$$R^K = s(\bar{\omega}) R^* \quad (\text{C.2})$$

Next, find the values for output  $Y$  and capital  $K$  by combining B.6 with B.11 to get

$$Y = \left\{ \left[ \frac{\alpha}{R^K - (1 - \delta)} \right]^\alpha L^{(1 - \alpha)} \right\}^{\frac{1}{1 - \alpha}} \quad (\text{C.3})$$

and

$$K = Y \frac{\alpha}{R^K - (1 - \delta)} \quad (\text{C.4})$$

Investment follows automatically from the assumption in B.16:

$$I = (g - 1 + \delta) K \quad (\text{C.5})$$

By definition, net worth is  $N = K/k(\bar{\omega})$ .

Now, using B.10, lending becomes simply

$$B = [k(\bar{\omega}) - 1] N \quad (\text{C.6})$$

Wages of entrepreneurs  $W^e$  and households  $W$  follow now from B.8 and B.9 respectively:

$$W^e = (1 - \alpha) \Omega Y \quad (\text{C.7})$$

$$W = (1 - \alpha) (1 - \Omega) \frac{Y}{H} \quad (\text{C.8})$$

The value of the firm may be computed in at least two ways, e.g. using B.13:

$$V = \frac{Ng - W^e}{\phi} \quad (\text{C.9})$$

or, equivalently, from B.14.

Entrepreneurs' consumption follows from B.15:

$$C^e = (1 - \phi) V \quad (\text{C.10})$$

Risk premium comes from B.5:

$$\Psi = \bar{\Psi} = \frac{g^\sigma}{\beta R^*} \quad (\text{C.11})$$

Domestic consumption comes from  $C = \frac{C}{\bar{Y}}Y$ .

Net exports  $NX$  comes from B.17

$$NX = Y - C - C^e - I - \mu \int_0^{\bar{\omega}} \omega f(\omega) d\omega R^K K \quad (\text{C.12})$$

Foreign debt  $D$  now stems from B.1

$$D = \frac{WH - C}{\Psi R^* - g} \quad (\text{C.13})$$

Marginal utility of consumption comes from B.4

Next, one can obtain the endogenous rescaling parameter  $\tau$  in the GHH utility function, by combining the labor supply and labor demand equations, eliminating wages  $W$  and solving for  $\tau$ :

$$\tau = \frac{(1 - \alpha)(1 - \Omega)Y}{H^\gamma}$$

Having  $\tau$ , obtain the value for marginal utility of consumption  $\lambda$  as:

$$\lambda = \left( C - \tau \frac{H^\gamma}{\gamma} \right)^{-\sigma}$$

Finally, table 4 summarizes all parameters which are found endogenously.

Table 4: Endogenously solved parameters

Variable or ratio	Description	Comment
$\bar{\Psi}$	constant in risk premium function	solved from B.5
$\eta$	risk premium elasticity	solved from F.1
$\tau$	parameter at GHH utility	solved from B.3

## D Log-linearized model

Budget constraint

$$C\hat{C}_t - Yg\hat{D}_{t+1} = WH(\hat{W}_t + \hat{H}_t) - R^*D\bar{\Psi}\hat{\Psi}_t - \bar{\Psi}R^*Y\hat{D}_t \quad (\text{D.1})$$

where we define  $\hat{D}_t = \frac{D_t - D}{Y}$  to account for a negative  $D$  in the non-stochastic steady state.

Risk premium

$$\hat{\Psi}_t = \frac{\tilde{\Psi}Y}{\bar{\Psi}}\hat{D}_t + \hat{\Phi}_t \quad (\text{D.2})$$

Labor supply for GHH preferences

$$(\gamma - 1)\hat{H}_t - \hat{W}_t = 0 \quad (\text{D.3})$$

Marginal utility of consumption for GHH preferences

$$\hat{\lambda}_t + \frac{\sigma C}{C - \tau \frac{H^\gamma}{\gamma}} \hat{C}_t - \frac{\sigma \tau H^\gamma}{C - \tau \frac{H^\gamma}{\gamma}} \hat{H}_t = 0 \quad (\text{D.4})$$

Euler with foreign bonds

$$\hat{\lambda}_t = E_t \hat{\lambda}_{t+1} + \hat{\Psi}_{t+1} \quad (\text{D.5})$$

Production function

$$\hat{Y}_t = \hat{A}_t + \alpha \hat{K}_t + (1 - \alpha) \hat{L}_t \quad (\text{D.6})$$

Labor aggregation

$$\hat{L}_t = (1 - \Omega) \hat{H}_t \quad (\text{D.7})$$

Entrepreneurial labor demand

$$\hat{Y}_t = \hat{W}_t^e \quad (\text{D.8})$$

Labor demand

$$\hat{Y}_t - \hat{H}_t = \hat{W}_t \quad (\text{D.9})$$

Investment funds

$$\hat{Q}_t + \hat{K}_{t+1} = \frac{N}{K} \hat{N}_{t+1} + \frac{B}{K} \hat{B}_{t+1} \quad (\text{D.10})$$

Return on capital *ex post*

$$\hat{R}_t^K = \frac{\alpha \frac{Y}{K}}{R^K} \hat{Y}_t - \frac{\alpha \frac{Y}{K}}{R^K} \hat{K}_t + \frac{1 - \delta}{R^K} \hat{Q}_t - \hat{Q}_{t-1} \quad (\text{D.11})$$

Interest rates

$$\frac{\bar{\omega} [\Gamma \bar{\omega} - \mu G \bar{\omega}]}{\Gamma - \mu G} \hat{\omega}_t = -\hat{R}_t^K + \hat{B}_t - \hat{K}_t - \hat{Q}_{t-1} \quad (\text{D.12})$$

where  $\hat{\omega}_t = \frac{\bar{\omega}_t - \bar{\omega}}{\bar{\omega}}$

Evolution of net worth

$$\hat{N}_{t+1} = \frac{\phi V}{Ng} (\hat{v}_t + \hat{V}_t) + \frac{W^e}{Ng} \hat{W}_t^e \quad (\text{D.13})$$

Value of firms

$$V \hat{V}_t = \Xi R^K K \hat{R}_t^K + K (\Xi R^K - R^*) (\hat{Q}_{t-1} + \hat{K}_t) - \bar{\omega} \mu G \bar{\omega} R^K K \hat{\omega}_t + R^* N \hat{N}_t \quad (\text{D.14})$$

Entrepreneurial consumption

$$\hat{C}_t^e = \hat{V}_t \quad (\text{D.15})$$

Motion of capital

$$g \hat{K}_{t+1} = (1 - \delta) \hat{K}_t + (g - 1 + \delta) \hat{I}_t \quad (\text{D.16})$$

Market clearing

$$\widehat{TB}_t = (1 - TB) \hat{Y}_t - \frac{C}{Y} \hat{C}_t - \frac{C^e}{Y} \hat{C}_t^e - \frac{I}{Y} \hat{I}_t - \frac{\mu GR^K K}{Y} \left( \hat{R}_t^K + \hat{Q}_{t-1} + \hat{K}_t \right) - \frac{\bar{\omega} \mu G_{\bar{\omega}} R^K K}{Y} \hat{\omega}_t \quad (\text{D.17})$$

where

$$\widehat{TB}_t \equiv \frac{NX_t}{Y_t} - \frac{NX}{Y} = TB_t - TB$$

Home technology shock

$$\hat{A}_t = \rho_A \hat{A}_{t-1} + \epsilon_{A,t} \quad (\text{D.18})$$

Optimal omega

$$\bar{\omega} \frac{\Gamma_{\bar{\omega}^2} \Lambda - \Sigma \Gamma_{\bar{\omega}}}{\Lambda^2} \left( \frac{R^K}{R^*} \Theta - 1 \right) E_t \hat{\omega}_{t+1} + \frac{R^K}{R^*} \left[ (1 - \Gamma) + \frac{\Theta \Gamma_{\bar{\omega}}}{\Lambda} \right] E_t \hat{R}_{t+1}^K = 0 \quad (\text{D.19})$$

where  $\Xi = (1 - \mu G)$ ,  $\Theta = \Gamma - \mu G$ ,  $\Lambda = \Gamma_{\bar{\omega}} - \mu G_{\bar{\omega}}$ ,  $\Sigma = \Gamma_{\bar{\omega}^2} - \mu G_{\bar{\omega}^2}$  and  $\Gamma \equiv \Gamma(\bar{\omega})$ ,  $\Gamma_{\bar{\omega}} \equiv \Gamma_{\bar{\omega}}(\bar{\omega}) = \frac{\partial}{\partial \bar{\omega}} \Gamma(\bar{\omega})$ ,  $\Gamma_{\bar{\omega}^2} \equiv \Gamma_{\bar{\omega}^2}(\bar{\omega}) = \frac{\partial^2}{\partial \bar{\omega}^2} \Gamma(\bar{\omega})$  as well as  $G \equiv G(\bar{\omega})$ ,  $G_{\bar{\omega}} \equiv G_{\bar{\omega}}(\bar{\omega}) = \frac{\partial}{\partial \bar{\omega}} G(\bar{\omega})$ ,  $G_{\bar{\omega}^2} \equiv G_{\bar{\omega}^2}(\bar{\omega}) = \frac{\partial^2}{\partial \bar{\omega}^2} G(\bar{\omega})$ .

Price of capital

$$\hat{Q}_t = \varphi g \hat{K}_{t+1} - \varphi g \hat{K}_t + \beta E_t \left\{ (1 - \delta) \hat{Q}_{t+1} - \varphi g^2 \hat{K}_{t+2} + \varphi g^2 \hat{K}_{t+1} \right\} \quad (\text{D.20})$$

## E GMM estimation

The HP filtered model moments were obtained using the procedure suggested by Burnside (1999). In order to account for possible autocorrelation as well as cross-correlation across countries, we apply the Driscoll and Kraay (1998) estimator, a modification of the HAC estimator adjusted for panel data<sup>3</sup>. The estimator involves a minimization of expected (over time) values of cross-country average errors:

$$\frac{1}{T} \sum_{t=1}^T \mathbf{h}_t(\boldsymbol{\theta}) \quad \text{with} \quad \mathbf{h}_t(\boldsymbol{\theta}) = \frac{1}{N(t)} \sum_{i=1}^{N(t)} \mathbf{h}_{i,t}(\boldsymbol{\theta})$$

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<sup>3</sup>We follow the exposition of Hoechle (2007) who discusses the case of unbalanced panels.

where  $\mathbf{h}_{i,t}(\boldsymbol{\theta})$  is a  $9 \times 1$  vector of the following moment errors:

$$\mathbf{h}_{i,t}(\boldsymbol{\theta}) = \begin{pmatrix} m_1(\boldsymbol{\theta}) - Y_{i,t}^2 \\ \frac{m_2(\boldsymbol{\theta})}{m_1(\boldsymbol{\theta})} - \frac{C_{i,t}^2}{m_1(\boldsymbol{\theta})} \\ \frac{m_3(\boldsymbol{\theta})}{m_1(\boldsymbol{\theta})} - \frac{I_{i,t}^2}{m_1(\boldsymbol{\theta})} \\ \frac{m_4(\boldsymbol{\theta})}{m_1(\boldsymbol{\theta})} - \frac{TB_{i,t}^2}{m_1(\boldsymbol{\theta})} \\ m_5(\boldsymbol{\theta}) - \frac{TB_{i,t}Y_{i,t}}{\sqrt{m_1(\boldsymbol{\theta})m_4(\boldsymbol{\theta})}} \\ m_6(\boldsymbol{\theta}) - \frac{C_{i,t}Y_{i,t}}{\sqrt{m_1(\boldsymbol{\theta})m_2(\boldsymbol{\theta})}} \\ m_7(\boldsymbol{\theta}) - \frac{I_{i,t}Y_{i,t}}{\sqrt{m_1(\boldsymbol{\theta})m_3(\boldsymbol{\theta})}} \\ \frac{m_8(\boldsymbol{\theta})}{m_1(\boldsymbol{\theta})} - \frac{R_{i,t}^2}{m_1(\boldsymbol{\theta})} \\ m_9(\boldsymbol{\theta}) - \frac{R_{i,t}Y_{i,t}}{\sqrt{m_1(\boldsymbol{\theta})m_8(\boldsymbol{\theta})}} \end{pmatrix} \quad (\text{E.1})$$

We start the estimation with an identity matrix and re-estimate the model using the optimal weighting matrix obtained in the first step. The estimator of the GMM weighting matrix  $\mathbf{W}$  is given by

$$\hat{\mathbf{W}}^{-1} = \hat{\boldsymbol{\Omega}}_0 + \sum_{j=1}^{m(T)} \left[ 1 - \frac{j}{m(T) - 1} \right] (\hat{\boldsymbol{\Omega}}_j + \hat{\boldsymbol{\Omega}}_j')$$

with

$$\hat{\boldsymbol{\Omega}}_0 = \frac{1}{T} \sum_{t=1}^T \mathbf{h}_t(\hat{\boldsymbol{\theta}}) \mathbf{h}_t(\hat{\boldsymbol{\theta}})' \quad \text{and} \quad \hat{\boldsymbol{\Omega}}_j = \frac{1}{T} \sum_{t=j+1}^T \mathbf{h}_t(\hat{\boldsymbol{\theta}}) \mathbf{h}_{t-j}(\hat{\boldsymbol{\theta}})'$$

where

$$\mathbf{h}_t(\hat{\boldsymbol{\theta}}) = \frac{1}{N(t)} \sum_{i=1}^{N(t)} \mathbf{h}_{i,t}(\hat{\boldsymbol{\theta}})$$

and  $m$  is the number of lags. We set  $m = 2$  following a commonly used criterion  $m(T) = \lceil 0.75T^{1/3} - 1 \rceil$ . Note also that  $N(t)$  varies over time.

## F Risk premium elasticity

The following computation derives the elasticity of the risk premium with respect to the leverage ratio, denoted as  $\eta_{s,k}$ . It closely follows Gertler, Gilchrist and Natalucci (2007). By definition,  $s(\bar{\omega}) = \frac{\lambda(\bar{\omega})}{\Psi(\bar{\omega})}$  and  $k(\bar{\omega}) = \frac{\Psi(\bar{\omega})}{1 - \Gamma(\bar{\omega})}$ , where  $s(\bar{\omega}) = \frac{R^K}{R}$  is the risk premium and  $k(\bar{\omega}) = \frac{QK}{N}$  is the leverage ratio. The elasticity is computed as  $\eta_{s,k} = \frac{d \log s}{d \log k} = \frac{d \log s}{d \bar{\omega}} \frac{d \bar{\omega}}{d \log k}$ .

$$\frac{d \log s}{d \bar{\omega}} = \frac{d [\log \lambda(\bar{\omega}) - \log \Psi(\bar{\omega})]}{d \bar{\omega}} = \frac{\lambda_{\bar{\omega}}(\bar{\omega})}{\lambda(\bar{\omega})} - \frac{\Psi_{\bar{\omega}}(\bar{\omega})}{\Psi(\bar{\omega})}$$

and

$$\frac{d \log k}{d \bar{\omega}} = \frac{d [\log \Psi(\bar{\omega}) - \log (1 - \Gamma(\bar{\omega}))]}{d \bar{\omega}} = \frac{\Psi_{\bar{\omega}}(\bar{\omega})}{\Psi(\bar{\omega})} + \frac{\Gamma_{\bar{\omega}}(\bar{\omega})}{1 - \Gamma(\bar{\omega})}$$

Combining, we obtain

$$\eta_{s,k} = \frac{\left[ \frac{\lambda_{\bar{\omega}}(\bar{\omega})}{\lambda(\bar{\omega})} - \frac{\Psi_{\bar{\omega}}(\bar{\omega})}{\Psi(\bar{\omega})} \right]}{\left[ \frac{\Psi_{\bar{\omega}}(\bar{\omega})}{\Psi(\bar{\omega})} + \frac{\Gamma_{\bar{\omega}}(\bar{\omega})}{1-\Gamma(\bar{\omega})} \right]} \quad (\text{F.1})$$

## G Log-normal distribution and related functions

We follow the standard notation established in the original BGG paper. The idiosyncratic productivity of a firm is denoted by  $\omega$ . It is distributed log-normally, i.e.  $\ln \omega \sim N(\mu_{\omega}, \sigma^2)$ . Let  $f(\omega)$  be the probability distribution function (pdf) of  $\omega$ . It is given by

$$f(\omega) = \frac{1}{\omega \sigma \sqrt{2\pi}} \exp \left[ -\frac{(\ln \omega - \mu_{\omega})^2}{2\sigma^2} \right]$$

The cumulative distribution function (cdf) is

$$F(\bar{\omega}) = \int_0^{\bar{\omega}} f(\omega) d\omega$$

In the model  $E\omega$  is normalized to 1, therefore  $\mu_{\omega} = -\frac{\sigma^2}{2}$ .

The gross fraction of entrepreneurs' revenue that goes to the lenders is defined as

$$\Gamma(\bar{\omega}) \equiv \int_0^{\bar{\omega}} \omega f(\omega) d\omega + \bar{\omega} \int_{\bar{\omega}}^{\infty} f(\omega) d\omega$$

and

$$\begin{aligned} G(\bar{\omega}) &\equiv \int_0^{\bar{\omega}} \omega f(\omega) d\omega \\ \frac{\partial}{\partial \bar{\omega}} \Gamma(\bar{\omega}) &= \Gamma_{\bar{\omega}}(\bar{\omega}) = 1 - F(\bar{\omega}) \\ \frac{\partial}{\partial \bar{\omega}} G(\bar{\omega}) &= G_{\bar{\omega}}(\bar{\omega}) = \bar{\omega} f(\bar{\omega}) \\ \frac{\partial^2}{\partial \bar{\omega}^2} \Gamma(\bar{\omega}) &= \Gamma_{\bar{\omega}^2}(\bar{\omega}) = -F'(\bar{\omega}) = -f(\bar{\omega}) \\ \frac{\partial^2}{\partial \bar{\omega}^2} G(\bar{\omega}) &= G_{\bar{\omega}^2}(\bar{\omega}) = f(\bar{\omega}) + \bar{\omega} f_{\bar{\omega}}(\bar{\omega}) \end{aligned}$$

where

$$f_{\bar{\omega}}(\bar{\omega}) = -\frac{1}{\bar{\omega}^2 \sigma \sqrt{2\pi}} \left( 1 + \frac{\ln \bar{\omega} + \frac{\sigma^2}{2}}{\sigma^2} \right) \exp \left\{ -\frac{\left( \ln \bar{\omega} + \frac{\sigma^2}{2} \right)^2}{2\sigma^2} \right\}$$

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