경제학석사학위논문

Business Cycle in Emerging Countries

Cross-country Analysis

국가별 자료를 통해 본 신흥국 경기변동의 요인

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Abstract

Business Cycle in Emerging Countries: Cross−country Analysis

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This paper evaluates models accounting for excess volatility of consumption in emerging countries against cross−country data. Two leading approaches in this line of research are, one driven exclusively by shocks to productivity, both transitory and permanent, and the other without stochastic growth but featuring explicit financial frictions. Much evidence has been provided in the literature in favor of each approach. This paper departs from the usual practice in these studies which base their empirical arguments on the data for a single country. To this end, a standard RBC model augmented with permanent shocks to productivity and a second one extended with reduced−form financial frictions are studied. In particular, their ability to confront observed patterns between pairs of moments in the data is examined. I find that the financial frictions model does a better job at accounting for cross−country variations than the stochastic trend model along several dimensions, especially when the countries with high relative consumption volatility are considered. By doing this exercise, this paper provides a more comprehensive assessment on the merits of the two approaches and hopes to shed light on the debate regarding if deeper frictions in the economy can be summarized by the persistence of Solow residuals alone rather than distortions in the response of investment and consumption to underlying productivity.

Keywords : Emerging economies; Business cycles; Financial frictions; Country risk premium; Stochastic trend shocks; Small open economy

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I. Introduction

Business cycle in emerging markets is characterized with excessive volatility of consumption relative to output, which is in stark contrast with developed markets. In recent literature, the debate on the sources of this empirical regularity is divided into two strands. The first one argues that in order to explain fluctuations in emerging-market economies, theoretical models must explicitly incorporate the role of market failures such as financial frictions (Neumeyer and Perri, 2005). Second, Aguiar and Gopinath (2007) argue that business cycles in emerging markets can be explained well using a neoclassical model without distortions, driven solely by shocks to total factor productivity. They introduce a nonstationary component to aggregate shocks to total factor productivity, inducing a stochastic productivity trend. This line of research argues that combined effects of deeper frictions in the economy can be modeled as an aggregate shock to total factor productivity with a large nonstationary component.

In this paper, I undertake an investigation of the hypothesis that an RBC model driven by a combination of permanent and transitory shocks to total factor productivity can account satisfactorily for observed aggregate dynamics in emerging countries against the hypothesis that explicit financial frictions are needed. To this end, an empirical analysis is conducted where I compare model moments under different specifications with the sample moments from cross-country data. I undertake parallel experiments on the two models, one driven exclusively by shocks to productivity, both transitory and permanent, and the other without stochastic growth but featuring explicit financial frictions. The use of cross-country data in this paper is motivated by what I believe is an important drawback of existing studies advocating extending the RBC model to include financial frictions in order to explain business cycles in emerging countries. Namely, the empirical argument using samples from a singe country as a representative of emerging market economies[1]. Also, I evaluate the two main mechanisms by their ability to confront observed pattern between pairs of data moments. In particular, I take relative volatility of consumption and compare other key moments against it. By doing so, I achieve two goals. First, model moments are compared against cross-country data. Second, this exercise identifies if each model has to "sacrifice" other moments to match the excessive consumption volatility. In other words, if in one model, some of the key moments fail to match the cross-country data while the model tries to match consumption volatility, then the mechanism

[1] Recent work by Miyamoto and Nguyen (2017) is one of the few exceptions.

at which this model works can be seen as not validated by the cross-country data.

I find that when judged against the cross-country data, the model with financial frictions does a better job than the model with stochastic growth at explaining observed business cycles in emerging countries along several dimensions. One such dimension is the volatility of investment and output. The stochastic growth model predicts output and investment to be significantly more volatile than its corresponding empirical counterpart for those with large relative volatility of consumption. By contrast, the model featuring financial frictions produces excess consumption volatility at a stable and realistic level of output volatility, in line with the observed pattern. In addition, a disparity is observed between the data and computed moments of both models in the correlation between volatility of consumption and investment, both relative to output. Furthermore, I find that the stochastic growth model does not match satisfactorily the comovement of output with investment and trade balance. Lastly, a salient feature of the model with financial frictions is that it matches well the interest rate dynamics.

This paper is related to a long-standing debate between the role of stochastic growth and financial frictions in explaining excessive consumption volatility in emerging countries. A main contribution of this paper is to provide a broader perspective on the empirical accuracy of financial frictions models relative to the stochastic growth model. In most studies in this strand of literature, the empirical argument is made using data from one country, many of which use the data for Mexico or Argentina, both for the characterization of observed business cycles and for the estimation of the parameters of the theoretical model. It is natural to wonder if the analysis stands when it is based on a broader dataset. In other words, it is necessary to evaluate relative merits of the two models out of sample. Cross-country variation might be important in evaluating the key mechanism of business cycle fluctuations in emerging markets. For example, Kim and Kim (2018) conclude that sources of excess consumption volatility in emerging markets vary among countries. They show that in the case of Korea trend shock plays a more important role than transitory shock coupled with financial frictions, unlike Mexico.

Chang and Fernandez (2013) introduce an "encompassing model" to evaluate the role of the trend shock channel and the financial frictions channel. The encompassing model includes both stochastic growth and interest rate shocks coupled with financial frictions. As shown later, a closer look into the estimated parameters value might invite questions regarding their findings based on the encompassing model. By comparing the performance of two models each featuring one key mechanism, this paper provides more evidence regarding the merits of stochastic trends and financial frictions.

The remainder of the paper is organized as follows: Section II states the models under study. Section III presents and discusses the results of empirical analysis. Section IV presents several robustness exercises. Section V concludes.

II. Models

I present two versions of the model following the setup of Chang and Fernandez (2013): the stochastic trend model and the financial frictions model. Both models are an augmented version of the standard small open economy model developed by (Mendoza, 1991), a standard small open economy model with one final good and one asset. Technology is characterized by a Cobb-Douglas production function $\mathrm{Y_t} = z_t\,\mathrm{F}\left(K_t, \Gamma_t h_t\right) = z_t K_t^{1-\alpha}\left(\Gamma_t h_t\right)^{1-\alpha}$. $\mathrm{Y_t}$ denotes output, K_t capital available in period t, h_t labor input and α is labor's share of output. z_t and Γ_t represent productivity processes. z_t is assumed to follow $\log z_t = \rho_z \log z_{t-1} + \epsilon_t^z$ where $|\rho_{\mathrm{z}}| < 1$ and $\epsilon_{\mathrm{t}}^{\mathrm{z}}$ is an i.i.d. shock with mean 0 and variance σ_{z}^2. Γ_t represents the labor augmenting productivity growth.

The equilibrium is characterized by the representative household maximizing the present discounted value of utility subject to the

$$\mathrm{E}\sum_{t=0}^{\infty} \beta^t U\left(C_t, h_t, \Gamma_{t-1}\right) \tag{1}$$

production function and the per−period budget constraint:

$$\mathrm{W_t} h_t + u_t K_t + q_t D_{t+1} = C_t + I_t + D_t \tag{2}$$

$\mathrm{W_t}$ is the wage rate and u_t is the rental rate of capital. The periodic

$$\mathrm{u}\left(C_t, h_t, \Gamma_{t-1}\right) = \frac{C_t - \left(\tau \Gamma_{t-1} h_t^{\omega}\right)^{1-\sigma}}{1-\sigma} \tag{3}$$

utility function is assumed as follows:

The agent has access to world capital market for risk−free bond D_t. The price of borrowing from world capital market faced by households in this economy is q_t, given by

$$\frac{1}{q_t} = R_t + \kappa\left(\frac{D_{t+1}}{\Gamma_t}\right) \tag{4}$$

where $R_t = S_t R_t^*$. R_t^* denotes the world interest rate, and D_{t+1} denotes the country's aggregate debt, which equals to the household's debt D_{t+1} in equilibrium. The debt−elastic interest premium is specified as

$$\kappa\left(\frac{D_{t+1}}{\Gamma_t}\right) = \psi\left[\exp\left(\frac{D_{t+1}}{\Gamma_t} - d\right) - 1\right] \tag{5}$$

Capital depreciates at the rate δ and capital accumulation follows

$$K_{t+1} = (1-\delta)K_t + I_t - \Phi(K_{t+1}, K_t) \tag{6}$$

where the cost of capital adjustment is specified as

$$\Phi(K_{t+1}, K_t) = \frac{\phi}{2} K_t \left(\frac{K_{t+1}}{K_t} - \mu\right)^2 \tag{7}$$

1. Stochastic Trend Model

The model here is based on Aguiar and Gopinath (2007). The economy is driven exclusively by shocks to productivity, which include trend and transitory shocks. There are two revisions to the standard model stated above.

First, in the stochastic trend model (hereafter the ST model) Γ_t is allowed to be stochastic:

$$\Gamma_t = g_t \Gamma_{t-1}$$

where

$$\log\frac{g_t}{\mu} = \rho_g \log\frac{g_{t-1}}{\mu} + \epsilon_t^g$$

$\left|\rho_g\right| < 1$, ϵ_t^g is an i.i.d. process with mean 0 and variance σ_g^2, and μ denotes the mean value of labor productivity growth.

Second, the world interest rate R_t^* is held constant at R^* and there is no difference between country−specific rate and the world interest rate, so $R_t = R_t^* = R^*$.

2. Financial Frictions Model

In the financial frictions model (hereafter the FF model), there is no shocks to growth. Instead the economy is driven by stochastic world interest rate and features financial frictions.

So first, Γ_t is assumed to follow a deterministic path:

$$\Gamma_t = \mu \Gamma_{t-1}$$

Second, the world interest rate follows a random process, fluctuating around its long−run value R^* as follows

$$\log\frac{R_t^*}{R^*} = \rho_R \log\frac{R_{t-1}^*}{R^*} + \epsilon_t^R$$

where $\left|\rho_R\right| < 1$, ϵ_t^R is an i.i.d. process with mean 0 and variance σ_R^2.

Third, there is country-specific spread S_t and $R_t = S_t R_t^*$. Deviations of the country-specific spread from its long-run level are assumed

$$\log \frac{S_t}{S} = -\eta E_t \log z_{t+1} \tag{8}$$

to follow:

Lastly, there is an additional friction that firms must finance a fraction θ of wage bill one-period ahead, following the formulation of Neumeyer and Perri (2005):

$$\mathrm{W_t}[1 + \theta(R_{t-1} - 1)] = z_t F_2\left(K_t, \Gamma_t h_t\right) \Gamma_\mathrm{t} \tag{9}$$

This friction makes the labor demand sensitive to the interest rate shocks one period ahead. A decrease in the interest rate at the previous period implies a lower effective labor cost and increase the demand for labor for a given wage. In this way, changes in country risk act as an amplification mechanism of fluctuations in productivity. As explained in Neumeyer and Perri (2005), the resulting employment in the equilibrium following this increase in labor demand will rely on the nature of labor supply. In current setup of preference, labor supply is independent of interest rate shocks. Hence the increase in labor demand results in a rise in employment in equilibrium. As capital stock is relatively stable at business cycle frequencies, this increase employment leads to increased output.

Chang and Fernandez (2013) uses Equation (8) to capture the idea "induced country risk" proposed in Neumeyer and Perri (2005) in a reduced form. In its basic concept, a financial friction refers to the gap between the rate savers receive and the return from the use of capital. In current setup, two frictions generate the wedges. Equation (8) introduces time-varying premium to the rate at which households could save and shows up indirectly as the wedge between the return from saving and marginal productivity of capital. The working capital constraint shows up in the labor market equilibrium equation as a wedge between the real wage and marginal productivity of labor.

Models are solved numerically by log-linearizing the first-order conditions and budget constraints around the steady state. Theoretical moments of the models are computed at the estimated posterior modes. This paper uses posterior modes from the estimation result of Chang and Fernandez (2013) to maximize comparability with Chang and Fernandez's work. The parameter values are presented in Table 2. They use Bayesian methods to estimate separately the stochastic trend model and the financial frictions model as well as the encompassing model. They employ the Mexican data set of Aguiar and Gopinath (2007) for comparability.

As explained in their work, they do not include the interest rate data in the set of observables.

For consistency, I calibrate parameters to the values used in Chang and Fernandez (2013), as listed in Table 1. A period is taken to be one quarter. The coefficient of relative risk aversion is set at 2, and ω and τ are set so that labor supply elasticity is 1.67 and a third of time is spent working in the long run. The debt−to−GDP ratio is calibrated to 10% and the quarterly depreciation rate to 5%, the values used in Aguiar and Gopinath (2007). The steady−state value of the interest rate and country spread is based on Uribe and Yue (2006). Following their work, real world interest rate is 3−month gross U.S. Treasury Bill rate divided by the gross U.S. inflation over the previous four quarters and country spread is J.P. Morgan' s EMBI+ stripped spread for Mexico. Following the literature on small open economy models, the elasticity of the interest rate to debt level parameter ψ is calibrated to a very small value to ensure a stationary solution in the equilibrium. (Schmitt−Grohé and Uribe, 2003)

Table 1. Calibrated parameters

Parameter	Description	ST and FF
σ	Intertemporal elasticity of substitution [1/σ]	2.000

ω	Labor supply elasticity $[\frac{1}{\omega-1}]$	1.600
α	Labor share of income[2]	0.6868
R^*	Gross world interest rate	1.0025
τ	Labor parameter so that $\mathrm{h} = \frac{1}{3}$ in the long run	1.7168
ψ	Debt elastic interest rate parameter	0.001
β	Discount factor	0.9976
S	Long-run gross country interest rate premium	1.0120
δ	Depreciation rate of capital	0.050
d	Debt-to-GDP ratio	0.100
R	Gross country-specific interest rate	1.0145

Table 2. Estimated parameters

Parameter	Description	ST	FF
ρ_z	AR(1) coef. transitory tech. process	0.9424	0.8932
σ_z	S.D. of transitory tech. shock	0.0072	0.0066
ϕ	Capital adjustment cost parameter	3.4463	14.7555
μ	Gross quarterly growth rate	1.0058	1.0063

[2] In the financial frictions model α is calibrated as the labor share times $[1 + (\mathrm{R}-1)\theta]$. So α is computed from labor share using the posterior mode of θ.

ρ_g	AR(1) coef. permanent tech. process	0.7259	/
σ_g	S.D. of permanent tech. shock	0.0069	/
ρ_R	AR(1) coef. world interest rate process	/	0.8058
σ_R	S.D. of world interest rate shock	/	0.0042
θ	Working capital parameter	/	0.6853
η	Spread elasticity	/	0.7287

III. Empirical Analysis

1. Empirical Approach

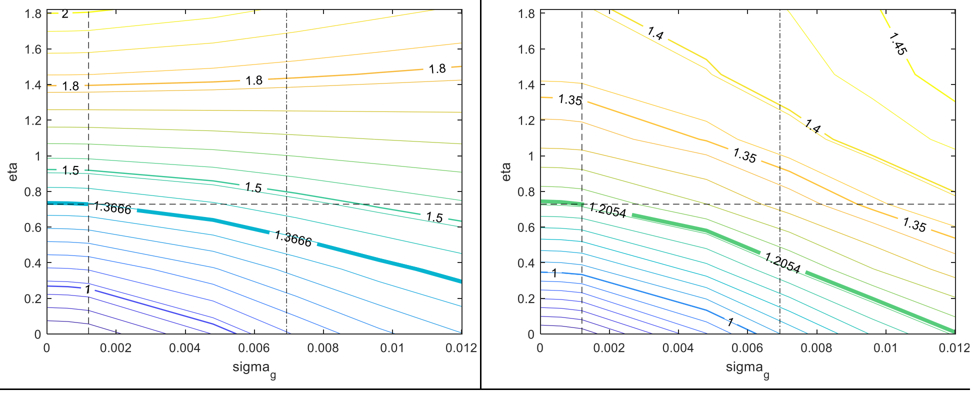
First, I conduct a simple exercise to motivate the empirical approach adopted by this paper. Figure 1 is contour plots of volatility of consumption relative to output. The plots show the variation in the encompassing model moments computed at different values of two parameters: η (the elasticity of the spread to the country' s fundamentals) and σ_g (the size of trend shock volatility). The dashed line indicates estimated posterior modes of the parameters in the encompassing model. The dot-dashed line indicates posterior mode of σ_g in the ST model.

In Figure 1.A, almost horizontal contour lines are drawn, indicating the consumption volatility is barely sensitive to the change in variation of trend shocks. However, under a lower investment adjustment cost (ϕ is set at the estimated posterior mode of the stochastic trend model) variance of trend shocks plays a significant role in generating excessively volatile consumption as indicated by downward sloping contour curves that are more densely drawn and steeper in Figure 1.B.

This might undercut the findings from (Chang & Fernandez, 2013) that trend shocks played trivial role (2.1% in accounting for the variance of consumption) and that variance of all four aggregates is mostly explained by transitory shocks to technology. This is because the estimated investment adjustment cost it too high and trend shock variation too small, which in a way might suppress the role of trend shocks. Chang and Fernandez use Bayesian method to estimate the parameters, so their approach does not directly answer the question of which moments might fall far from empirical counterparts if the trend shock variation were estimated to be more volatile. This leads to the main exercise of this paper where I compare several key model moments against relative volatility of consumption under different specifications. By this exercise, I hope to provide a more comprehensive assessment on the merits of two models.

Figure 1 Contour plots of relative volatility of consumption

A. high ϕ, encompassing model	B. low ϕ, encompassing model



In the rest of this section, the respective role of trend shocks and financial frictions in matching empirical regularities observed in the cross−country data is investigated. To this end, I study the change in some key moments of restricted versions of the encompassing model. Specifically, I evaluate the two models at different values of their respective core parameters: σ_g in the ST model, η in the FF model, holding all other parameters fixed. For each environment, key moments of the simulated economy are computed and plotted against the sample moments computed with the cross−country data. All moments use log−differenced variables except for trade balance share of output where level differences are used. The range of parameters are restricted to match the minimum and maximum value of the volatility of consumption in the data.

2. Data

21 countries are included in the analysis. The sample consists of emerging countries following the MSCI market classification that have at least 90 quarters of data during 1980:Q1 – 2018:Q4. The series of aggregate private consumption(C), gross fixed capital formation(I), GDP(Y), trade balance as exports minus imports over GDP (TBY) are retrieved, which are in local currency, in constant prices and seasonally adjusted. The Appendix provides more details on the source of data for each economy in the sample.

Following Uribe and Yue (2006), real world interest rate is 3-month gross U.S. Treasury Bill rate divided by the gross U.S. inflation over the previous four quarters and country spread is J.P. Morgan's EMBIG stripped spread.

In the second part where moments associated with interest rate is analyzed, due to the limited availability of country specific premium data, the data is restricted to a subset of the sample that is covered by EMBIG series, for the period after 1994:Q1. For the first part, all countries in the sample are analyzed and the sample lengths are typically longer which varies by countries due to data availability.

3. Results

1) Moments of the Aggregate Variables

The analysis of this paper starts with the following observation. Figure 2 plots volatility of consumption, investment and output against relative volatility of consumption where crosses in grey denote data points, round circles in blue theoretical moments of the ST model, and triangles in green theoretical moments of the FF model. This notation is consistently used throughout the paper. Clearly, both models can deliver consumption more volatile than output. But note that a fair share of the observed volatility of consumption relative to output is placed much further from 1. Figure 2 shows that in order to match the relative consumption volatility of these countries, the ST model delivers an exponential increase in the volatility of consumption, investment and output. This is inconsistent with the data. In other words, the mechanism at work in the ST model to induce greater volatility of consumption through trend shocks cannot account for the cross−country variation observed in the data, when the countries with large relative volatility of consumption are included.

Figure 2. Volatility of consumption, investment and output

A. Consumption	B. Investment	C. Output

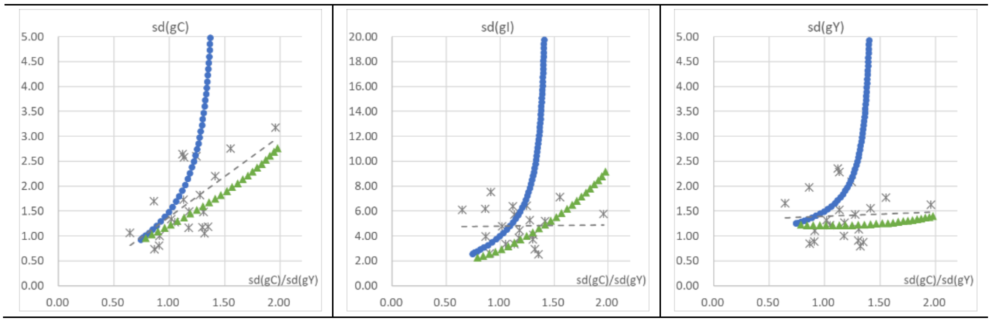


Table 3 Second moments, ST model and FF model

Variable	Mexican Data	Average	ST Model	FF Model
% Standard deviations				
gY	1.32	1.41	1.55	1.23
gC	1.34	1.67	1.59	1.67
gI	4.79	4.83	4.26	4.61
dTBY	0.96	1.58	1.08	1.45
gR	1.30	1.76	0.00	0.63
% Standard deviations relative to Y				
gC	1.02	1.18	1.03	1.36
gI	3.63	3.54	2.75	3.74
dTBY	0.72	1.19	0.70	1.18
gR	0.97	1.38	0.00	0.51
Correlation with gY				
gC	0.82	0.54	0.93	0.95
gI	0.81	0.52	0.90	0.80
dTBY	−0.54	−0.16	−0.54	−0.64
gR	−0.52	−0.20	0.47	−0.63
Correlation with dTBY				
gC	−0.60	−0.30	−0.80	−0.84
gI	−0.60	−0.35	−0.85	−0.97
gR	0.36	0.22	−0.18	1.00
Serial correlation				
gY	0.39	0.25	0.13	0.19

gC	0.34	0.19	0.08	0.18
gI	0.40	0.19	−0.02	−0.06
dTBY	−0.03	−0.11	−0.05	−0.08
gR	−0.02	0.00	0.92	−0.07

Notes: gX denotes log difference, dX denotes first differences. Model moments are computed as estimated posterior modes. Moments associated with interest rate data are computed with the restricted dataset.

i. Relative consumption volatility and output volatility

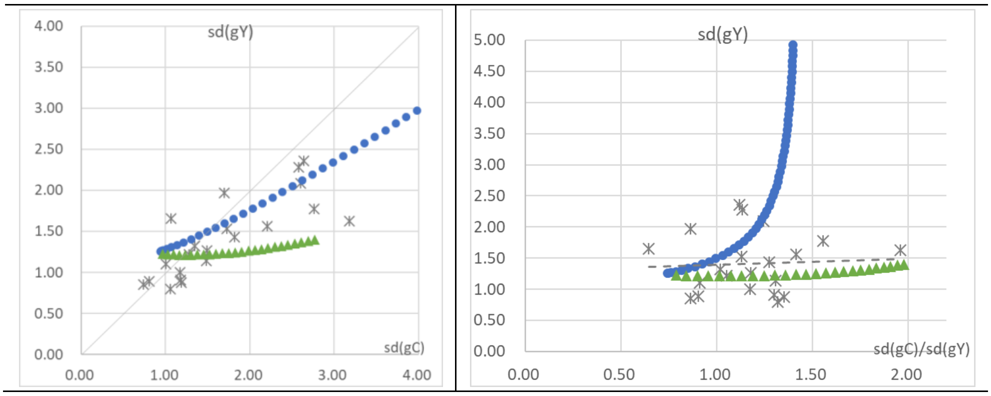
The sample moments show that output volatility ranges from 0.8 to 2.4 and the consumption volatility from 0.7 to 3.2. On average, consumption volatility relative to outcome is 1.18, with 17 out of 21 countries in the sample having more volatile consumption than output. This is in line with the characterization of business cycles of emerging countries in the literature.

As shown in Table 3, at benchmark values of the parameters, both models are able to deliver consumption more volatile than output. Judged against the observed pattern indicated by cross−country data, however, the FF model does a better job in explaining the behavior of emerging markets in that it can deliver higher consumption volatility at a lower level of volatility of output. Figure 3.A plots the volatility of outcome against the volatility of consumption. Note that the slope of the two volatilities of the ST model is much closer to the 45−degree line than the FF model. Such difference explains why the pattern in Figure 2. C emerges. In the ST model excess volatility of consumption relies on a prolonged response of output to productivity shocks. Along the Permanent Income Hypothesis, the initial response of consumption is greater than output. But to match a stronger excess volatility of consumption in some emerging-market countries, the ST model requires trend shocks whose variances so large that output becomes unrealistically volatile. This translates into Figure 3.B which indicates that the volatility of output increases exponentially as relative volatility of consumption increases in the ST model. In the robustness analysis section the same exercise is done with larger intertemporal elasticity of substitution, but the same pattern emerges.

On the contrary, the FF model generates excess consumption volatility at a stable and realistic level of output volatility. This is related to the mechanism at work in the FF model through which consumption responds more strongly to output. In the FF model, changes in the interest rate in response to productivity shocks induce further changes in consumption by setting the price for intertemporal substitution.

Figure 3. Volatility of consumption

A. Against absolute volatility of consumption	B. Against relative volatility of consumption

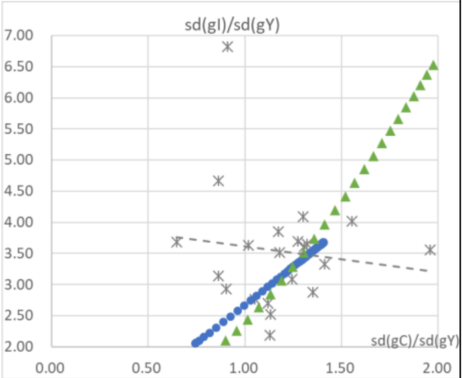


ii. Investment volatility

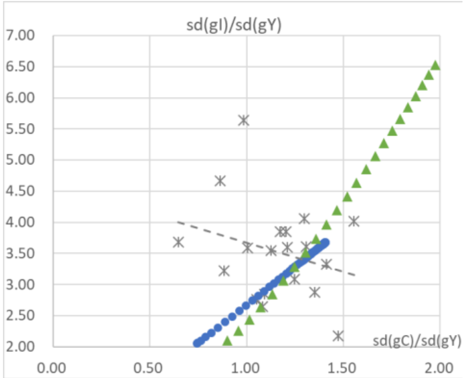
As Figure 2.B shows, the data records highly volatile investment, from 2.5 to 7.5, in general uniformly distributed. Note that investment volatility delivered by the FF model matches the data satisfactorily. On the other hand, the ST model requires large trend shocks to match the higher range of consumption volatility, which shows up as excessively volatile investment. The FF model is estimated to have a higher investment adjustment cost (value of ϕ, the parameter governing investment adjustment cost, is 14.8 in the FF model, as opposed to 3.4 in the ST model), which prevents investment from responding freely to productivity shocks, thus stabilizing output variance. This corresponds to the difference between two models in delivering output volatility discussed above.

Figure 4. Relative volatility of investment

A. Using all available data



B. Using data for periods after 1995 Q1



It is worth noticing a disparity between the data and computed moments of both models. It is when the correlation between volatility of consumption and investment is compared, both relative to output, the disparity emerges. See Figure 4.A. Both models produce positively correlated relative volatility of consumption and investment while the data shows roughly negative correlation. In other words, countries with grater volatility of consumption relative to output tend to have more volatile investment relative to output.

The positive correlation in the model moments are expected. In the ST model excess volatility of consumption comes from the exaggerated response of investment in response to a permanent productivity shock. In the FF model, excess volatility of consumption is driven by the interest rate change following productivity shocks, which simultaneously affect consumption and investment. In other words, both mechanisms work through investment and affect consumption and investment in the same direction. Therefore, despite its success in matching Mexican data moments, the reduced form of financial frictions employed in the FF model fails to account for the cross-country variation. This finding suggests the importance of specifying the mechanism through which interest rate fluctuations amplify the effects of fundamental shocks, echoing the result of Neumeyer and Perri (2005).

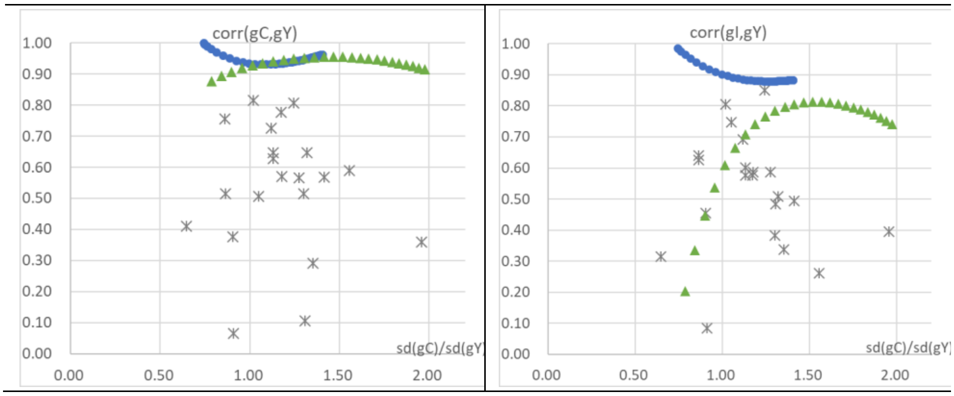
The disparity also implies that additional shocks or frictions may be necessary. For example, incorporating a shock to the marginal productivity of investment, first developed by Greenwood et al. (1988) and discussed by Justiniano et al. (2010) might induce a less positively correlated relative volatilities of consumption and investment. Intuitively, a positives shock to the marginal productivity of investment increases the rate of return, giving households an incentive to save more. This raises investment in equilibrium and thus output, thereby off-setting some of the decrease in consumption.

iii. Cyclicality of consumption and investment

Correlation coefficients of both consumption and investment with output in the data sample are diversely ranged. From as low as 0.07 to the maximum of 0.82 for consumption, and 0.08−0.85 for investment. Both models generate very high correlation coefficients, around 0.9, invariably for different parameter values, which is higher than most data points. As neither model features government spending, excess comovement of consumption with output is expected. Also, in the current setup of the ST model driven exclusively by technology shocks, high comovement of macroeconomic variables is generated by design. In this specification, a decrease in contemporaneous correlation of output with both consumption and investment depends on how large the impact on future productivity realizations is of a shock at the present. On the other hand, the FF model does slightly better at matching investment comovement with output, given its introduction of interest rate shocks.

Figure 5 Cyclicality of consumption and investment

A. Cyclicality of consumption	B. Cyclicality of investment

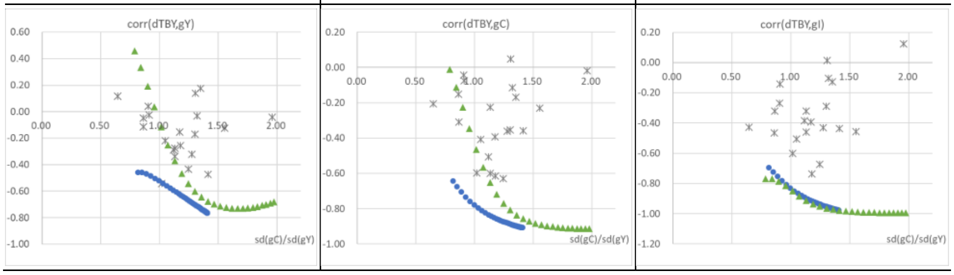


The coefficient of comovement between investment and output decreases in the ST model as the volatility of trend shock increases but converges around 0.9. The decrease is because with higher trend shocks, the role of transitory productivity shocks relatively decreases. The persistence of transitory shocks is the key channel for the contemporaneous correlation between investment and output given the near-zero movements in the interest rate. In the estimated model the productivity process is very persistent (posterior mode of ρ_z is 0.94) so the coefficient converges at a high level. In the FF model, as η increases, interest rate movement becomes more negatively correlated with the Solow Residuals. A drop in the interest rate increases investment in physical capital since the return from the bond is lower. The induced correlations between investment and output than increases. As η becomes very high, around 1.5 times the value of posterior modes, the negative correlation between investment and output decreases slightly causing a reversed trend in the comovement of investment and output. This is because enhanced financial frictions push the comovement in a positive direction for a given productivity shock, whereas given an interest rate shock, a higher η pushes the comovement of output with investment in a negative direction. At a high enough value of η, the former effect is offset by the latter.

iv. Cyclicality of trade balance

Figure 6 Cyclicality of trade balance

A. Comovement with output	B. Comovement with consumption	C. Comovement with investment



The data shows prevailing counter-cyclicality of trade balance, as documented in the literature. (Aguiar & Gopinath, 2007; Uribe & Schmitt-Grohé, 2017) Both models deliver negatively correlated trade balance and output at parameter values around the estimated mode.

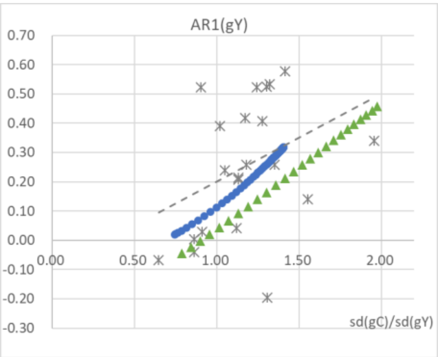
In the ST model, as is well known through works of Aguiar and Gopinath (2007), a shock to the growth rate, which implies a larger boost to future output than to current output given a growing economy, causes consumption to respond more aggressively than income, reducing savings and generating a negative trade balance. In the FF model a negative response of the interest rate to the productivity shocks cause additional increases in consumption and investment in addition to the channel of output, leading to a negative trade balance.

In the ST model, the way consumption responds more aggressively than output is realized through borrowing more from abroad, which translates into a more countercyclical trade balance. In response to a positive trend shock, investment increases to exploit the future increase in marginal productivity. Hence, with more volatile trend shocks, such impacts on the two aggregates enhances, inducing a more strongly negatively correlated investment and trade balance. In the FF model, as explained above in the investment volatility section, excess volatility of consumption works through interest rate movement. Since the effects of an interest rate change on investment and saving work in opposite directions, the negative correlation between investment and trade balance becomes stronger as the financial frictions become more significant.

v. Persistence

Output and consumption growth in the data show moderate or high persistency, and countries with higher relative consumption volatility tend to have more persistent output growth, which is consistent with the result of both models. In the models output movements are mostly driven productivity shocks and the parameters for the productivity shock process is estimated, inducing a persistent output growth consistent with the data. The data shows a large cross-country variation in the persistency of trade balance and investment, with more than half of the data points have negative autocorrelation coefficient of trade balance.

Figure 7 Persistence of macroeconomic aggregates

<table>
<tr><td>A. Output</td><td>B. Consumption</td></tr>
<tr><td>


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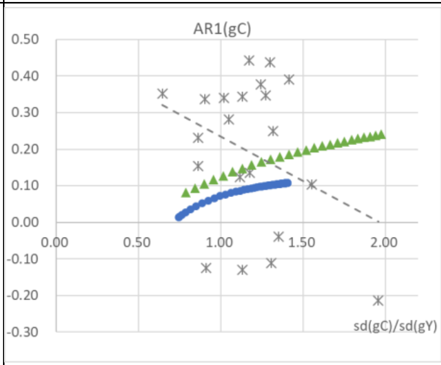
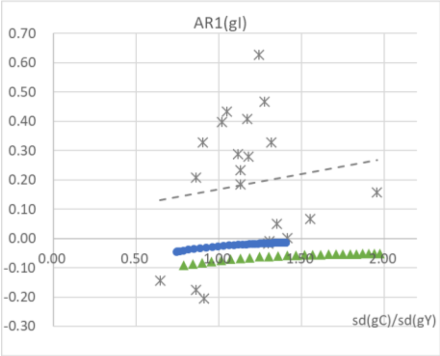
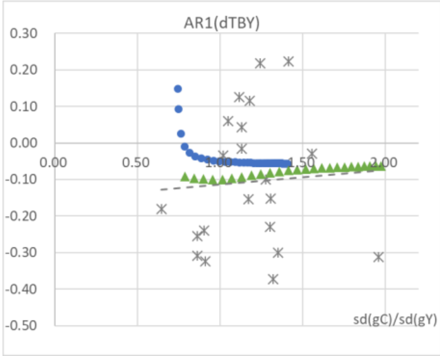


</td></tr>
<tr><td>C. Investment</td><td>D. Trade balance</td></tr>
</table>





2) Moments Associated with the Interest Rate

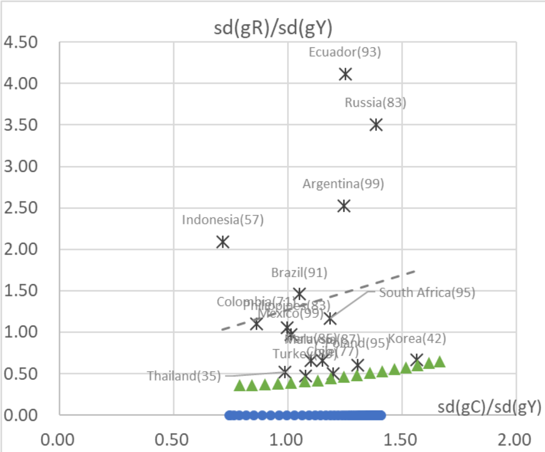
Since the ST model does not feature interest rate shocks and the interest rate does not respond to any other shocks, the interest rate is essentially kept constant and follows the dynamics of country debt level through debt-elastic interest premium as in Equation (5). Given that the debt-elastic interest parameter Ψ is calibrated to 0.001, the interest rate is almost constant and highly persistent in the ST model. In other words, the ST model does not aim to match interest rate movements by design. This notwithstanding, it is still worth evaluating the performance of the FF model along this dimension.

i. The interest rate volatility

In the data most countries have very volatile interest rate. The relative standard deviations range from 0.5 to 4.1, with a sample mean of 1.38. Given that the posterior parameters of the FF model are estimated without interest rate data, this is quite remarkable. In

FF model, with a positive productivity shock the interest rate go down through the channel of country premium that responds negatively to Solow Residual, which induces increase in consumption relative to the future by lowing the price for intertemporal substitution. This interaction between financial frictions and productivity shocks generate volatile interest rate.

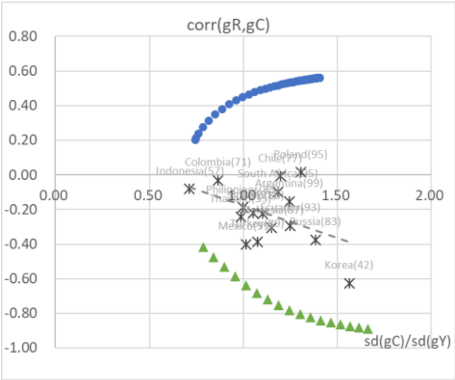
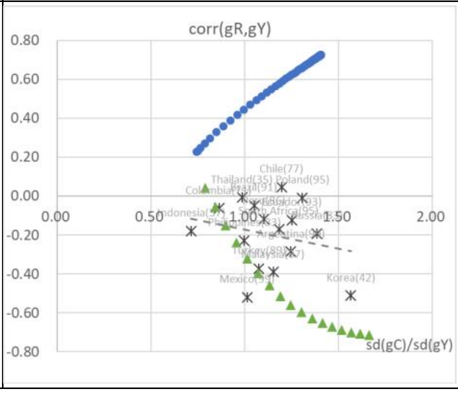
Figure 8 The interest rate volatility



ii. Cyclicality of the interest rate

The data indicates that most countries have counter−cyclical or acyclical interest rate, with the correlation coefficient of the interest rate with output all below 0 except Chile. Comovement of the interest rate with consumption is similar to that with output in the data, coefficients ranging from −0.63 to 0.01. Also, the data shows that countries with more volatile consumption relative to output tend to have more strongly counter-cyclical interest rate, as the downward-sloping dotted plot indicates.

Figure 9 Cyclicality of the interest rate

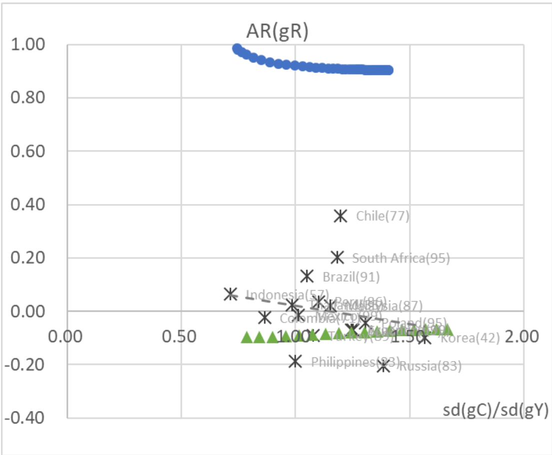
A. Comovement with consumption	B. Comovement with output
	

ST model fails to account for this pattern for the reasons explained in the beginning of this part. It generates procyclical interest rate. Another problem of the ST model is that to deliver higher consumption volatility the model requires higher positive correlation between the interest rate and output growth, which is contradictory to the observation from the data. The poor performance of the ST model is due to the fact that the interest rate is essentially constant and that an increase in trend shocks volatility affects output and consumption but not the interest rate. On the other hand, the FF model generates counter-cyclical interest rate movements whose correlation coefficient increases in magnitude as the financial friction effect enhances. This is because of the country premium that negatively responds to expected future productivity in FF model. Both features are consistent with the data.

iii. Persistence of the interest rate

The data presents first autocorrelations of the interest rate as close to zero. Contrary to the data, the ST model delivers a highly persistent interest rate, since the interest change is fully driven by the debt−elastic interest premium. FF model delivers a close to zero persistence coefficient of the interest rate, in line with most of the sample observations.

Figure 10 Persistence of the interest rate



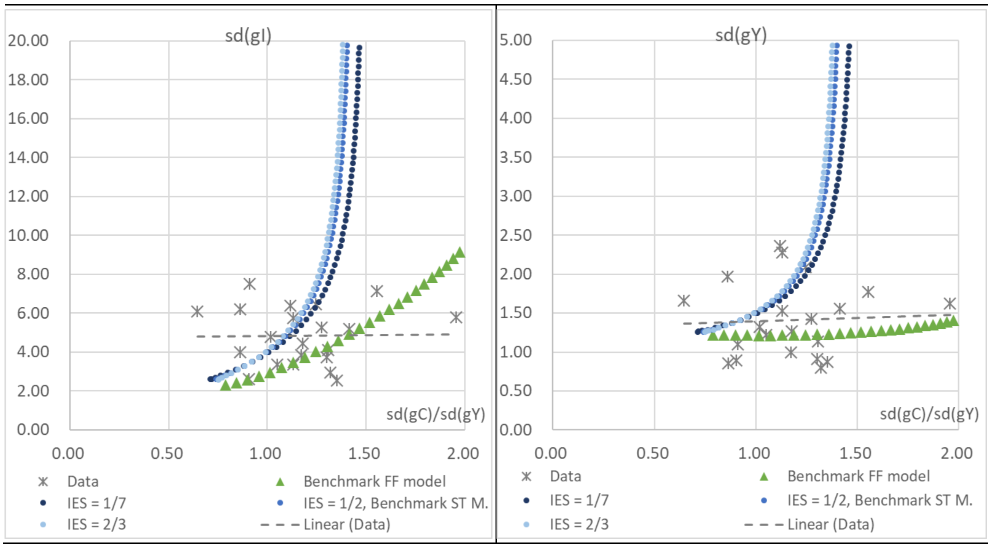
IV. Robustness

1. Lower intertemporal elasticities of substitution

Figure 11 shows the implication of lower intertemporal elasticity of substitution. To do this, I undertake the same exercise as in the first part of the previous section except that I experiment with different values σ. Since households are faced with a volatile interest rate, the FF model is subject to overpredicting the volatility of consumption than the ST model. Therefore, this exercise gives answer to if a lessened willingness of households to substitute, which is associated with a higher σ and a lower elasticity of substitution, is a possible way of bringing the ST model in line with the data. The result shows that the discrepancy between the ST model and the data remains, although a lower intertemporal elasticity of substitution does decrease the volatility of macroeconomic aggregates for any given value of trend shock variance.

Figure 11 Lower intertemporal elasticities of substitution

A. Investment volatility	B. Output volatility

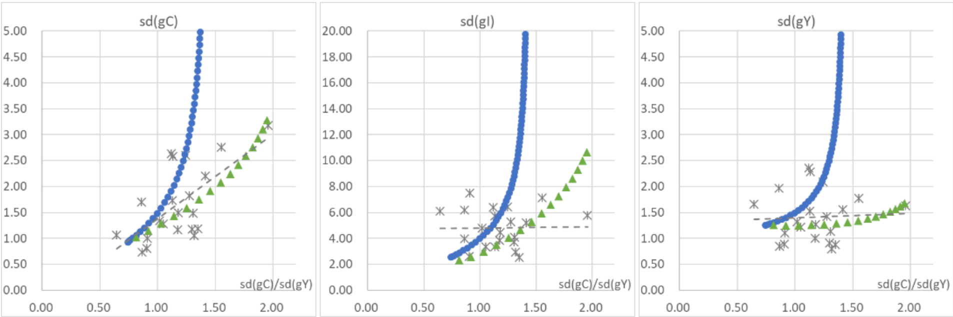


2. Tightened working capital constraints

In Neumeyer and Perri (2005) the parameter governing the working capital constraints, θ, is set at 1 in their baseline specifications. As working capital constraints in this paper followed their formulations, I conduct a robustness check to see if different degrees of working capital constraints change the findings. To do this, the same exercise as in the previous section except that I now set θ to 1 instead of 0.69. Figure 12 presents one of the results. It turns out that the discrepancy between the ST model and the data remains as in Figure 2.

For the reasons stated above, a smaller intertemporal elasticity of substitution might increase the relative role of working capital constraints in turning interest rate dynamics into fluctuations in macroeconomic aggregates. The result shows that with lower intertemporal elasticities of substitution, the same pattern emerges.

Figure 12 Volatility of macroeconomic aggregates
under tightened working capital constraints



3. Subgroup Analysis

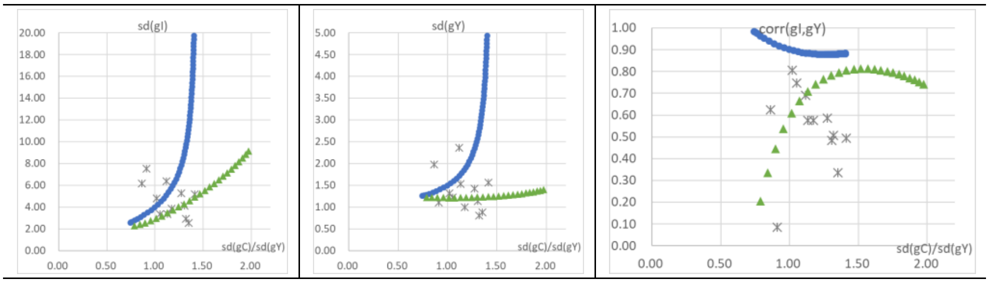
As mentioned above, it has been shown in the literature that models with stochastic shocks to growth can account for the business cycle of Mexico. This paper mainly looks at the cross−country variation to suggest the stochastic shocks are not sufficient to explain fluctuations in emerging economies. But it is possible that business cycle of some emerging countries can be satisfactorily explained by the ST model. So in this part I look into the characteristics of the countries in the data sample. In particular, I make use of measures of financial frictions of the countries to divide the sample into two groups. The proxy for the degree of financial friction is the Financial

Market Depth index provided by IMF. Among many indices that gauge the degree of financial market development, this index captures closely the financial frictions specified in the FF model governed by the parameter η. This index includes the size of the stock market and how active it is, the outstanding volume of international debt securities of sovereigns and international and domestic debt securities of financial and nonfinancial corporations.

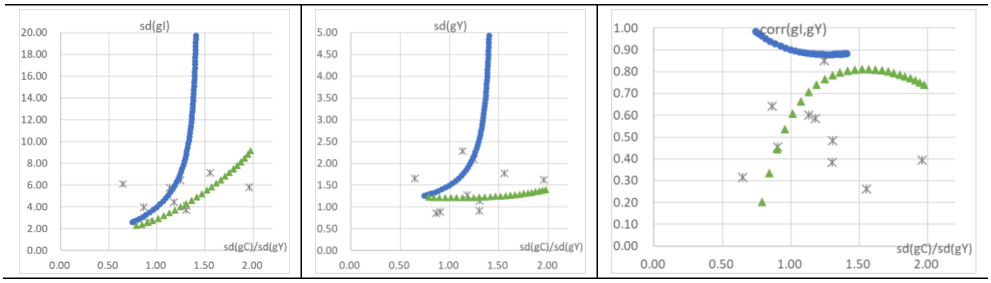
First the countries are divided into two groups, based on the average value of the index across the sample period. The countries that has an average value of the index lower than median are placed into the FF group, and the rest of the countries belong to the ST group. When the scatter plots in the previous part are redrawn respectively for each group, they show that the data pattern of the FF group is more closely in line with the predictions of the FF model. Although due to the small size of the sample a rigorous statistical analysis is not possible, this exercise adds to the evidence that for some emerging countries, they are clearly subject to more severe financial frictions in the economy, and the model with shocks to productivity alone cannot account for the business cycle of those emerging countries.

Figure 13 Moments comparison by groups

A. The ST group (weaker financial frictions)



B. The FF group (stronger financial frictions)



V. Concluding Remarks

Business cycle fluctuations in emerging-market economies are characterized differently from those in developed-market economies. Recent research in the literature has proposed two sources that drive business cycles in emerging countries, one relying on permanent and transitory shocks to productivity and the other based on stochastic interest rates interacting with financial frictions. The present study scrutinizes both ideas.

The starting point of this investigation is the notion that if either of these sources play an important role in accounting for emerging countries' business cycles, then they should be able to confront observed pattern between pairs of moments in the cross-country data. This calls for a broader cross-country dataset. Accordingly, I build a dataset covering 21 emerging-market countries. Then the dataset is used to paint a more complete picture of the aggregate fluctuations in emerging countries. The analysis of this paper presents a departure from the usual practice in the related studies which base their empirical argument on the data for a small group of countries.

Chang and Fernandez (2013) aims similar as this paper but adopts an encompassing model approach where both mechanisms are incorporated. Since this approach might suppress the role of stochastic trend shocks by design, the present paper uses two models each featuring these two ideas instead. One is a standard RBC model of the small open economy driven by permanent and transitory productivity shocks, and the other is driven by transitory productivity shocks and interest rate shocks coupled with financial frictions.

Comparing the predictions of the two models with the cross-country data, this paper arrives at the conclusion that the financial frictions model does a better job at accounting for cross-country variations than the stochastic trend model along several dimensions. One such dimension is the volatility of investment and output. The stochastic growth model predicts output and investment to be significantly more volatile than its corresponding empirical counterpart for the countries whose relative volatility of consumption is very large. By contrast, the model featuring financial frictions produces excess consumption volatility at a stable and realistic level of output volatility, in line with the observed pattern. In addition, this paper finds a disparity between the data and computed moments of both models in the correlation between volatility of consumption and investment, both relative to output. Furthermore, this paper finds that the stochastic growth model does not match satisfactorily the comovement of output with investment and trade balance. Lastly, a salient feature of the model with financial frictions is that it matches well the interest rate dynamics.

I interpret these results as suggesting that severe financial frictions in the economy show up as distortions in the response of investment and consumption to underlying productivity, rather than captured by the persistence of Solow residuals alone, as Aguiar and Gopinath (2007) state. This also suggests it is promising to formulate and quantitatively evaluate dynamic stochastic models of the emerging economy with micro-founded financial frictions.

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Appendix

1. Data

1) Macroeconomic aggregates (C, I, TBY, Y)

Country	Start of period	End of period	Data source
Argentina	Q2 1993	Q4 2018	Oxford Economics
Brazil	Q2 1996	Q4 2018	OECD QNA*
Chile	Q2 1996	Q4 2018	OECD QNA
Colombia	Q2 2000	Q4 2017	OECD QNA
Czech	Q2 1994	Q4 2018	OECD QNA
Ecuador	Q2 1990	Q4 2018	Oxford Economics
Hungary	Q2 1995	Q4 2018	OECD QNA
Indonesia	Q4 1990	Q4 2018	Oxford Economics
Israel	Q2 1995	Q4 2018	OECD QNA
Malaysia	Q2 1980	Q4 2018	Oxford Economics
Mexico	Q2 1993	Q4 2018	OECD QNA
Peru	Q2 1990	Q4 2018	Oxford Economics
Philippines	Q2 1981	Q4 2018	Oxford Economics
Poland	Q2 1995	Q4 2018	OECD QNA
Romania	Q2 1995	Q4 2018	National Institute of Statistics, Romania
Russia	Q2 1995	Q4 2018	OECD QNA
Slovak Republic	Q2 1995	Q4 2018	OECD QNA

South Africa	Q1 1980	Q4 2018	OECD QNA
South Korea	Q1 1980	Q4 2018	OECD QNA
Thailand	Q2 1993	Q4 2018	NESDB**, Thailand
Turkey	Q1 1980	Q4 2018	OECD QNA

*OECD QNA refers to OECD Quarterly National Accounts.

**NESDB refers to Office of the National Economic and Social Development Board.

2) Country-specific spread (S)

Country	Start of period	End of period
Argentina	Q2 1994	Q4 2018
Brazil	Q2 1996	Q4 2018
Chile	Q4 1999	Q4 2018
Colombia	Q2 2000	Q4 2017
Ecuador	Q3 1995	Q3 2018
Indonesia	Q4 2004	Q4 2018
Malaysia	Q2 1997	Q4 2018
Mexico	Q2 1994	Q4 2018
Peru	Q3 1997	Q4 2018
Philippines	Q2 1998	Q4 2018
Poland	Q2 1995	Q4 2018
Russia	Q2 1998	Q4 2018
South Africa	Q2 1995	Q4 2018

South Korea	Q2 1994	Q3 2004
Thailand	Q4 1997	Q2 2006
Turkey	Q4 1996	Q4 2018

3) Financial Market Depth Index (FMD)

	Average FMD	Group
Argentina	0.0927	FF
Brazil	0.2097	ST
Chile	0.3053	ST
Colombia	0.1126	FF
Czech	0.0987	FF
Ecuador	0.0320	FF
Hungary	0.1420	FF
Indonesia	0.1539	FF
Israel	0.2531	ST
Malaysia	0.6251	ST
Mexico	0.1712	ST
Nigeria	0.0561	FF
Peru	0.1076	FF
Philippines	0.4109	ST
Poland	0.1015	FF
Romania	0.0243	FF
Russia	0.1688	ST
Slovak Republic	0.0453	FF

South Africa	0.4703	ST
South Korea	0.4537	ST
Thailand	0.4110	ST
Turkey	0.1755	ST
Median	0.1614	

Notes: The average is for the period between 1980–2016, and the data source is Financial Development Index Database, IMF.

국문초록

본 논문에서는 신흥국에서 소득대비 소비의 변동성이 크게 나타나는 원인을 국가별 자료를 사용하여 살펴보았다. 선진국과 달리 신흥국에서 소득대비 소비의 변동성이 크게 나타나는 원인에 대한 연구는 크게 영구적인 생산성충격이 이를 유발한다는 견해와 명시적인 금융제약과 결합한 일시적 생산성충격이 이를 유발한다는 견해로 두 갈래로 나누어 진행되었다. 여러 논문에서 특정 국가의 자료를 이용하여 각각의 접근법 모두 과도한 소비 변동성을 유발할 수 있음을 실증적으로 분석하였는데, 본 논문은 여러 국가의 자료를 사용한다는 점에서 차이를 가진다. 본 논문은 이를 위해 전통적인 RBC 모형에 영구적 생산성 충격을 도입한 모형과, 금융제약을 도입한 모형에 대해 분석을 실시하였다. 구체적으로 두 개의 모형이 각각 국가별 자료에서 나타나는 거시변수의 모멘트의 패턴에 잘 부합하는지 살펴본 결과 다음과 같은 사실을 확인할 수 있었다. 소비변동성이 매우 큰 나라들을 포함한 국가별 자료와 비교했을 때, 금융제약이 있는 모형이 영구적 생산성 충격이 있는 모형보다 신흥국의 경기변동을 더 잘 설명한다는 점이다. 본 논문은 두가지 접근법에 대해 보다 포괄적인 실증적 증거를 제시함으로써 금융제약이 투자와 소비의 충격에 대한 반응에 명시적으로 나타나지 않고 영구적 생산성충격만으로 요약될 수 있다는 관점에 반하는 증거를 제시한다.

주요어: 신흥국 경제, 경기 순환, 금융제약, 국가 리스크 프리미엄, 확률적 추세성장 충격, 소규모 개방경제

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