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By

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ABSTRACT

ESSAYS ON BUSINESS CYCLES IN EMERGING ECONOMIES

By

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In the last several decades, business cycles were significant in emerging economies. An important observation is that real interest rates are negatively correlated with output, while there is no such pattern in developed economies. This raises the question: Do real interest rate shocks drive business cycles in emerging economies? Extant literature modifies the standard small open economy RBC model by introducing a working capital constraint and shows that international interest rate shocks can drive business cycles in emerging economies through their effects on the labor market. This thesis aims to show that financial constraints can play a role in transmitting interest rate shocks and international interest rate shocks can drive business cycles in emerging economies through their effects on the credit market.

<u>Chapter 1</u>: Real Interest Rates, Credit Constraints and Business Cycles in Emerging Economies (with Raoul Minetti)

This essay studies how international real interest rate shocks can drive business cycles in emerging economies. We present evidence that, in emerging economies, real interest rates and real estate prices are negatively correlated and real interest rates are countercyclical. Motivated by this evidence, we develop a model of a small open economy, where the entrepreneur is borrowing constrained and the domestic lenders is lending constrained. We show that a positive interest rate shock leads to a fall in the real

estate price and, through the credit constraints, to a decline in output. The model is calibrated to Argentina data. Simulation results show that our model can explain the countercyclicality of real interest rates and the output pattern better than a model with the borrowing constraint but without the lending constraint.

Chapter 2: Real Interest Rates and Business Cycles in Emerging Economies

This essay studies the relationship between real interest rates and business cycles in emerging economies in a dynamic general equilibrium setting. I modify the standard small open economy RBC model by introducing a net worth constraint. The net worth constraint serves as a financial accelerator which can amplify and prolong the effects of interest rate shocks. I calibrate the model economy to Argentina data. Quantitative results show that real interest rates are negatively correlated with output and this negative relationship is stronger for a more constrained economy than for a less constrained economy.

Chapter 3: The Determinants of Country Risk Spreads: Evidence from Argentina

This essay studies the determinants of the country risk spread by using Argentina's monthly data during the period January 1998 to December 2006. We find that the country risk spread is not a perfect measure of the default risk. Our estimation results suggest that although international investors tend to take into account the default risk. Other factors which may not represent the existence of the default risk, such as contagion effect, investors' memory, IMF bailout expectations are also important in determining the country risk spread.

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Chapter 1

Lending Constraints, Real Estate and Business Cycles in Emerging Economies

1. Introduction

In the last several decades, emerging economies experienced significant business cycles. Associated with output fluctuations, a number of facts can be observed: (1) Credit and property price experience large fluctuations. For instance, over the 1980-95 period, the volatilities of bank credit to private sector for Argentina, Brazil, Mexico were 34.4, 32.8, 22.1, respectively, while they were 3.4, 2.5, 3.1 for the United States, Japan and Germany, respectively (Goldstein and Turner, 1996). In addition it is found that during the last four decades, rising (falling) property price was strongly associated with the build up (declining) phase of credit boom in emerging economies (Mendoza and Terrones, 2008). (2) Real interest rates are countercyclical. For example, during 1994 to 2001, the average correlation coefficient between output and the real interest rate for the five emerging economies (Argentina, Brazil, Korea, Mexico, and Philippines) was -0.55, while this correlation coefficient for the five small open developed economies (Australia, Canada, Netherlands, New Zealand, and Sweden) was 0.19 (Neumeyer and Perri, 2005).

The objective of this paper is to develop a small open economy model with credit constraints tied to real estate prices to account for the countercyclicality of real interest rates in emerging economies. In our model, entrepreneurs borrow from domestic households and foreign lenders. Both entrepreneurs and domestic households face credit frictions. Entrepreneurs must pledge collateral for borrowing. As in Iacoviello and Minetti (2006), to capture the feature that domestic households have more information about liquidating collateral, we assume that domestic households incur smaller transaction costs for deploying collateral and, hence, for given collateral values, they can grant larger loans to entrepreneurs than foreign lenders. However, unlike in Iacoviello and Minetti (2006), in our model domestic households also face credit frictions. In particular, domestic households' lending is constrained by the value of their real estate holdings. This modeling of the lending constraint is supported by empirical evidence. Chiuri et al. (2001) document that during the last decade an increasing number of emerging economies have adopted a bank capital adequacy requirement following the spirit of the Basel I Capital Accord. The capital adequacy requirement imposes that banks maintain a minimum capital-risk weighted asset ratio. Using bank-level data from 16 emerging economies, Chiuri et al. (2001) find that the enforcement of bank capital adequacy requirements significantly curtailed credit supply in these countries.

We show that a positive real interest rate shock causes a reduction in the real estate price. As a result, both the borrowing constraint and the lending constraint tighten, which leads to a decrease in entrepreneurs' investment in real estate and variable capital, and a subsequent output drop. We compare quantitatively our model with a benchmark model with the borrowing constraint but without the lending constraint. In order to carry out quantitative comparisons, we calibrate the model to

Argentina data. The impulse response functions show that a positive interest rate shock induces a 0.8% decline in output in the model with both credit constraints (our preferred model), while it induces a 0.4% output drop in the model without the lending constraint (the comparison model). Simulation results show that in the preferred model the correlation coefficient between real interest rate and output is -0.72, which is close to the data -0.75. This suggests that a model incorporating both the borrowing constraint and the lending constraint can better explain the regularities of real interest rates and business cycles in emerging economies.

The remainder of this paper is organized as follows. Section 2 discusses the related literature. Section 3 documents the empirical regularities of real interest rates, real estate prices and output in emerging and in developed economies. In addition, we provide empirical evidence about the relationship between bank lending and bank capital. Section 4 presents our preferred model. Section 5 presents the model without the lending constraint. Section 6 specifies the shock processes and parameterization. Section 7 discusses the transmission mechanism and presents the results. Section 8 concludes.

2. Related Literature

This paper most closely relates to Neumeyer and Perri (2005), Kiyotaki and Moore (1997) and Iacoviello and Minetti (2006). Neumeyer and Perri (2005) study the countercyclical pattern of real interest rates in emerging economies. They modify the standard small open economy RBC model by introducing a working capital constraint and show that a positive interest rate shock has a negative effect on labor demand, causing a decline in output. Our paper differs from Neumeyer and Perri (2005) in that the transmission mechanism operates through the credit market rather than through the labor market.

Kiyotaki and Moore (1997) analyze the dynamic interaction between a borrowing constraint and asset prices and how this interaction can transmit small shocks to large, persistent output fluctuations. Iacoviello and Minetti (2006) extend Kiyotaki and Moore (1997) to an open economy environment. They assume that domestic and foreign lenders have different liquidation technologies, which induces entrepreneurs to adjust their debt exposure and allocation of collateral between domestic and foreign lenders in response to productivity shocks. The objective of Iacoviello and Minetti (2006) is to explain the comovement of output across countries. Although our paper shares a similar transmission mechanism of shocks, it is distinct from Kiyotaki and Moore (1997) and Iacoviello and Minetti (2006) as it introduces a lending constraint and studies the aggregate consequences of interest rate shocks rather than technology shocks.

The novelty of our approach is that we consider an economy in which not only entrepreneurs are borrowing constrained but also lenders are lending constrained. The extant literature on the financial accelerator focuses either on the firm's balance sheet channel (Bernanke et al. , 1998, Kiyotaki and Moore, 1997, Iacoviello, 2005, etc.) or the bank lending channel (Minetti, 2007, Van and Heuvel, 2007, etc.). An exception is Holmstrom and Tirole (1997) who consider moral hazard problems when a firm manages its investment and when financial intermediaries monitor firms. Holmstrom and Tirole (1997) show that a credit crunch (a reduction in the financial intermediary's capital) or a collateral squeeze (a reduction in firms' net worth) raises firms' threshold of net worth (above which the firm can obtain external finance without violating the firm's and the financial intermediary's incentive compatible constraints and the investor's participation constraint) and leads to a decrease in investment. The model in Holmstrom and Tirole (1997) is static and the analysis is qualitative. By contrast, our model is dynamic and the analysis is quantitative.

There exists a growing literature on business cycles in emerging economies. Aguiar and Gopinath (2007) identify shocks to trend growth as the primary source of fluctuations in emerging economies in a standard RBC model. Uribe and Yue (2006) investigate the intricate relation linking the world interest rate, country risk spreads and emerging market fundamentals and the roles of world interest rates and country risk spreads in driving business cycles in emerging economies. Oviedo (2005) explores the relation among interest rates, borrowing-lending spreads and business cycles in emerging economies.

3. Stylized Facts

In this section, we document the empirical regularities of real interest rates, real estate prices and output in seven emerging economies (Argentina, Hong Kong, Korea, Malaysia, Mexico, Thailand and Turkey) and contrast them with those of seven small open developed economies (Austria, Australia, Canada, Denmark, Netherlands, New

Zealand and Sweden). We also explore the relationship between bank lending and bank capital.

3.1 The Empirical Regularities of Real Interest Rates, Real Estate Prices and Output in Emerging and Developed Economies

3.1.1 Data Overview

The key variables we are interested in are real interest rates, real estate prices and real output. There is no single database containing real estate prices for different countries. For all the above countries except Argentina, we use the house price index (HPI) obtained from various sources as a proxy for real estate prices. For Argentina, since the house price index is not available, we use the Global Property Research (GPR) Argentina General Index as a proxy for real estate prices. The GPR Argentina General Index is calculated based on total return (price return and dividend return) on shares of IRSA, the largest real estate company in Argentina. The availability of the HPI (or the GPR index) is a major factor why we choose the above countries. For the seven developed economies, the sample starts in the first quarter of 1994 and ends in the fourth quarter of 2006. For Argentina, Hong Kong, Korea, Thailand and Turkey, the sample starts in the first quarter of 1994. For Malaysia, the sample starts in the first quarter of 1999. For emerging economies, the sample has at least 32 quarters of data. Appendix A provides details on the source of data for each economy.

We choose the year 2000 as a base year and compute the real house price index (or the real GPR) by dividing the house price index (or the GPR) by the consumer price index. We construct real interest rates as in Neumey and Perri (2005). For developed economies, the real interest rate is obtained by subtracting the expected inflation rate from the short term nominal interest rate reported in OECD statistics. The expected inflation rate is computed as the average of inflation in the current period and in the three preceding periods. For Argentina, Korea and Thailand, the nominal interest rates are constructed as the 90-day U.S. T- bill rate (proxy for the world interest rate) plus the J.P Morgan EMBI (Emerging Market Bond Index) spread. The real interest rates are obtained by subtracting expected U.S. inflation rate from the nominal dollar rate. As argued by Neumey and Perri (2005), constructing real interest rates in this way has the advantage of not relying on the local inflation rate, which is usually volatile and difficult to compute. Moreover, it has the advantage of reflecting the true intertemporal terms of trade faced by local private agents during financial crises. In fact, during crises most of the new borrowing of emerging countries in the international financial markets occurs through official institutions. For Malaysia and Turkey, although EMBI spread are available, there are many missing data in our sample, so we construct the real interest rate by subtracting the expected inflation rate from the local currency denominated short term interest rate (3-month T-bill rate for Malaysia and interbank interest rate for Turkey).

3.1.2 Observations

We test each series for a seasonal component and deseasonalize the series when a significant seasonal component is discovered. We then filter the series using the

Hodrick-Prescott filter with smoothing parameter 1,600 to derive business cycle movements.

Table 1.1 reports the correlation coefficients among real interest rates, real estate prices and output for emerging economies and for developed economies. The first column of Table 1.1 reveals that there is a negative comovement between real interest rates and real estate prices in emerging economies, while there is no such pattern in developed economies. In emerging economies, on average the correlation coefficient is - 0.36 and it ranges from - 0.70 in Korea to - 0.14 in Thailand. In developed economies, on average the correlation coefficient is 0.19 and it ranges from 0.50 in Canada to 0.06 in New Zealand.

The second column of Table 1.1 documents the correlation of real estate prices with output. In both sets of economies real estate prices are procyclical. However, the average correlation coefficient for emerging economies is 0.34, while it is 0.29 for developed economies, signaling that the relationship between real estate prices and output in emerging economies is stronger than in developed economies.

The third column of Table 1.1 reports the correlation of real interest rates with output. Our results are consistent with those in existing literature. In emerging economies, real interest rates are countercyclical. The correlation coefficient ranges from - 0.75 in Argentina to - 0.21 in Thailand, with an average of - 0.44. In developed economies, real interest rates are procyclical or acyclical. The correlation coefficient ranges from 0.46 in Canada to – 0.11 in Australia, with an average of 0.23.

Table 1.1 Business cycles in emerging and developed economies

	Corr (R,HPI)	Corr (HPI,Y)	Corr (R, Y)
Emerging economies			
Argentina	- 0.42	0.45	- 0.75
Hong Kong (China)	- 0.18	0.49	0.05
Koreal	- 0.70	0.52	- 0.45
Malaysia	- 0.34	0.39	- 0.42
Mexico	- 0.27	0.34	- 0.44
Thailand	- 0.14	0.27	- 0.21
Turkey	- 0.20	0.08	- 0.36
Average	- 0.32	0.36	- 0.37
Developed economies			
Austria	0.10	0.16	0.11
Australia	0.02	0.17	- 0.01
Canada	0.50	0.22	0.46
Denmark	0.26	0.64	0.44
New Zealand	0.06	0.26	0.13
Netherlands	- 0.13	0.59	0.13
Sweden	0.05	0.62	0.48
Average	0.12	0.38	0.25

For developed countries, the procyclicality or acyclicality of real interest rates and the positive relation between real interest rates and real estate prices could stem from the endogenous monetary policy stance. However, a detailed exploration of these relationships in developed economies is beyond the purpose of the present paper.

3.2 The Relationship between Bank Lending and Bank Capital in Emerging Economies

Since the lending constraint is the critical feature in our model, in this subsection, we conduct empirical analysis to test whether the amount of lending and the level of bank capital are closely related in emerging economies. To investigate the effects of bank capital on bank lending, we estimate the following equation,

$$loan_t = \alpha + \beta \, capital_{t-1} + \varepsilon_t$$

Where α is a constant, β captures the effects of bank capital at period t-1 on bank lending at period t. ε_t is the error term. The data on loans and bank capital are aggregate data. The data has monthly frequency except the data of Korea, for which only quarterly data is available.

Table 1.2 shows the regression results. In general, the results are satisfactory from the perspective of the signs and level of significance of the coefficients. For example, for Argentina, an increase in bank capital by 1 peso will lead to an increase in bank lending by 3.5 pesos. This effect is strongly statistically significant (t = 27.51). For Thailand, an increase in bank capital by 1 baht is expected to cause an increase in bank lending by 6.02 baht. This effect is also statistically significant (t = 8.62). Thus, our analysis provides additional evidence that there is a close relationship between bank lending and bank capital in emerging economies.

Table 1.2 Regression Results

Country	$\hat{\beta}$	t statistic
Argentina	3.5	27.51
Korea	9.93	8.00
Malaysia	8.72	21.74
Mexico	1.9	24.61
Slovak	8.08	0.64
Thailand	6.02	8.62
Turkey	6.4	29.55

4. The Model Economy

This section describes a small open economy in which the empirical regularities established in the preceding section can be interpreted as the equilibrium of an economy subject to shocks to the world interest rate. We build on Iacoviello and Minetti (2006) but impose a lending constraint and model the real interest rate following Neumeyer and Perri (2005).

Time is discrete and infinite, t = 0,1,2...... There are three types of agents in this economy: entrepreneurs, households and foreign lenders. There is a final good which is invested and produced by entrepreneurs and consumed by entrepreneurs and households. There are two kinds of assets. One is a fixed amount of real estate that can be used either by entrepreneurs as input for production and collateral for loans or by households as a consumption good. The other asset is a non-contingent bond that can be traded by entrepreneurs, households and foreign lenders in the domestic and international financial markets. In each period, the economy is subject to interest rate shocks and productivity shocks, which are revealed at the beginning of the period.

4.1. Households

Preferences and constraints There are a large number of identical infinitely lived households in the model economy. Households derive utility from consumption, real estate services and leisure. The representative household's expected lifetime utility is given by

$$E_0 \sum_{t=0}^{\infty} \beta^t (\ln c_t' + j \ln h_t' - \frac{\tau}{\eta} n_t'^{\eta}) \tag{1}$$

Where E_0 denotes the expectation operator conditioned on the information available in period 0. β is the household's subjective discount factor, c'_t is the household's consumption, h'_t is its real estate holdings, n'_t is its labor supply, φ is the utility weight on the household's real estate. η is the labor supply elasticity and τ is the weight parameter on the disutility of labor.

In each period, the household enters with real estate h'_{t-1} and bonds coming to maturity B'_{t-1}. It rents labor to entrepreneurs, purchases bonds issued by entrepreneurs, invests in real estate and consumes. The household's period budget constraint is

$$c_t'+B_t'+q_t(h_t'-h_{t-1}') = \omega_t n_t'+R_{t-1}B_{t-1}' \tag{2}$$

where q_t is the real estate price in terms of the consumption good, ω_t is the real wage rate, R_t is the real interest rate.

When households lend to entrepreneurs, their lending is constrained. In particular, the household's lending is subject to the following lending constraint

$$B_t' \leq \sigma q_t h'_{t-1} \tag{3}$$

Where σ is a constant satisfying $0 \leq \sigma \leq 1$. In period t, the household's lending cannot exceed a fraction of the value of its real estate holdings at the beginning of the period. The parameter σ can be thought of as the inverse of the capital adequacy ratio. We tie the household's lending to the value of its previous period real estate holdings since this value can represent the major component of its net worth. Indeed, the price of real estate and bank capital are closely related. "A reduction in the price of real estate will decrease bank capital directly by reducing the value of the bank's own real estate assets. It will also reduce the value of loans collateralized by real estate and may lead to defaults, which will further reduce bank capital" (Herring and Watcher, 1999).

The Household's problem In each period, the household choose consumption, real estate holdings, labor supply, and the amount of lending to maximize its expected lifetime utility (1) subject to the budget constraint (2) and the lending constraint (3). Before we solve the household's problem, we make the following assumption:

Assumption 1 The household's subjective discount factor, β, satisfies

$$\beta R > 1.$$

In conjunction with assumption 2 below, this assumption ensures that the household will lend to the entrepreneur in equilibrium since it is more patient than the entrepreneur. This assumption will also ensure that the household's lending constraints is binding in steady state. Under assumption 1, we can treat that the lending constraint is binding around the steady state of the economy.

Let λ_t' be the multiplier associated with the lending constraint. The first order conditions for the household's problem are:

$$[c_t']: \quad \frac{1}{c_t'} + \lambda_t' = E_t \beta \frac{1}{c_{t+1}'} R_t \tag{4}$$

$$[h_t']: \quad \frac{1}{c_t'} q_t = \frac{j}{h_t'} + E_t \beta \left(\frac{1}{c_{t+1}'} q_{t+1} + \lambda_{t+1}' \sigma q_{t+1} \right) \tag{5}$$

$$[n_t']: \quad \tau n_t'^{\eta - 1} = \frac{1}{c_t'} \omega_t \tag{6}$$

The household chooses consumption, real estate holdings and labor supply by equating marginal utility losses and marginal utility gains. Equation (6) is the standard first order condition for labor supply. The first order conditions for bond holdings (equation (4)) and the first order condition for household's real estate demand (equation (5)) are different from standard ones due to the presence of the lending constraint.

4.2. Entrepreneurs

Preferences and Constraints There are a large number of identical infinitely lived entrepreneurs who maximize the following expected lifetime utility

$$E_t \sum_{t=0}^{\infty} \gamma^t \ln c_t , \tag{7}$$

where γ is the representative entrepreneur's subjective discount factor, and c_t denotes consumption.

The entrepreneur's production function is a Cobb-Douglas given by

$$y_t = F(k_t, h_t, n_t; A_t) = A_t k_{t-1}{}^{\mu} h_{t-1}{}^{\nu} n_t{}^{1-\mu-\nu} , \tag{8}$$

where y_t is output, k_t is the variable capital stock that can be reproduced from the final good, h_t is the entrepreneur's real estate, n_t is the labor input and A_t is the exogenous stochastic productivity. μ and ν are the variable capital share parameter and the real estate share parameter, respectively.

Variable capital accumulation follows the law of motions

$$k_t = i_t + (1-\delta) k_{t-1}, \tag{9}$$

where i_t is the investment expenditure in period t, and δ is the depreciation rate.

In each period, the entrepreneur borrows from the household and the foreign lender, invests in variable capital and real estate, produces using the variable capital, real estate and labor, pays wages, repays debt, and consumes. The entrepreneur's period budget constraint is given by

$$A_t k_{t-1}^{\mu} h_{t-1}^{\nu} n_t^{1-\mu-\nu} + B_t^H + B_t^F = c_t + k_t - (1-\delta)k_{t-1} +$$
$$+ q_t(h_t - h_{t-1}) + R_{t-1}B_{t-1}^H + R_{t-1}B_{t-1}^F + \omega_t n_t \tag{10}$$

where B_t^H is the entrepreneur's domestic borrowing while B_t^F is the entrepreneur's foreign borrowing.

When the entrepreneur borrows from the household and the foreign lender, she faces a borrowing constraint, i.e. she cannot borrow more than the expected present value of her pledgeable resources net of any recovery cost. We assume that the entrepreneur can use only real estate as collateral for loans. We also assume that the household pays less transaction costs for disposing of the collateral than the foreign lender. This assumption wants to capture the idea that households have relatively more local experience or knowledge necessary for the recovery and redeployment of the collateral. In the event of debt repudiation, the household expects to pay a transaction cost $E_t((1-m_H)q_{t+1}h_t)$ and expects to receive a recovery value of

$$E_t(q_{t+1}h_t - (1-m_H)q_{t+1}h_t) = E_t(m_H q_{t+1}h_t) \tag{11}$$

where m_H can be thought of as a proxy for domestic loan to value ratio. The foreign lender expects to pay a transaction cost $E_t((1-m_F)q_{t+1}h_t)$ and expects to receive a recovery value of

$$E_t(q_{t+1}h_t - (1-m_F)q_{t+1}h_t) = E_t(m_F q_{t+1}h_t) \tag{12}$$

where $m_F < m_H$ can be thought of as a proxy for the foreign loan to value ratio. Since $m_F < m_H$, the entrepreneur would like to borrow from the household as much as possible. However, she may not be able to do so since the household is lending constrained. In this case, the entrepreneur will borrow partly from the foreign lender in order not to waste collateral. Let α_t be the share of real estate h_t used by the entrepreneur as domestic collateral and 1 - α_t the share used as international collateral. The entrepreneur's borrowing constraints are

$$R_t B_t^H \leq E_t(\alpha_t m_H q_{t+1} h_t) \tag{13}$$

$$R_t B_t^F \leq E_t((1-\alpha_t) m_F q_{t+1} h_t) \tag{14}$$

The entrepreneur's problem The entrepreneur chooses factor inputs (real estate, variable capital, labor), the amount of borrowing and consumption to maximize her lifetime expected utility (7) subject to the budget constraint (10) and the borrowing constraints (13) and (14). Before we solve the entrepreneur's problem we make the following assumption.

Assumption 2 The entrepreneur's subjective discount factor satisfies

$$\gamma R < 1$$

Under assumptions 1 and 2, we can treat the borrowing constraints are binding around the steady state of the economy.

Let λ_t^H, λ_t^F denote the multipliers associated with the domestic and foreign borrowing constraints, respectively. The first order conditions for the entrepreneur's problem are:

$[c_t]$: $$\frac{1}{c_t} = \lambda_t^H R_t + E_t \frac{\gamma}{c_{t+1}} R_t \tag{15}$$

$[c_t]$: $$\frac{1}{c_t} = \lambda_t^F R_t + E_t \frac{\gamma}{c_{t+1}} R_t \tag{16}$$

[h_t]: $$\frac{1}{c_t} q_t = E_t(\lambda_t^H \alpha_t m_H q_{t+1} + + \lambda_t^F (1-\alpha_t) m_F q_{t+1} + \frac{\gamma}{c_{t+1}}(v \frac{y_{t+1}}{h_t} + q_{t+1})) \tag{17}$$

[k_t]: $$\frac{1}{c_t} = E_t \frac{\gamma}{c_{t+1}}(\mu \frac{y_{t+1}}{k_t} + 1 - \delta) \tag{18}$$

[n_t]: $$(1-\mu-v) y_t = \omega_t n_t \tag{19}$$

The entrepreneur chooses factors demands and borrowing by equating marginal utility costs and marginal utility gains. Equations (18) and (19) are standard first order conditions for variable capital stock and labor demand. Equations (15) and (16) are first order conditions for consumption. Equation (17) is the first order condition for the entrepreneur's real estate demand. Equations (15), (16) and (17) are different from the standard first order conditions due to the presence of the borrowing constraints.

If the maximum present value of the entrepreneur's domestic debt limit, $E_t m_H q_{t+1} h_t / R_t$, is less than the household's lending limit, $\sigma\, q_t h_{t-1}'$, then the household's lending constraint has no effect on the entrepreneur's borrowing. To rule out this uninteresting case, we assume that in equilibrium $E_t m_H q_{t+1} h_t / R_t > \sigma\, q_t h'_{t-1}$ holds and check that this is true in the steady state equilibrium[(1)]. This means that in equilibrium $E_t(\alpha_t m_H q_{t+1} h_t / R_t) = \sigma\, q_t h'_{t-1}$, i.e. the domestic borrowing equals domestic lending (Recall that we assumed that the domestic borrowing and the lending constraints are binding in equilibrium). This condition determines α_t, the fraction of borrowing from the household.

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(1): Given mH and R are close to 1, this condition is satisfied as long as the gap between h and h' is not large.

4.3. Discussion

Novelty of the paper The novelty of this paper is that we consider an economy in which the entrepreneur's borrowing constraint and the household's lending constraint can bind simultaneously in equilibrium. In a closed model economy this cannot be true. In fact, if one constraint binds, the other will not bind (unless the debt capacity and the lending capacity are the same). However, in our small open economy environment, this can be true since when the lending constraint is binding, entrepreneurs can still borrow from foreign lenders up to her debt capacity, although they can only borrow less from foreign lenders.

Colletaral-based constraints in emerging economies Although most of the existing models with collateral-based borrowing constraints aim to explain business cycles in developed economies, recent empirical studies show that collateral-based credit is a more common phenomenon in emerging economies. Based on a panel dataset of 3199 manufacturing establishments from 1984 to 1994 in Mexico, Gelos et al. (2002) explore the role of real estate as collateral by examining the relationship between firms' investment and the value of their real estate holdings. They find that the value of real estate has a significant positive effect on the investment decisions of all firms and this effect is stronger after the financial liberalization in 1989. Using a dataset of 560 credit files of Thai commercial banks, Menkhoff et al. (2005) document that the incidence and degree of real estate based collateralization are higher in Thailand than in developed countries. The relatively important role of collateral in emerging economies' credit activities is easily understood. Theoretically, collateral is regarded as a means to solve the potential enforcement problem in the credit relationship and the problem of credit rationing due to asymmetric information between lenders and borrowers. Since these problems are more severe in emerging economies, the need for collateral in credit activities is higher in emerging economies than in developed economies.

Real interest rate As in Neumeyer and Perri (2005), we assume that all agents in the model economy face the same real interest rate, which is charged by foreign lenders. This is justified by the following three assumptions. First, we have assumed that there is only one financial asset, a noncontingent bond in the model economy. Second, we assume that that the emerging economies are net debtors to the rest of the world. This assumption can be justified by the fact that most economies in Latin America are net debtors to the rest of the world. Third, we assume the emerging economy we study is a small open economy. The one real interest rate assumption simplifies the modeling but does not change the general results of the issue we are interested in.

Household's budget constraint In a standard small open economy RBC model, a bond holding adjustment cost is commonly modeled in the household's budget constraint to ensure stationarity. In a standard small open economy model, since the real interest rate is exogenous, the steady state of the model depends on the household's initial bond holdings and the equilibrium dynamics of the endogenous variables possess a random walk component. Thus, a bond holding adjustment cost is needed to guarantee stationary. However, in our model, because of the lending constraint, the steady state household's initial bond holdings are tied to the steady states of real estate price and real estate holdings. Thus, we do not add a bond holding adjustment cost in the household's budget constraint.

4.4 Equilibrium

Given initial variable capital stock (k_0), initial real estate holdings (h_0, h'_0), initial bonds (B_0, B'_0)and a sequence of interest rates R_t and productivity A_t , an equilibrium of this economy is a sequence of allocations { $c_t, h_t, B_t, k_t, n_t, \alpha_t$ } for entrepreneurs, a sequence of allocations { c'_t, h'_t, B'_t, n'_t } for households and prices { q_t, ω_t } such that:

(i) The entrepreneur solves her optimization problem.

(ii) The household solves its optimization problem.

(iii) The real estate market, the labor market, and the domestic credit market clear.

4.5. Real Interest Rate

Our model economy is subject to interest rate and productivity shocks. We follow the literature to model real interest rates in emerging economies as a product of world interest rates and country risk spreads.

$$R_t = R_t^{\,w} D_t \qquad (20)$$

Where $R_t^{\,w}$ denotes the world interest rate and D_t denotes the country risk spread. The world interest rate is identified as the 3–month T–bill rate in the United States. Country risk spreads capture foreign lenders responses to investment risks and uncertainty in emerging economies. There is no single theory about how to model the country risk spread. Uribe and Yue (2006) model country risk spreads as a function of current and past values of a set of endogenous variables (output, investment and balance of payments) and world interest rates. Li (2007) models country risk spread as a function of net external debt position. Neumey and Perri (2005) model country risk spreads as a function of expected future productivity. All of them link the country risk spreads to economic fundamentals since empirical analyses show that fundamentals in emerging economies has effects on country risk spreads (see Uribe and Yue (2006) for a literature review). We follow Neumey and Perri's (2005) approach to model country risk spreads. That is,

$$D_t = f(E_t A_{t+1}) \tag{21}$$

where f is a decreasing function. Although this modeling has the problem that productivity is exogenous, it is simple and we believe that it still captures some features of country risk behavior in emerging economies. For instance, according to Kehoe (2003), after Argentina launched Convertibility Plan to reduce inflation in 1991, it experienced significant interest rate spikes during the early days of the plan, during the Tequila Crisis and in late 2000. This is because foreign (domestic) investors fear that the Convertibility plan would be abandoned during these periods and inflation would be serious. Empirical evidence has shown that inflation and TFP are negatively correlated in Argentina (Kehoe 2003). Thus, we can think of fears on the part of investors about the high inflation in an emerging economy as their expectations of a low future productivity in that country. In other words, country risk spread and expected future productivity are negatively correlated.

5. A Model without the Lending Constraint

For quantitatively comparison purpose, we introduce a model with borrowing constraint but without lending constraint. In this case, the entrepreneur would borrow from the household up to her debt capacity, i.e. $\alpha_t = 1$. Since the household does not face lending constraint now, we add a bond holding adjustment cost in the household's budget constraint to guarantee stationarity. The household's budget constraint becomes

$$c_t' + B_t' + q_t(h_t' - h_{t-1}') + \frac{\kappa}{2}(B_t' - B')^2 = \omega_t n_t' + R_{t-1} B_{t-1}'$$

(22)

Where $\frac{\kappa}{2}(B_t' - B')^2$ is the bond holding adjustment costs. B' is the steady state of B'_t and κ is a constant parameter. The household's problem is choosing decision variables to maximize lifetime utility subject to the budget constraint (9).

Given initial variable capital stock (k_0), initial real estate holdings (h_0, h'_0), initial bonds (B_0, B'_0)and a sequence of interest rates R_t and productivity A_t, an equilibrium of this economy is a sequence of allocations { c_t, h_t, B_t, k_t, n_t } for entrepreneurs, a sequence of allocations { c'_t, h'_t, B'_t, n'_t } for households and prices { q_t, ω_t } such that:

(iv) The entrepreneur solves his optimization problem.

(v) The household solves his optimization problem.

(vi) The real estate market and labor market clear.

6. Shock processes and parametization

6.1 Shock processes

To close the model, we need to specify the processes for productivity, the world interest rate and the country risk spread. Let the variable $\hat{x}_t$ denote the log deviation of x_t from an HP filtered trend. We assume that total factor productivity, $\hat{A}_t$, and the world interest rate, $\hat{R}_t$, follow AR(1) processes given by (23) and (24)

$$\hat{A}_t = \rho_A \hat{A}_{t-1} + \varepsilon_{A,t}$$

(23)

$$\hat{R}_t = \rho_{RW} \hat{R}_{t-1} + \varepsilon_{R,t} \tag{24}$$

where ρ_A is the autocorrelation coefficient for the productivity process. ρ_{R_W} is the autocorrelation coefficient for world interest rate process, $\varepsilon_{A,t}$ $\varepsilon_{R,t}$ are normally distributed independent productivity and world interest rate shocks with standard deviations $\sigma_{A,t}$ and $\sigma_{Rw,t}$, respectively.

The process for the country risk spread is given by

$$\hat{D}_t = -\overline{\eta} E_t \hat{A}_{t+1} + \varepsilon_{D,t},$$

(25)

Where $\overline{\eta}$ >0 is a constant capturing how much the country risk spread responds to expected productivity shocks and $\varepsilon_{D,t}$ is a normally distributed independent shock with standard deviation $\sigma_{D,t}$.

6.2 Parameterization

To quantitatively analyze the model, we need to set values for the following parameters or exogenous variables: the parameters describing preferences (γ, β, j, η), the parameters describing technology (μ, ν, δ), the loan to value ratios for domestic and foreign debts (m_H, m_F), the inverse of the capital adequacy ratio (σ), the steady state value for the exogenous real interest rate R, and the parameter values for the stochastic processes for productivity and the world real interest rate ($\rho_A, \rho_{Rw}, \overline{\eta}, \sigma_{A,t}, \sigma_{Rw,t}, \sigma_{D,t}$). For the model without the lending constraint, we also need to set values for the household's steady state bond holdings (B') and the bond holding adjustment cost parameter (κ). The parameter values are set either by referring to existing literature on Argentina or by calibration and estimation.

Following Kehoe (2003), we set the labor share ($1 — \mu — \nu$) at 0.6. In Kehoe(2003), the capital share and the land share are set at 0.3 and 0.1, respectively. Since in our model, the real estate does not mean land only, we choose the variable capital share to be 0.2 and the real estate share to be 0.2. The depreciation rate for the variable capital δ is set at 11.3% per year as in Kydland and Zarazaga (2002). This gives us a quarterly depreciate rate of 2.8%. We set the steady state real interest rate equal to 1.1. This value is consistent with an average U.S. interest rate of about 4% and an average country risk spread of about 7% in Argentina. Kydland and Zarazaga (2002) choose the same real interest rate steady state value when they study the driving forces of Argentina's depression in 1980s. Because of the presence of the lending constraint, the household's subjective discount factor β cannot be determined in the usual way (i.e. $R\ \beta\ \neq 1$). We choose β at 0.94, which is between the value

(0.9445) set in Kehoe (2003) and the value (0.93) set in Neumey and Perri (2005). Since we have assumed $\frac{1}{\beta} < R < \frac{1}{\gamma}$ in the steady state, we set the entrepreneur's subjective discount factor γ at 0.9.

The domestic and foreign loan to value ratios are set equal to $m_H = 0.8$ and $m_F = 0.6$. The inverse of capital adequacy ratio is set at 0.3, implying that the share of the entrepreneur's borrowing from the household is about 0.6. The utility weight on the household's real estate is set at 0.2, implying that entrepreneurs and households approximately equally split the real estate stock. As in Iacoviello and Minetti (2006), we set labor supply elasticity equal to 0.05 so that the response of output to shocks depends almost entirely on the behavior of technology and on changes in entrepreneur's real estate holdings in stead of on labor supply.

For the model without the lending constraint, the household's steady state of bond holdings is not uniquely pinned down. We set it at 0.01. The bond holding adjustment cost κ is set at 10^{-5}, the minimum value that guarantees that the equilibrium solution is stationary.

We estimate the parameters for the productivity process based on Solow residuals estimated by Maia and Kweitel (2003) for Argentina from 1960 to 2000. We first take logarithm of these residuals and detrend them using HP filter to get the series $\hat{A}_t$. We then estimate equation (23) and get the estimated correlation coefficient ρ_A =0.81. Given the estimated correlation coefficient, we construct series for the shocks, $\varepsilon_{A,t}$, and use them to find the estimated standard deviation $\sigma_{A,t}$ = 3.8%. Finally, the parameter values determining the process for the world interest rate and

Table 1.3 Parameterization

Parameter values	symbol	core model	comparison model
household discount	β	0.94	0.91
entrepreneur discount	γ	0.90	0.90
h utility weight	j	0.2	0.2
Labor wage elasticity	$1/(1-\eta)$	0.05	0.05
Capital share	μ	0.3	0.3
Real estate share	ν	0.1	0.1
Depreciate rate	δ	0.028	0.028
Real interest rate	R	1.1	1.1
Domestic LTV for h	m_H	0.8	0.8
Foreign LTV for h	m_F	0.6	0.6
Household's bond holdings	B'		0.01
Bond holding adjustment cost	κ		10^{-5}
Inverse of capital requirement	σ	0.3	
Productivity	ρ_A	0.81	0.81
	$\sigma_{A,t}$	3.8%	3.8%
World interest rate	ρ_{Rw}	0.81	0.81
	$\sigma_{Rw,t}$	0.63%	0.63%
Country risk	$\overline{\eta}$	1.04	1.04
	$\sigma_{D,t}$	1.7%	1.7%

the country risk spread are taken from Neumeyer and Perri (2005). Table 1.3 summarizes our parameterization results.

7. Characterization of Equilibrium and Results

In this section we conduct qualitative analysis to study the transmission mechanism of real interest rate shocks to the aggregate economy implied in our model. We then report the main results of impulse response functions and cyclical properties of the model economy.

7.1. The Transmission Mechanism of Interest Rate Shocks

In our economy, the real estate price is determined in the real estate market in which the supply of real estate is fixed and both entrepreneurs and households demand the real estate. To better grasp the forces to work, we momentally assume $m_H = m_F = m$. The necessary condition for the entrepreneurs' real estate demand in log-linearized form can be stated as

$$\begin{aligned}(1-\nu)(1-(\frac{1}{R}-\gamma)m-\gamma)\hat{h}_t &= -\frac{m}{R}\hat{R}_t + (1-\frac{m}{R})(\hat{c}_t - \hat{c}_{t+1}) - \hat{q}_t + (r+\frac{m}{R}-mr)\hat{q}_{t+1} \\ &+ (1-(\frac{1}{R}-r)m-r)\hat{A}_{t+1} + (1-(\frac{1}{\mathrm{R}}-\gamma)m-\gamma)\mu\,\hat{k}_t \\ &+ (1-(\frac{1}{R}-r)m-\gamma)(1-\mu-\nu)\hat{n}_{t+1}\end{aligned} \tag{26}$$

where the coefficients for all the variables are positive under our parameterization. First, suppose that real estate price does not respond to interest rate shocks, i.e. $\hat{q}_t = \hat{q}_{t+1} = 0$. Since productivity is exogenous, it does not respond to interest rate shocks, i.e. $\hat{A}_{t+1} = 0$. Variable capital could fall or not change much on impact of interest rate shocks and by assumption we made employment respond little to interest rate shocks. Then a positive interest rate shock has a negative direct effect on real estate demand through the first term and has an indirect effect by inducing changes in consumption. Since entrepreneurs are borrowers, the substitution effect and the income effect of interest rate shocks work in the same direction. A positive interest rate shock reduces current consumption, i.e. $\hat{c}_t - \hat{c}_{t+1} < 0$. Intuitively, when current consumption decreases, the marginal cost of investing in real estate increases and entrepreneurs' real estate demand decreases.

The necessary condition for households' real estate demand in log-linearized form can be stated as

$$\frac{j}{h'}\hat{h}_t = \frac{q}{c'}(\hat{c}_t' - \beta\hat{c}'_{t+1}) - \frac{q}{c'}\hat{q}_t + \frac{\beta q}{c'}\hat{q}_{t+1} + \beta\lambda'\sigma q\hat{q}_{t+1} + \beta\lambda'\sigma q\hat{\lambda}'_{t+1} \qquad (27)$$

where the coefficients for all the variables are positive under our parameterization. We can ignore the last two terms since the coefficients are small. If the real estate price does not respond to interest rate shocks, then a positive interest rate shock can have a negative effect on the household's real estate demand. Since households are lenders, the substitution effect and the income effect of interest rate shocks work in opposite directions. The substitution effect implies a reduction in current consumption, while the income effect can be neglected since labor supply responds little to interest rate shocks.

Thus, if the real estate price does not respond to interest rate shocks, both the entrepreneur's and the household's real estate demand holdings tend to fall. However, this cannot be true since the real estate supply is fixed. If the entrepreneur's (household's) real estate decreases, the real estate price must fall to induce the household (entrepreneur) to increase real estate holdings. Note that our model implies that it is possible for the entrepreneur to increase real estate holdings in response to a positive interest rate shock, while in Kiyotaki and Moore(1997), the entrepreneur's real estate holdings always decline when there is a negative technology shock.

The decline in real estate price tightens both the borrowing constraint and the lending constraint. Consequently, the entrepreneur cuts its investment in variable capital and real estate. This causes a subsequent fall in output

7.2. Impulse Response Functions

Figure 1.1 depicts the impulse response functions to a positive world real interest rate shock for the core model economy. On impact, the price of real estate falls as expected. A 1% increase in the world interest rate leads to about a 4% decrease in the real estate price. In the meantime, there is a slight increase in output. This is because although we restrict the elasticity of labor supply to a small value, we do not eliminate the effect of interest rate shocks on the labor supply. When there is an increase in interest rate, people tend to work more and hence output increases. However, this effect is very small and output falls shortly after the interest rate shocks. A 1% increase in the interest rate can induce about a 0.8% fall in output in the second quarter and then output gradually approaches its steady state. Figures 1.2-1.4 report the impulse response functions of the entrepreneur's and the household's real estate holdings, consumption and variable capital and employment to a real interest rate shock. These results are consistent with our analysis in section 7.1. In short, a positive interest rate shock leads to a decrease in the entrepreneur's real estate holdings, an increase in the household's real estate holdings, a decrease in both the entrepreneur's and the household's consumption, a decrease in variable capital and a very limited increase in employment.

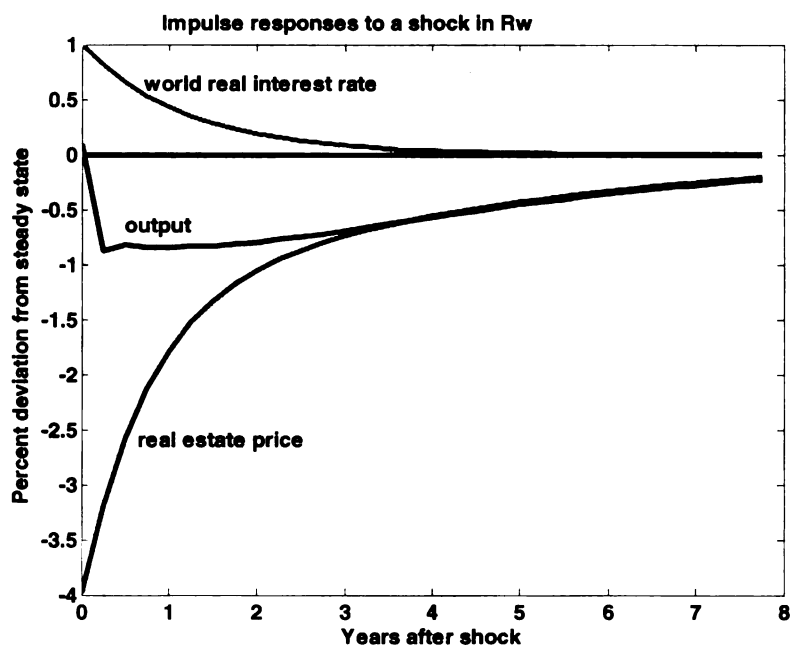

Figure 1.1 Impulse response functions of y and q to a shock in R_w

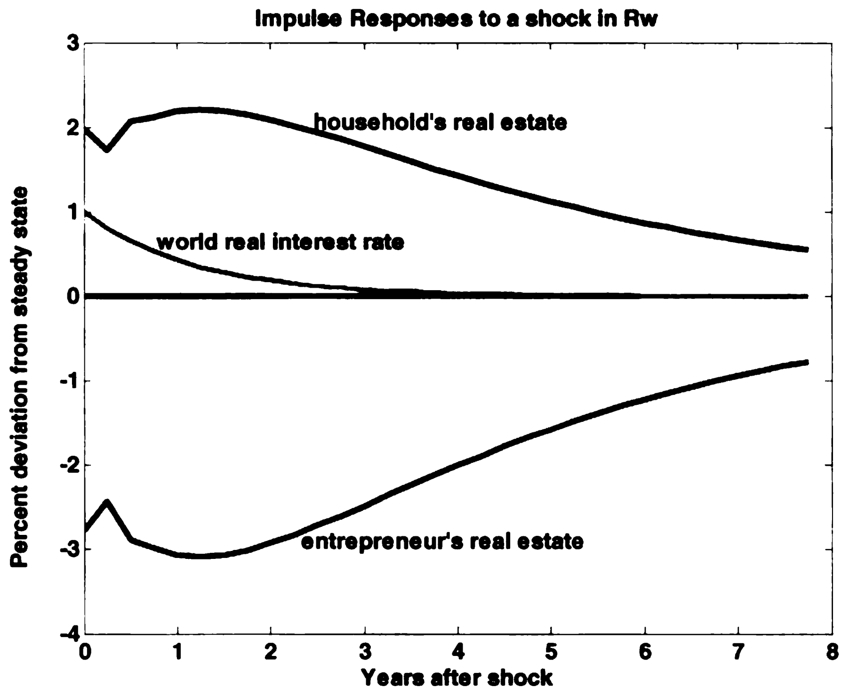

Figure 1.2 Impulse response functions of h and h' to a shock to R_w

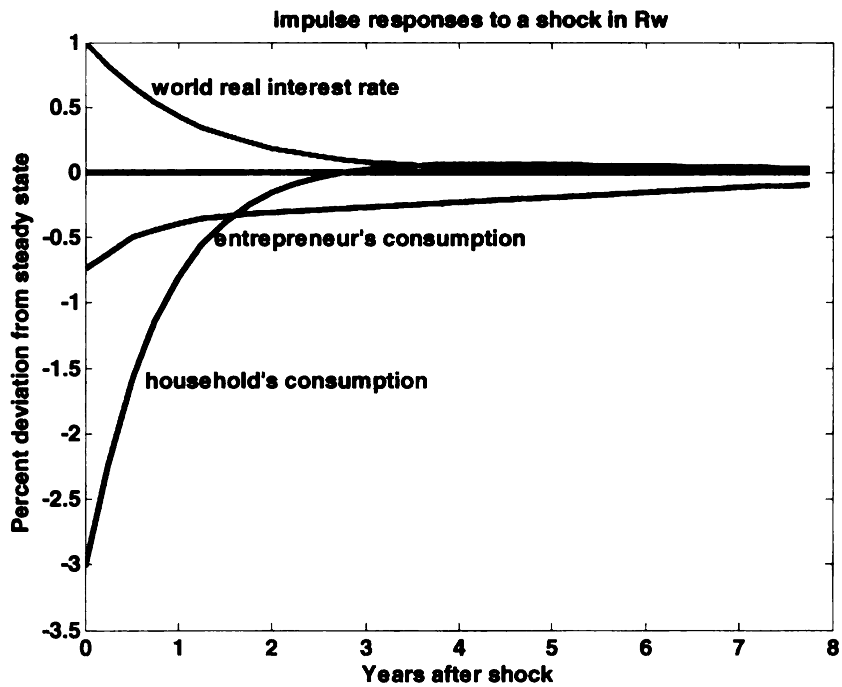

Figure 1.3 Impulse response functions of c and c' to a shock to R_w

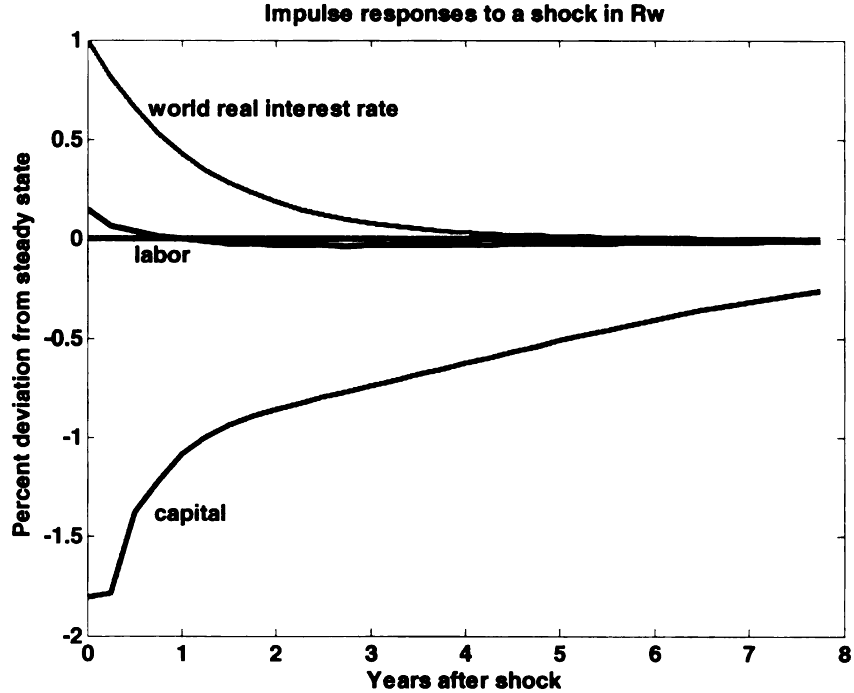

Figure 1.4 Impulse response functions of k and n to a shock in R_w

Figure 1.5 depicts the impulse response functions of output and the real estate price to a world interest rate shock for the model economy without the lending constraint. In this case, the negative effect of interest rate shocks to output is smaller than that in the core model. Our explanation is the following. In the core model, a positive interest rate shock leads to a decrease in the real estate price, a decrease in the entrepreneur's real estate holdings, and an increase in the household's real estate holdings but the extent of this increase is less than that of the decrease in the real estate price. This implies that both the borrowing constraint and the lending constraint are tightened in response to the interest rate shock. Consequently, output experiences a relatively large fall. By contrast, in the model without the lending constraint, a positive interest rate shock leads to a decrease in the real estate price, a decrease in the household's real estate holdings and an increase in the entrepreneur's real estate holdings but the extent of this increase is less than that of the decrease in the real estate price (see Figure 1.6). In this case, although the entrepreneur's borrowing constraint is tightened, the large reduction in the value of the household's real estate has no effect on the entrepreneur's borrowing. Consequently, output experiences a relatively small reduction.

Figure 1.7 shows the impulse response functions of output and the real estate price to a productivity shock. A 1% increase in productivity induces a 5.5% rise in the real estate price on impact of the shock. It also induces a 1.7% increase in output in the second quarter following the shock. Figure 1.8 shows the impulse response functions of output and the real estate price to a productivity shock when the country risk spread is not a function of productivity (i.e. $\overline{\eta} = 0$). In this case, a 1% increase in

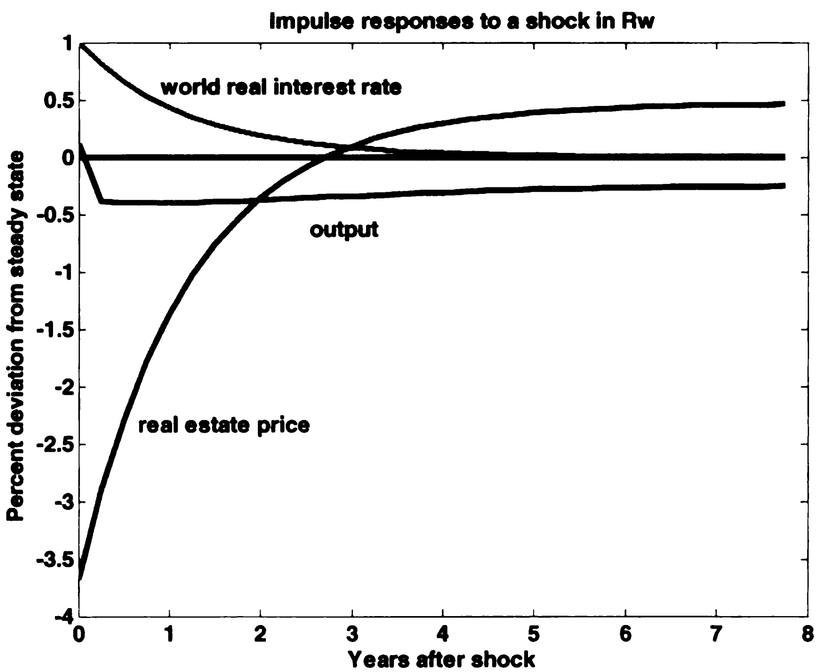

Figure 1.5 Impulse response functions of y and q to a shock R_w

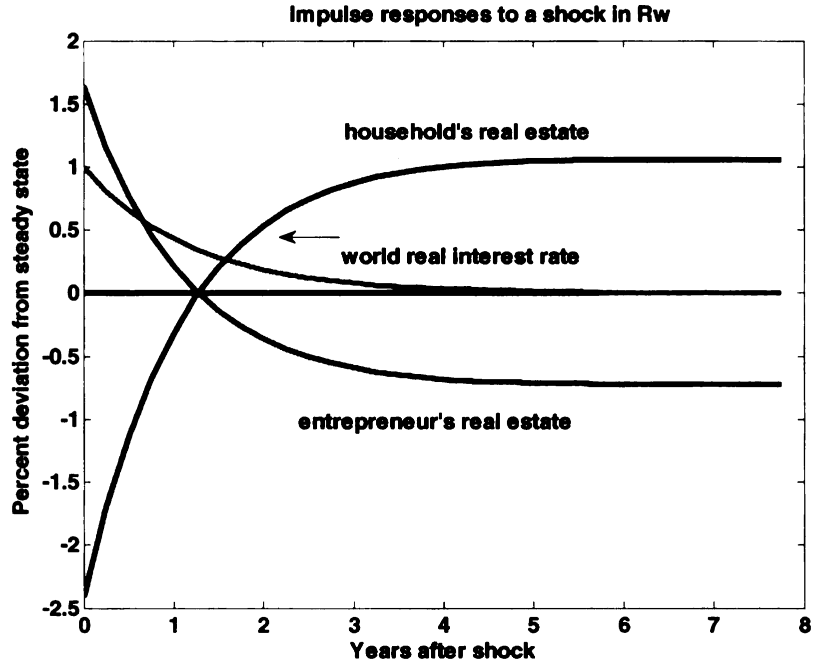

Figure 1.6 Impulse response functions of h and h' to a shock to R_w

productivity induces a 1.8% rise in the real estate price on impact of the shock. It also induces a 1.1% increase in output in the second quarter following the shock. Our explanation for the relatively larger impulse responses of output and the real estate price in our model is the following. When there is a positive productivity shock in period t, people will expect an increase in productivity in period t+1 since productivity exhibits persistence. This will reduce the country risk spread as well as the real interest rate. Equation (26) shows that a positive productivity shock will lead to a larger increase in entrepreneur's demand for real estate when the country risk spread is negatively correlated with productivity (since $\hat{A}_{t+1} > 0$ and $\hat{R}_t < 0$), while when the country risk spread is not a function of productivity, the increase in entrepreneurs' demand for real estate is smaller (since $\hat{A}_{t+1} > 0$ and $\hat{R}_t = 0$). Thus, in our model the real estate price experiences a larger increase in response to a positive productivity shock. This relaxes both the borrowing constraint and the lending constraint. Consequently, output experiences a larger increase.

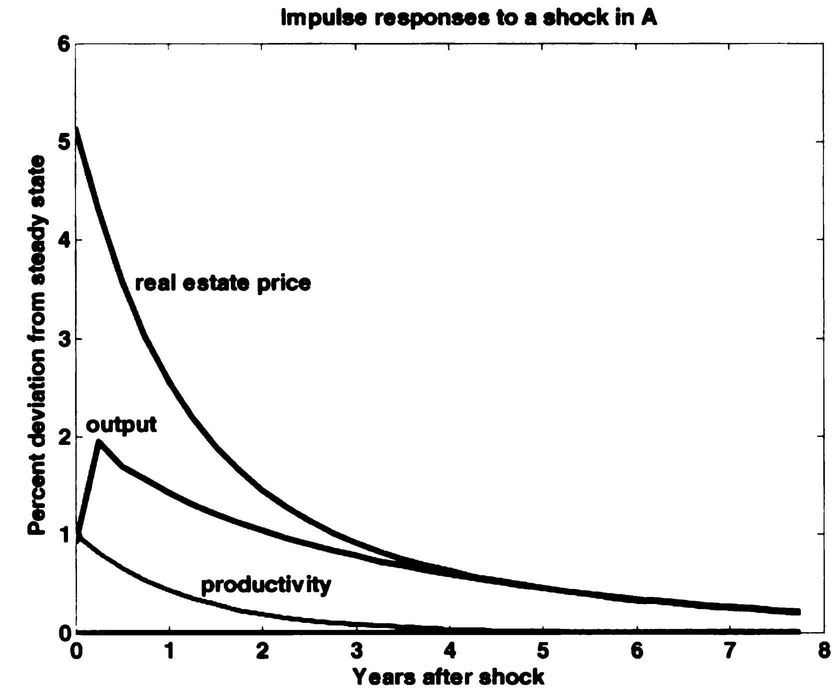

Figure 1.7 Impulse response functions of y and q to a shock in A_t ($\bar{\eta} > 0$)

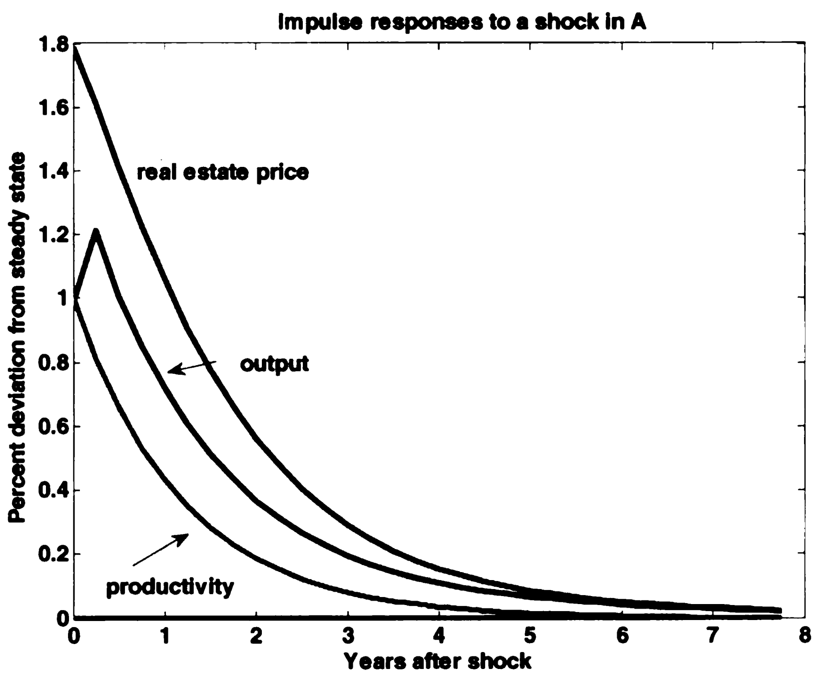

Figure 1.8 Impulse response functions of y and q to a shock in A_t ($\bar{\eta} > 0$)

7.3 Cyclical properties

We simulate the model with an HP-filtered series to obtain the second moments properties of the model economy. Table 1.4 reports the results. The model economy predicts that the correlation coefficient between the real interest rate and output in Argentina is -0.72, which is very close to the data -0.75. While the correlation coefficients between the real interest rate and the real estate price and that between the real estate price and output have the same signs as the data, they are significantly higher than the data. These differences could result from the fact that we use the GPR Argentina general index as a proxy for the real estate price.

Table 1.4 Cyclical properties

	Model	Argentina Data
Corr (R,q)	- 0.9	- 0.42
Corr (Y,q)	0.83	0.45
Corr (R,Y)	- 0.72	- 0.75

8. Conclusion

In this paper we present a simple model of a small open economy with credit constraints to explain the countercyclicality of real interest rates in emerging economies. We emphasize that both the borrowing constraint and the lending constraint can play a role in accounting for the countercyclicality of real interest rates in emerging economies. An extension of this paper could be to explicitly model bank's behavior. This would lead to a richer interaction between entrepreneurs' net worth and banks' capital and provide a better explanation for the observed regularities in emerging economies.

Chapter 2

Real Interest Rates and Business Cycles in Emerging Economies

1. Introduction

In the last decade or so, an important empirical regularity in emerging market economies was that business cycles were associated with real interest rates fluctuations. The real interest rate was observed to be countercyclical in emerging market economies, while it was acyclical in developed economies. For example, during 1994 to 2001, the average correlation coefficient between output and the real interest rate for the five emerging economies (Argentina, Brazil, Korea, Mexico, and Philippines) was –0.55, while this correlation coefficient for the five small open developed economies (Australia, Canada, Netherlands, New Zealand, and Sweden) was 0.19 (Neumeyer and Perri, 2005). A natural question is: Do real interest rate shocks drive business cycles in emerging economies? If the answer is yes, then how does it occur? The present paper attempts to address this question and it emphases the role of net worth borrowing constraints as the financial accelerator in transmitting real interest rate shocks.

The paper is closely related to Neumeyer and Perri's paper (2005, henceafter NP) but the transmission mechanisms in the two papers are different. NP (2005) studies the relationship between real interest rates and business cycles in emerging economies by introducing a working capital constraint into the standard small open economy RBC model. The working capital constraint implies that the real interest rate has an impact on labor demand. They also assume that households have GHH preferences (proposed by Greenwood, Hercovitz and Huffman), which implies that the labor supply is independent of consumption and the real interest rate. Thus, a positive real interest rate shock will decrease the labor demand and hence output falls. Following NP (2005), other studies (for example, Uribe and Yue, 2006) also introduce a working capital constraint to study the relationship between real interest rates and business cycles in emerging economies.

Oviedo (2005) argues that including a working capital constraint in the standard small open economy model is not an effective mechanism to align the interest-rate macro volatility predicted by the model with what is observed in emerging economies. Oviedo (2005) shows that when a working capital constraint is added into the standard small open model economy, the equilibrium condition for labor demand has the property that a very large fall in interest rate is required to make up for a small increase in the wage rate to keep output unchanged. In contrast, a small rise in productivity is enough to induce the same result. This implies that for the working capital constraint to add a significant amplification mechanism to interest rate shocks, both the interest rate level and swings must be large.

In this paper, we propose another transmission mechanism, i.e., a credit channel, to explain the impact of the real interest rate shocks on the aggregate economy in emerging economies. In our model economy, entrepreneurs face net worth borrowing constraints when they borrow from domestic and foreign investors. A positive interest rate shock will increase debt repayment, decrease entrepreneurs' net worth and tighten the borrowing constraint. Consequently, investment and output fall. The decrease in output will further tighten entrepreneurs' net worth and cause a further decrease in entrepreneurs' investment and output. Our motivation to include a borrowing constraint to the small open model economy comes from two considerations. The first consideration is the fact that in emerging (developing) countries, financial market imperfections are more pervasive and deeper than in developed countries. The second consideration is due to a significant role of financial constraints in business cycle models. That is, they can act as a financial accelerator which transmits small shocks to large fluctuations in aggregate variables.

When we set up the model, an important issue is how to model the real interest rate in emerging economies. We follow NP's (2005) approach to model the real interest rate. First, in the model economy all the agents face the same real interest rate, which is charged by foreign lenders. This is justified by the following three assumptions. The first assumption is that we assume that there is only one financial asset, a noncontingent bond. The second assumption is that we assume that the emerging economies are net debtors to the rest of the world. This assumption can be justified by the fact that most economies in South American are net debtors to the rest of the world. The third assumption is that the model economy is a small open economy. These three assumptions imply that all the agents in the model economy face the same real interest rate. Second, the real interest rate in emerging economies is modeled as a product of the world real interest rate and a country risk spread. The world real interest rate is identified as the rate on non-investment grade bonds in the United States. When foreign investors invest in emerging economies, they face country risks which may come from the possibility of expropriation of assets, entrepreneurs' debt default etc. In response to the country risks, foreign investors charge a country risk spread

When dealing with the effects of the real interest rate on the aggregate economy in emerging economies, an interesting question is whether the fundamentals of the emerging economies also have an impact on the real interest rate. Since the emerging economies are small open economies, the world real interest rate is not affected by the fundamentals of emerging economies. However, a large body of empirical literature shows that the country risk spread is related to the fundamentals of the emerging economies. (see Uribe and Yue, 2006). Following NP (2005), we model the country risk spread as a function of productivity. Thus, the real interest rate shocks will affect the aggregate economy through a borrowing constraint. On the other hand, the fundamentals of the economy, represented by the productivity, may affect the real interest rate and aggravate the effects of the productivity shocks on the aggregate economy.

We calibrate the model to Argentine data. Quantitative results show that the model predictions are consistent with the data in general. In particular, the real interest rate is countercyclical and it has a larger and longer impact on output than in the NP model. The correlation between the real interest rate and output is -0.54, In addition, the model predicts that output exhibits high volatility and that consumption is more volatile than output. Sensitivity analysis shows that the negative relationship between the real interest rate and output are stronger for more borrowing constrained firms than for less borrowing constrained firms.

The paper is built on the NP model. The key difference between the NP model and our model is that we impose a borrowing constraint in the small open RBC model. This means that the transmission mechanism of interest rate shocks as well as the productivity shocks to the economy is through the credit market instead of the labor market. The paper is also related to the literature on the credit channel of business cycles (Benanke et al, 1998, Kiyotaki and Moore, 1997, etc.). The transmission mechanism is similar to that in Aghion et al (2004). Aghion et al (2004) study a general equilibrium currency crisis model in emerging economies in which the possibility of currency crisis is driven by the interplay between firms' net worth constrains and nominal rigidities. Our paper is distinct from their paper in that the entrepreneur's net worth is not affected by the fluctuations of exchange rates but by the fluctuations of real interest rates. Although there is a large body of literature on the effects of credit market imperfections on business cycles, to our knowledge, no paper introduces firm borrowing constraints to analyze the impacst of real interest rate shocks on business cycles in emerging economies.

The remainder of the paper is organized as follows. Section 2 describes the model. Section 3 defines the equilibrium and characterizes the dynamics. Section 4 calibrates the model to Argentine Data. Section 5 presents the results. Section 6 Concludes.

2. The Model

Time is discrete and infinite. There are three types of agents in this small open economy: entrepreneurs, households and foreign lenders. There is one good, which is produced by entrepreneurs and consumed by entrepreneurs and households. The only asset traded by entrepreneurs, households and foreign investors in the domestic and international financial markets is a noncontingent bond. The economy is subject to interest rate shocks and production shocks, which are revealed at the beginning of each period.

2.1 Entrepreneurs

There are a large number of entrepreneurs. We assume that entrepreneurs are identical and normalize the total number of entrepreneurs to 1. The assumption of a large number of entrepreneurs implies that entrepreneurs behave competitively, that is, their actions do not affect market prices in the economy. The representative entrepreneur has lifetime utility over consumption, which is given by

$$U(c_1, c_2, \ldots c_t, \ldots) = E_t \sum_{t=0}^{\infty} \gamma^t \ln c_t \tag{1}$$

where c_t is consumption at period t, γ is the discount factor. At each period, the entrepreneur consumes, invests, borrows from households and foreign lenders, and produces using capital and labor. The entrepreneur's production function is Cobb-Douglas

$$y_t = A_t k_{t-1}^{\alpha} n_t^{1-\alpha} \tag{2}$$

where y_t is output, k_{t-1} is capital, n_t is labor input, A_t is the exogenous stochastic productivity, and α is the elasticity of output with respect to capital.

The stock of capital evolves according to

$$k_t = i_t + (1-\delta)k_{t-1} \tag{3}$$

where δ is the depreciation rate.

The period budget constraint for the entrepreneur is

$$A_t k_{t-1}^{\alpha} n_t^{1-\alpha} + B_t = c_t + k_t - (1-\delta)k_{t-1} + \omega_t n_t + R_{t-1} B_{t-1} \tag{4}$$

where B_t is bond issued by the entrepreneur and ω_t is the real wage rate. At period t, the entrepreneur spends the output and borrowed funds on wage payment, debt repayment, investment and consumption.

The financial market in which entrepreneurs, domestic households and foreign lenders participate is not frictionless. The friction comes from the possibility that entrepreneurs may default on their debt obligation. To prevent this enforcement problem, a borrowing constraint is imposed on the financial contract. The entrepreneur can only borrow an amount up to a fraction φ of his net worth, W_t, which is defined by period t output net of debt repayment, wage payment, consumption and the nondepreciated capital stock. Thus

$$B_t \le \varphi W_t \tag{5}$$

where $W_t = A_t k_{t-1}^{\alpha} n_t^{1-\alpha} - c_t - \omega_t n_t - R_{t-1} B_{t-1} + (1-\delta) k_{t-1}$ and $0 < \varphi < 1$.

The entrepreneur's investment is funded by borrowing (B_t) and net cash flows (W_t *)

$$i_t = B_t + W_t{}^* \tag{6}$$

where $W_t{}^* = A_t k_{t-1}^{\alpha} n_t^{1-\alpha} - c_t - \omega_t n_t - R_{t-1} B_{t-1}$

Combining equations (3) (5) (6), we obtain

$$B_t \le \frac{\varphi}{1+\varphi} k_t = \theta k_t \tag{7}$$

where θ is a constant.

The entrepreneur's problem is to choose consumption c_t, labor demand n_t, capital stock k_t and bond holdings B_t to maximize his expected lifetime utility subject to the budget constraint and the borrowing constraint. That is, the entrepreneur solves the following problem:

$$\max E_0 \sum_{t=0}^{\infty} \gamma^t \ln c_t$$

$$\text{s.t} \quad A_t k_{t-1}^{\alpha} n_t^{1-\alpha} + B_t = c_t + k_t - (1-\delta)k_{t-1} + \omega_t n_t + R_{t-1} B_{t-1}$$

$$B_t \le \theta k_t$$

Before we solve the entrepreneur's problem, we make two assumptions.

Assumption 1: The subjective discount factor for the entrepreneur γ is less than that for the household β. This assumption ensures that the entrepreneur will not postpone production and has to borrow from the household, since he is less patient than the household.

Assumption 2: the parameters $\alpha, \beta, \gamma, \theta, \delta$ are restricted by the following expression $\alpha \left[\frac{(1-\theta)\beta + \gamma\beta\delta + \gamma\theta - \gamma\beta}{\alpha\gamma\beta}\right]^{\alpha - 1} + 1 - \delta \ge \frac{1}{\beta}$. This assumption ensures that at the steady state, the rate of return to investment is greater than the real interest rate, so that the entrepreneur will invest as much as possible.

Under Assumptions 1 and 2, the borrowing constraint is binding in equilibrium. Let λ_t be the Lagrangian multiplier associated with the budget constraint. Let χ_t be the Lagrangian multiplier associated with the borrowing constraint. The Lagrangian for the entrepreneur's problem can be written as follows:

$$L = E_0 \sum_{t=0}^{\infty} \gamma^t \{\ln c_t + \lambda_t [A_t k_{t-1}^{\alpha} n_t^{1-\alpha} + B_t - c_t - k_t + (1-\delta)k_{t-1} - \omega_t n_t - R_{t-1} B_{t-1}] + \chi_t (B_t - \theta k_t)\}$$

The first order conditions with respect to consumption c_t, labor demand n_t, capital stock k_t and B_t are:

$$[c_t]: \qquad \frac{1}{c_t} = \lambda_t \tag{8}$$

$$[n_t] \qquad A_t(1-\alpha)k_{t-1}{}^{\alpha}n_t{}^{-\alpha} = \omega_t \tag{9}$$

$$[k_t] \quad \lambda_t + \chi_t\theta = \gamma E_t\lambda_{t+1}[\alpha A_{t+1}k_t{}^{\alpha-1}n_{t+1}{}^{1-\alpha} + 1 - \delta \tag{10}$$

$$[B_t]: \qquad \lambda_t + \chi_t = \gamma E_t\lambda_{t+1}R_t \tag{11}$$

Combining (9), (10) and (11), we obtain,

$$\frac{1}{c_t} = \frac{\gamma}{1-\theta}E_t\frac{1}{c_{t+1}}[\alpha A_{t+1}k_t{}^{\alpha-1}n_{t+1}{}^{1-\alpha} + 1 - \delta - \theta R_t]$$

(12)

Equation (9) defines the entrepreneurs' labor demand schedule, by equating the marginal productivity of labor in period t to the real wage rate ω_t. Equation (12) is the entrepreneur's Euler condition for consumption. It is different from the usual Euler condition due to the presence of borrowing constraint.

2.2 Households

There are a large number of households in the economy and the number of households is normalized to 1. The representative household's period preference is described by GHH preference

$$u(c'_t, n'_t) = \frac{1}{1-\sigma}[c'_t - \psi n'_t{}^{\upsilon}]^{(1-\sigma)} \tag{13}$$

where c'_t is the household's consumption, n'_t is the labor supply. The intertemporal elasticity of substitution is given by $1/\sigma$. The elasticity of labor supply is given by $1/(1-\upsilon)$, where $\upsilon > 1$. ψ captures the labor weight in the household's preference, $\psi > 0$. GHH preferences are commonly used in small open economy business cycles models. They have the property that labor supply does not depend on consumption and thus is independent of the real interest rate.

In each period, the household supplies labor to the entrepreneur, receives labor payment and the principal and interest of last period's bonds. The household also buys new bonds, pays bond holding adjustment costs and consumes at the end of each period.

The household's period budget constraint is given by

$$c'_t + B'_t + \frac{\varepsilon}{2}(B'_t - B'^*)^2 = \omega_t n'_t + R_{t-1} B'_{t-1} \tag{14}$$

where B'_t is the household bond holding at period t. $\frac{\varepsilon}{2}(B'_t - B'^*)^2$ is the bond holding adjustment costs. B'^* is the steady state of B'_t and ε is a constant parameter. At period t, the household spends the proceeds from bond holdings and labor income on consumption, bond purchase and bond holding adjustment costs. A Bond holding adjustment cost is commonly used to guarantee stationarity in small open economy models when asset market is incomplete. As we shall see, the steady state of the model depends on the household's initial bond holdings, whose rate of return is exogenously determined abroad. This induces long-run effects of transient shocks on the steady state of the economy, i.e. the equilibrium dynamics of the endogenous variables possess a random walk component. However, all available techniques are valid locally around a given stationary path. Adding bond holding adjustment costs is one of the methods to solve the problem of nonstationarity. (Schmitt-Grohe and Uribe, 2003)

The household's problem is to choose consumption c'_t, labor supply n'_t, bond holdings B'_t to maximize the expected lifetime utility subject to the budget constraint. That is, the household solves the following problem:

$$\max E_0 \sum_{t=0}^{\infty} \beta^t \{\frac{1}{1-\sigma}[c'_t - \psi n'_t \upsilon]^{(1-\sigma)}$$

s.t. $$c'_t + B'_t + \frac{\varepsilon}{2}(B'_t - B'^*)^2 = \omega_t n'_t + R_{t-1} B'_{t-1}$$

The Lagrangian of the household's problem is

$$L = E_0 \sum_{t=0}^{\infty} \beta^t \{\frac{1}{1-\sigma}[c'_t - \psi n'_t \upsilon](1-\sigma) + \pi_t [\omega_t n'_t + R_{t-1} B'_{t-1} - c'_t - B'_t -$$

$$-\frac{\varepsilon}{2}(B'_t - B'^*)^2]\}$$

where π_t is the Lagrangian multiplier associated with the budget constraint.

The first order conditions with respect to consumption c'_t. labor supply n'_t, bond holdings B'_t are:

$$[c'_t]: \quad [c'_t - \psi n'^{\,\upsilon}_t]^{-\sigma} = \pi_t \tag{15}$$

$$[n'_t]: \quad [c'_t - \psi n'^{\,\upsilon}_t]^{-\sigma} \psi \upsilon n'^{\,\upsilon-1}_t = \pi_t \omega_t \tag{16}$$

$$[B'_t] \quad \pi_t [1+ \varepsilon(B'_t - B'^*)] = \beta E_t \pi_{t+1} R_t \tag{17}$$

Equation (15) states that consumers choose consumption such that the marginal utility of consumption equals the marginal utility of wealth. Equation (16) defines consumers' labor supply schedule, by equating marginal disutility of labor to the marginal utility of wealth brought by real wage. Equation (17) is the non-arbitrage condition for bond holdings in equilibrium.

Combining equations (15) and (16), we obtain the optimal labor supply condition

$$\psi \upsilon n'^{\,\upsilon-1}_t = \omega_t \tag{18}$$

Combining equations (15) and (17), we obtain

$$[c'_t - \psi n'^{\,\upsilon}_t]^{-\sigma} [1+\varepsilon(B'_t - B'^*)] = E_t [c'_{t+1} - \psi n'^{\,\upsilon}_{t+1}]^{-\sigma} (\beta R_t) \; , \tag{19}$$

which is the household's Euler condition for consumption.

3. Equilibrium and Dynamics

3.1. Equilibrium

Given k_0 , B'_0 and a sequence of interest rates R_t and productivity A_t , equilibrium of this economy is a sequence of allocations { c_t, n_t, k_t, B_t } for entrepreneurs, a sequence of allocations { c'_t, n'_t, B'_t } for households and prices { ω_t } such that:

(i) The entrepreneur solves his optimization problem.

(ii) The household solves its optimization problem.

(iii) The labor market clears.

The equilibrium of this economy is characterized by equations (4), (7) (binding), (9), (12), (13), (18), (19) and the labor market clearing condition $n_t = n'_t$.

3.2. Steady State and Dynamics

Assume $R^* \beta = 1$ in the steady state. Set $A^* = 1$ in the steady state. The steady states of the endogenous variables $n^*, k^*, y^*, c^*, c'^*, B^*, \omega^*$ are given by:

$$n^* = [\frac{1-\alpha}{\psi \upsilon} \eta^{\alpha/(\alpha-1)}]^{1/(\upsilon-1)} ,$$

$$y^* = \eta^{\alpha/(\alpha-1)} n^*,$$

$$k^* = \frac{1}{\eta} y^*,$$

$$B^* = \theta k^*,$$

$$c^* = \alpha y^* + (\theta - \delta - \frac{1}{\beta} \theta) k^*,$$

$$c'^* = \omega^* n^* + (\frac{1}{\beta} - 1) B'^*,$$

$$\omega^* = (1-\alpha) \eta^{\alpha/(\alpha-1)} ,$$

where $\eta = \dfrac{(1-\theta)\beta + \gamma\beta\delta + \gamma\theta - \gamma\beta}{\alpha\gamma\beta}$

Loglinearize the equilibrium conditions around their steady states, we obtain the following system of equations: (where we use the condition $n_t = n'_t$ in equilibrium)

$$\hat{y}_t = \hat{A}_t + \alpha \hat{k}_{t-1} + (1-\alpha) \hat{n}_t \tag{24}$$

$$E_t\hat{c}_{t+1}-\hat{c}_t=\{(\alpha k*^{\alpha-1}n*^{1-\alpha})E_t\hat{A}_{t+1}+(\alpha(\alpha-1)k*^{\alpha-1}n*^{1-\alpha})E_t\hat{k}_t+$$
$$+(\alpha(1-\alpha)k*^{\alpha-1}n*^{1-\alpha})E_t\hat{n}_{t+1}-\theta(1/\beta)E_t\hat{R}_t\}/(\alpha k*^{\alpha-1}n*^{1-\alpha}+$$
$$+1-\delta-\theta(1/\beta)) \tag{25}$$

$$\hat{A}_t+\alpha\hat{k}_{t-1}-\alpha\hat{n}_t=\hat{\omega}_t \tag{26}$$

$$y*\hat{y}_t+B*\hat{B}_t=c*\hat{c}_t+k*\hat{k}_t-(1-\delta)k*\hat{k}_{t-1}+\omega*n*\hat{n}_t+\omega*n*\hat{\omega}_t+$$
$$+(1/\beta)B*\hat{B}_{t-1}+(1/\beta)B*\hat{R}_{t-1} \tag{27}$$

$$\hat{B}_t=\hat{k}_t \tag{28}$$

$$-\sigma/(\bar{c}-\psi\,\bar{n}\,\upsilon))[\bar{c}\hat{c}_t-\psi\upsilon\,n\,\upsilon\,\hat{n}_t]+\varepsilon B'*\hat{B}'_t=(-\sigma/(\bar{c}-\psi\,\bar{n}\,\upsilon))E_t\bar{c}\hat{c}'_{t+1}-$$
$$-\sigma/(\bar{c}-\psi\,\bar{n}\,\upsilon))\psi\,\upsilon\,n\,\upsilon E_t\hat{n}_{t+1}+E_t\hat{R}_t \tag{29}$$

$$(\upsilon-1)\,\hat{n}_t=\hat{\omega}_t \tag{30}$$

$$c'*\hat{c}'_t+B'*\hat{B}'_t=\omega*n*\hat{n}_t+\omega*n*\hat{\omega}_t+(1/\beta)B'*\hat{B}'_{t-1}+(1/\beta)B'*\hat{R}_{t-1} \tag{31}$$

Equations (24) –(31) are the log-linearization equations for the production function (24), the entrepreneur's Euler equation for consumption (25), the optimal labor demand condition (26), the entrepreneur's budget constraint (27), the entrepreneur's borrowing constraint (28), the household's Euler equation for consumption (29), the optimal labor supply condition (30), the household's budget constraint (31).

To close the model, we need to specify the processes for the productivity A_t, the world real interest rate R_t^w and the specification for the real interest rate in emerging economies R_t. We assume that the percentage deviations from the trend of A_t and R_t^w follow AR (1) processes, that is,

$$\hat{A}_t = \rho_1 \hat{A}_{t-1} + \varepsilon_{A,t}$$

(33)

$$\hat{R}_t^w = \rho_2 \hat{R}_{t-1} + \varepsilon_{Rw,t}$$

(34)

Where the disturbances $\varepsilon_{A,t}, \varepsilon_{Rw,t}$ are normally distributed and serially uncorrelated. The real interest rate in emerging economies R_t is the product of the world real interest rate R_t^w and the country risk premium D_t, i.e. $R_t = R_t^w D_t$. Following NP (2005), we model $\hat{D}_t$ relating to the productivity as follows:

$$\hat{D}_t = -\eta E_t \hat{A}_{t+1} + \varepsilon_{I,t}$$

where $\eta > 0$ is a constant capturing how much country risk premium responds to expected productivity shocks, $\varepsilon_{I,t}$ is a normally distributed independent shock. It follows that the process for $\hat{R}_t$ is

$$\hat{R}_t = \hat{R}_t^w - \eta E_t \hat{A}_{t+1} + \varepsilon_{I,t} \qquad (35)$$

Equations (24) – (35) describe the dynamics of the economy.

4. Calibration

To quantitatively analyze the model, we calibrate the model to Argentina's economy. The parameters are chosen to mimic some of the empirical regularities in

Argentina's economy. For comparison purposes, we share the parameter values chosen in the NP model. A period in the model is assumed to be a quarter. The remaining parameters need to be chosen are γ, θ and B'^*. We have assumed $\gamma < \beta$. β is chosen to be 0.93 to match an average real interest rate of 14.8% in Argentina (Neumeyer and Perri, 2005). We choose γ to be 0.90. As a benchmark case, we choose θ to be 0.33, implying the net worth constraint multiplier φ is 0.5. Later, we will change the value of θ for sensitivity analysis. The value of B'^* is not uniquely pinned down. We choose it to be – 0.3. This is consistent with the fact as well as the assumption in our model that the emerging economies are net debtors for the rest of the world. Table 2.1 summarizes the parameter values.

Table 2.1 Parameter values

Preference parameters	Symbol	Value
Discount factor	β	0.93
Utility curvature	σ	5
Labor curvature	υ	1.6
Labor weight	ψ	2.48
Capital share	α	0.38
Depreciation rate	δ	0.044
Borrowing constraint parameter	θ	0.33
Bond holding cost	ε	10^{-5}
Shocks		
Productivity	ρ_1	0.95
	$\sigma(\varepsilon_{A})$	1.98 %
World interest rate	ρ_2	0.81
	$\sigma(\varepsilon_{Rw})$	0.63%
Induced country risk	η	1.04
	$\sigma(\varepsilon_{I})$	1.7%

5. Results

In this section, we present impulse response functions and cyclical properties of the model economy. We also conduct sensitive analysis to test our hypothesis that the borrowing constraint plays a role in transmitting shocks. The results show that, in general, the model economy can predict the empirical regularities observed in Argentina.

5.1. Impulse Response Functions

Figure 2.1 depicts the impulse response function to a shock in the world interest rate. On impact, the interest rate shock has no effect on output, because debt repayment in period t is made at the real interest rate in period t-1 (R_{t-1}). Starting from period t+1, output declines. A 1% increase in interest rate induces about a 0.9% fall in output and about 0.6% fall in employment. In the NP model, a positive interest rate shock decreases labor demand and through the production function, output falls. So, the degree of the impact of interest rate shock on output is a fraction $1-\alpha$ of that on employment. The latter depends on υ and α. By assuming that firms need to borrow all the working capital, they obtain the maximum impact of the world real interest rate on output is about 0.6%. The impacts of interest rate on output and employment peak at period t+1 (the second quarter), then output and employment quickly approach to their steady states. In our model, an interest rate shock not only affect labor demand, but also affect investment through the net worth constraint, thus a positive interest rate shock can impact on output more than on employment. In addition, it will take more time for output and employment to go back to their steady states. Changing the values of γ, θ and B'^* will not change the general results. We conclude that in our model the net worth constraint acts as a financial accelerator, which amplifies and prolongs the effects of real interest rate shocks.

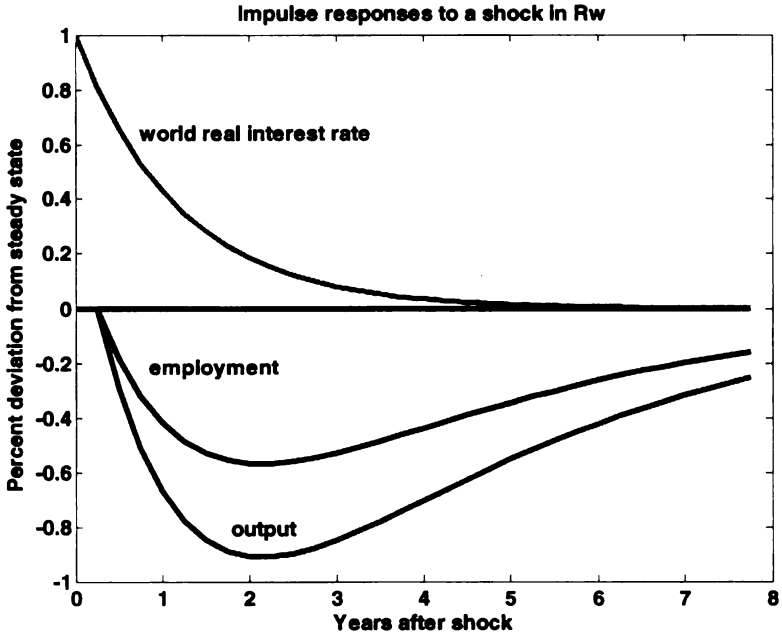

Figure 2.1 Impulse Responses to a shock to the world interest rate

Figure 2.1 shows the impulse response functions of output and employment to a country risk shock. A 1% increase in country risk can induce a 0.3% decline in output and about a 0.2% decline in employment. Thus, in our model economy, country risk shocks alone can have nonnegligible effects on the aggregate economy but these effects are smaller than the effects of world interest rate shocks.

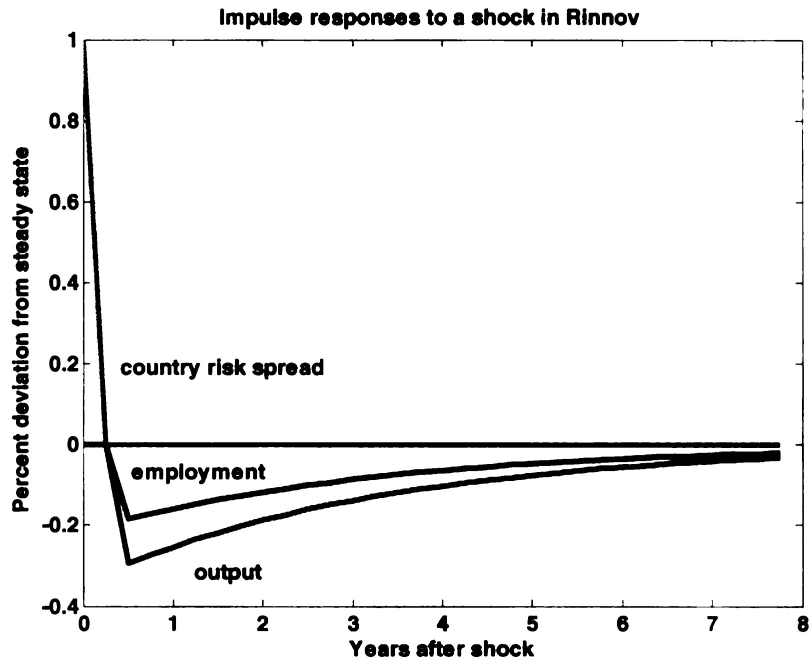

Figure 2.2 Impulse Responses to a shock in the country risk spread

Using a VAR approach, Uribe and Yue (2006) study the impulse response of aggregate variables to world interest rate shocks. The data set consists of a dynamic panel data for, including Argentina, seven emerging economies. Our model predictions of the impulse responses of output and employment to world interest rate shocks and country risk shocks are similar to their empirical result.

Figure 2.3 shows the impulse response function to a shock in productivity. On impact, a 1% increase in productivity induces a 1.7% increase in output. The response of output peaks at 3.6% in year 3. The relatively large response of output to productivity shocks comes from the specification that country risk spreads are a function of productivity. Since productivity generally exhibits persistence, a high productivity in period t induces economic agents to expect a high productivity in period t +1. This will reduce country risk spreads as well as the real interest rate, and relax the borrowing constraint. Thus, the effects of productivity shocks are amplified by changes in country risk spreads through the borrowing constraint. If productivity has no effect on country risk spreads, that is, if $\eta = 0$, Figure 2.4 shows that the impulse response of output to productivity shocks peaks at 2 %, which is 44% lower than that when country risk spreads are a function of productivity.

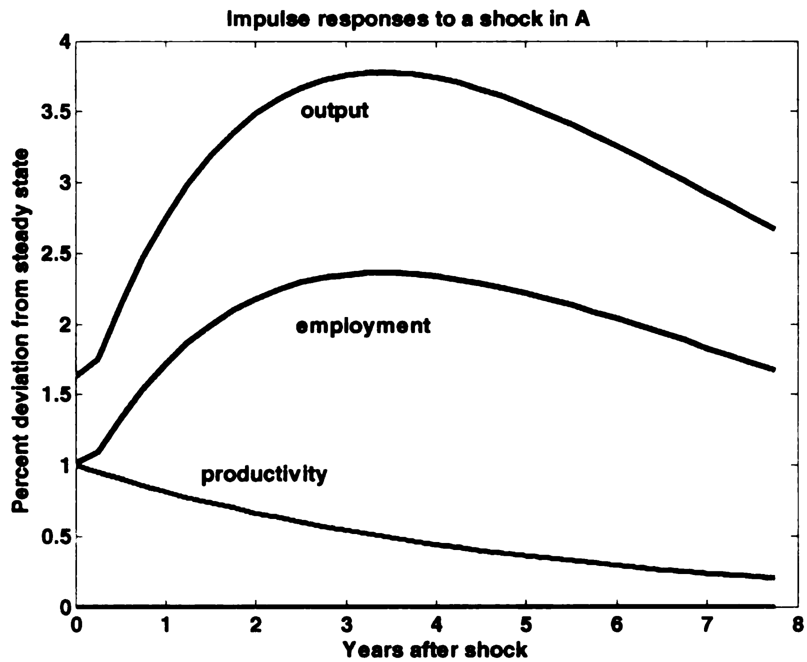

Figure 2.3 Impulse Response Function to a shock to productivity ($\eta > 0$)

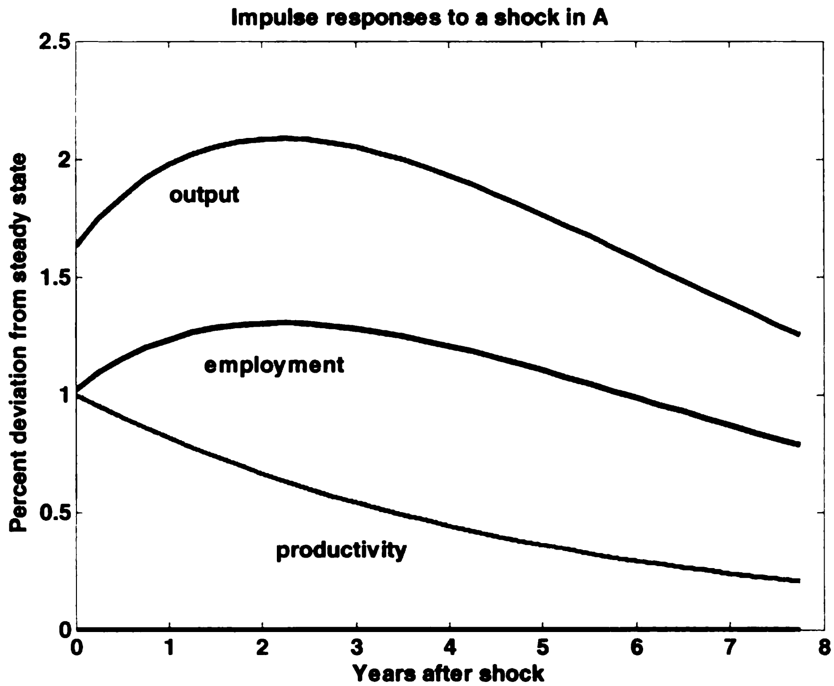

Figure 2.4 Impulse Response Function to a shock to productivity ($\eta = 0$)

5.2 Cyclical Properties

We simulate the model with HP-filtered series to obtain the second moments properties of the model economy. Table 2.2 shows the results. For comparison, we also report the second moments properties of data in Argentina and the small open developed economies. The simulation results show that the correlation between the real interest rate and output in the model economy is -0.54. In the data, this correlation is -0.63. The standard deviation of output is 5.9%. In the data, this value is 4.22% in Argentina and 1.37% in developed economies. The ratio of standard deviation of consumption to the standard deviation of output is 1.5. In the data, this ratio is 1.17 in

Argentina and 0.9 in developed economies. The volatility of real interest rate in the model is 3.12%. In the data, this volatility of the real interest rate is 3.87% in Argentina and 1.66% in developed economies. Thus, our model predicts that the volatility of output in emerging economies is larger than that in developed economies, that consumption is more volatile than output in emerging economies, and that the real interest rate has larger volatility in emerging economies than in developed economies. All these are consistent with the regularities in emerging economies.

Table 2.2 Cyclical properties

	Model	Argentina	Developed economies
Correlation Between Y and R	-0.54	-0.63	0.20
%Standard deviation of Y	5.9	4.22	1.37
%Standard deviation of R	3.12	3.87	1.66
%Standard deviation of C / %standard deviation of Y	1.5	1.17	0.9

notes: data in the table are taken from Neumeyer and Perri (2005). Data in developed economies are average data for the five small open economies: Australia, Cananda, Netherlands, New Zealand and Sweden.

5.3. Sensitivity Analysis

In this subsection, we conduct sensitivity analysis to test our hypothesis that the borrowing constraint plays a role in transmitting shocks to aggregate variables. In the benchmark model, we set θ equals 0.33, which corresponds to the parameter for net worth constraint φ being 0.5. Now, we set θ equals to 0.44 (φ =0.8) and 0.5 (φ=1) respectively. We redo the simulation and compare the results we obtain from different values of θ. Table 3 summarizes the results. We find that the negative correlation between the real interest rate and output is larger for more borrowing constrained economy than less borrowing constrained economy, which are the expected results. However, the volatility of output is large for less borrowing constrained economy than more borrowing constrained economy. This may be because more production activities are associated with higher volatility of output.

Table 2.3 Results for sensitivity analysis

	Correlation between Y and R	% Standard deviation of Y
$\theta = 0.33$	-0.54	5.9
$\theta = 0.44$	-0.43	7.29
$\theta = 0.5$	-0.38	8.38

5.4 The relative importance of the net cash flow and the undepreciated capital stock as debt collateral

To assess the relative importance of different components of the entrepreneur's net worth, i.e. the net cash flow (W_t*) and the undepreciated capital stock ($(1-\delta)\ k_{t-1}$) as debt collaterals in generating the negative correlation between real interest rates and business cycles, we consider two cases. First, we assume that the entrepreneur's borrowing is a fraction (φ_1) of his net cash flow only. Second, we assume that the entrepreneur's borrowing is a fraction (φ_2) of the undepreciated capital stock only. These modifications change the budget constraints, the Euler equations as well as the borrowing constraints for the entrepreneur's problem correspondingly. Assuming $\varphi_1 = 0.5$ and $\varphi_2 = 0.5$, we redo the quantitative analysis and find that the undepreciated capital stock as the debt collateral plays an important role in generating the negative correlation between real interest rates and business cycles, while the role of the net cash flow as the debt collateral is insignificant. Figure 2.5 and Figure 2.6 show the impulse response functions to a world interest rate shock in these two cases respectively. A 1% increase in the real interest rate can only induce a less than 0.2% decline in output in the first case, while it can induce about a -1.6% decline in output in the second case. However, when the undepreciated capital stock is the debt collateral only, the real interest rate is slight procyclical at the beginning of the impact. In additon, the magnitudes of out and employment responses to a world real interest rate shock are relatively larger. For our model to better replicate the relationship between real interest rates and business cycles in emerging economies, assuming that both the net cash flow and the undepreciated capital stock function as the debt collateral is more appropriate.

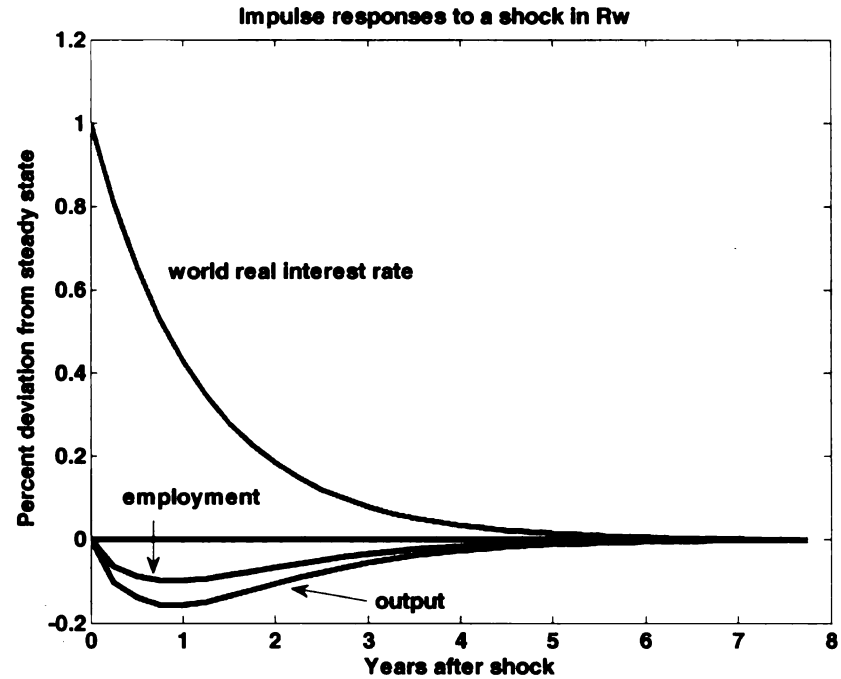

Figure 2.5 Impulse Response to a shock to the world interest rate

(net cash flow as debt collateral

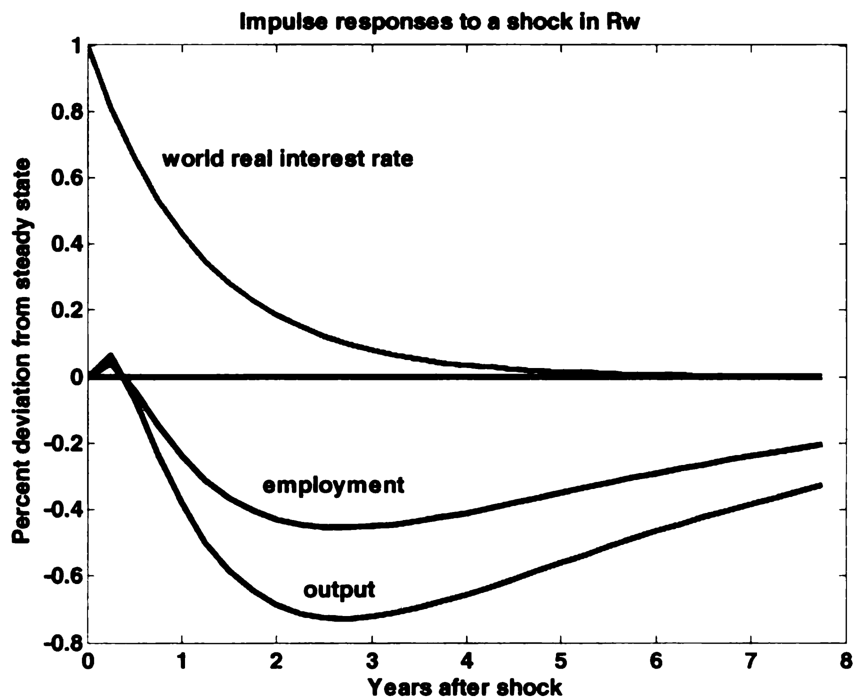

Figure 2.6 Impulse Response to a shock to the world interest rate

(undepreciated capital stock as debt collateral)

6. Conclusion

In this paper, we introduce a net worth constraint into the small open economy RBC model to study the effect of real interest rate shocks on the real economy in emerging economies. We find that real interest rate shocks have significant effects on the real economy due to the two way link between the real interest rate and the real economy and the presence of the net worth constraint. The model also predicts that output, consumption and real interest rates are more volatile in emerging economies than in developed economies.

Chapter 3

The Determinants of Country Risk Spreads: Evidence from Argentina

1. Introduction

Since 1980s, it has become a common phenomenon for many emerging economies to participate in the international financial markets. An important fact is that when these economies raise funds through issuing bonds or obtaining loans, they are charged by foreign investors an interest rate which is higher than the world interest rate. The difference between the interest rate faced by emerging economies and the world interest rate is called the country risk spread. Since different countries face different country risk spreads, it raises the question about what determine the country risk spread. Edwards (1984) shows that the country risk spread is determined by the default risk of a country. In principle, a higher default risk is associated with a higher country risk spread. Naturally, the factors that determine the default risk are the ones that determine the country risk spread. In this paper, we use monthly data during the period January 1998 to December 2006 to study the determinants of the country risk spread in Argentina. Following most of the current literature, we choose the J.P. Morgan EMBI+ spreads as a measure of country risk spreads. We find that broadly speaking, international investors tend to take into account the default risk of the specific emerging countries, where the extent of the risk is associated with the condition of the fundamentals. However, the country risk spread is not a perfect measure of the default risk. Other factors which may not represent the existence of the default risk, such as contagion effect, memory, IMF bailout expectation, etc, also play a role in determining the country risk spread.

The empirical study of the determinants of the country risk spread is important for several reasons. First, it provides a measure of the market's ability to pricing the default risk in emerging economies. It is argued that recent debt crises in emerging countries (as well as LDCs) may be due to foreign lenders' inability to assess these countries' default risk appropriately. By studying the determinants of the country risk spread, we can investigate to what extent the international financial market has taken into account the risk characteristics of emerging economies. Second, empirical studies suggest that there is a close relationship between real interest rates and business cycles in emerging economies. Since most emerging countries are open to international financial markets, real interest rates in these economies are closely determined by country risk spreads. Thus, understanding the determinants of the country risk spread can help us to make progress on understanding business cycles in emerging economies. Third, understanding the determinants of the country risk spread is useful for emerging economies to take positive steps towards reducing the country risk spread.

The issue on the determinants of the country risk spread has been addressed by a number of papers. Edwards (1984) studies the role of a set of fundamentals in determining the country risk spread. He finds that debt-output ratio is an important determinant of the country risk spread. Eichengreen and Mody (1998) study the determinants of emerging economies' bond launch spreads in the years 1991-1996. They find that although fundamentals are related to the country risk spread, changes in market sentiment instead of changes in fundamentals explain most of changes in the country risk spread. Dell'Ariccia et al (2006) analyze the effects of non-bailout of Russian in 1998 on sovereign bond spreads in emerging markets. They observe that the Russian crisis was followed by significant increases in the levels of spreads as well as significant increase in the cross-sectional dispersion of spreads. Jahjah and Yue (2007) analyze the impact of exchange rate policy on the sovereign bond spreads. Nogues and Grander (2001) study the determinants of country risk spread in Argentina for the period 1994 to 1998.

The present paper differs from previous literature in several aspects. First, most papers (Edwards(1984), Eichengreen and Mody (1998), Dell'Ariccia et al (2006), Jahjah and Yue (2007), etc) on the determinants of country risk spreads are cross-country studies. The advantage of using cross-country data is that the sample is larger. Thus, more information can be used in analysis. However, since the country risk spread may be affected by country specific factors or events, it might be more appropriate to use country specific data. Second, our paper uses an updated data (Jan 1998 to Dec 2006) in Argentina. Since IMF refused to bailout Argentina in 2001 when it went into debt crisis, using the updated data allows us to examine the effects of bailout expectations on the country risk spread. Third, to our knowledge, our paper is the first one which considers the effects of foreign investors' memory on the country risk spread.

The remainder of the paper is organized as follows. Section 2 analyzes the factors that affect the country risk spread. Section 3 specifies the econometric model and presents the results. Section 4 concludes.

2. The Determinants of Country Risk Spreads

We argue that the country risk spread in Argentina is affected by a set of fundamentals and nonfundamentals variables. In particular, the country risk spread is a function of the following variables:

1) the external debt – output ratio.[(1)] [(2)] This variable can be considered as an indicator of the degree of solvency in Argentina. It is expected that an increase in this ratio will result in a higher probability of default and have a positive effect on the country risk spread. The data on external debt was obtained from Joint External Debt Hub developed by BIS, IMF, OECD, and the World Bank. The data on GDP was obtained from International Financial Statistics (IFS).

2) the import – output ratio. This variable measures the degree of openness. In general, a more open economy is more vulnerable to foreign shocks. It is expected that this ratio is positively related to the default risk and the country risk spread. This variable was constructed from data obtained from IFS.

(1) We define the external debt as the sum of Brady bonds, loans from foreign controlled and foreign located banks, international debt securities, and officially supported trade credits.

(2) Data on external debt, import and GDP are only available quarterly. We employ cubic spline to transform them into monthly data.

3) GDP growth rate. It has been argued that a higher rate of growth of output will result in a lower probability of default, and thus a lower country risk spread.

4) Inflation rate. This variable is used as a proxy for sound macroeconomic management. A lower inflation rate indicates effective fiscal and monetary policies. We expect that an economy with low inflation will have a lower probability of default, and thus lower country risk spread. This variable was constructed from data obtained from IFS.

5) The country risk spreads in Brazil and Russia. These two variables are chosen to capture the contagion effects. It is documented that country risk spreads comove across countries (Mauro et al., 2002). This suggests that there exist contagion or spillover effects from one country's spreads to other countries' spreads. Contagion effects can be differentiated as fundamentals-based contagion and nonfundamentals-based contagion. The fundamentals-based contagion could arise due to both trade links and financial links between two countries. The nonfundamentals-based contagion could result from herd behavior. Due to incomplete information in the international financial markets, when foreign investors see a higher probability of default in one country, they tend to infer that the probability of default of other countries with similarities will increase as well even though the fundamentals of other countries are good. We expect that an increase in Brazil's or Russia's spread will have a positive effect on Argentina's spread. We also expect that the contagion effect

from Brazil's spread to Argentina's spread will be larger than that from Russia's spread to Argentina's spread. Argentina and Brazil are both Latin American countries. Their economies are closely linked. For example, Brazil is Argentina's main trading partner. Brazil is the destination of about 30 percent of Argentina's exports. On the contrary, the similarities and the degree of economic link between Argentina and Russia are much less.

6) The one-period lag of the country risk spread in Argentina. This variable captures the memory effect. We expect the sign of the coefficient of this variable is positive. Foreign investors tend to hold memories of past performances of emerging economies. A high probability of default in the previous period leads foreign lenders to think that the probability of default in the current period might be high. However, the probability of default in the current period is determined by the economic conditions in the current period. In other words, there is no direct link between the previous period spread and the default risk.

7) The 10-year U.S. Treasury bond rate. This variable is a proxy for global economic condition. This sign of the coefficient of this variable in the regression model could be positive or negative. This can be seen from analyzing the supply and demand for the emerging bond market.

In this market, emerging countries issue bonds, so they are suppliers. Foreign investors purchase bonds so they are demanders. The 10-year U.S. Treasury bond is a substitute for the emerging bond. When the 10-year U.S. Treasury bond rate increases, for the supplier, this means the cost of borrowing increases (since interest rate in emerging economies equals the world interest rate plus the country risk spread). It will lead to the supply curve of emerging bonds market shifting left, resulting in an increase in the price of the emerging bond and a decrease in the country risk spread (we call it the cost effect). For the demander, the increase in the U.S. Treasury bond rate make them switch to purchase the U.S. Treasury bond and decrease the demand for emerging bond. Thus the demand curve for the emerging bond market shifts to the left and results in a decrease in the price of the emerging bond and an increase in the country risk spread (we call it the substitution effect). The ultimate effect of an increase in the U.S. Treasury bond rate on the country risk spread depends on which of the above two effects are stronger.

8) IMF bailouts expectations. IMF bailouts are not a determinant of the default risk. However, IMF bailouts are expected to reduce investors' losses in case of default. When foreign investors believe that IMF will bailout emerging countries in case of default, they tend to think that the risk of holding emerging market bonds is less than that without IMF bailout. This is the so called investors' moral hazard. Thus, an increase in the belief of IMF bailout is expected to be associated with a decrease in the country risk spread.

All through the end of 1990s, Argentina did not experience non-bailout case. Argentina was regarded by IMF as important to the region of Latin America and as a major test-case for the liberalization program, the "Washington Consensus" policies advocated by IMF (Noy, 2003). In 2001, Argentina went into a serious debt crisis due to huge budget deficit, political turmoil and high interest burden. Although IMF committed to bailout Argentina throughout 2001, it refused to provide loan installment in December 2001. IMF resumed its bailout to Argentina in late 2002. We believe that at least in the first half of 2002, foreign investors' expectations about IMF bailout were significantly lower than the rest of time in our sample. Hence, we set $IMFbtex = 0$ for the period 2002m1-2002m6 and $IMFbtex = 1$ for the rest of the period.

3. Econometric Analysis and Results

To analyze the effects of fundamentals and nonfundamentals on the country risk spread in Argentina, consider the following econometric model;

$$\begin{aligned} \log sprds_t = {} & \beta_0 + \beta_1 \log(exdt/GDP)_t + \beta_2 \log(imp/GDP)_t + \beta_3 (GDPgr)_t \\ & + \beta_4 \inf l_t + \beta_5 \log Brazilsp_t + \beta_6 \log Russiasp_t + \beta_7 \log sprds_{t-1} \\ & + \beta_8 \log USTRB_t + \beta_9 IMFbtex_t + u_t \end{aligned} \tag{1}$$

where u_t is the identically distributed stochastic error term. The dependent variable and independent variables are in logarithmic forms so that the coefficients of the independent variables measure the elasticities of the country risk spread. However, some of the data on GDP growth rate and inflation rate are negative and cannot be transformed into logarithmic data. The coefficients of these two variables have a semi-elasiticty interpretation.

Since the presence of the one-period lag of spreads in the model, we suspect that the errors are serially correlated. We conduct serial correlation test for the errors and find that we cannot reject the null hypothesis that the errors are serially correlated (see appendix A). This means that we cannot use the usual t test to make inference about the coefficients. To correct the problem of serial correlation, we estimate the coefficients of the explanatory variables by OLS, but use the heteroskedastic and autocorrelation consistence (HAC) standard error (Newey-West standard error).

Table 3.1 shows the estimation results. In general, the results are satisfactory from the perspective of the signs and level of significance of the coefficients. As expected, increases in the ratio of external debt to GDP and the ratio of import to GDP lead to increases in the country risk spread ($\beta_1 = 0.63, \beta_2 = 1.27$). These effects are statistically significant ($t_{\hat{\beta}_1} = 2.25, t_{\hat{\beta}_2} = 2.66$). The effect of inflation on the country risk spread is economically large. A 1% increase in the inflation rate causes a 34% increase in the country risk spread. However, this effect is only marginally statistically significant ($t_{\hat{\beta}_4} = 1.55$). The effect of the GDP growth rate on the country risk spread has an unexpected sign ($\beta_3 = 0.057$). This may be because the monthly GDP data is obtained by interpolation and it incurs distortions when the GDP growth rate is calculated. Since the GDP growth rate is statistically very insignificant ($t_{\hat{\beta}_3} = 0.3$), we can ignore this variable without changing the regression results.

Most of the nonfundamentals variables have significant effects on Argentina's country risk spread. As expected, both Brazil's spread and Russia's spread have positive effects on Argentina's spreads. In particular, a 1% increase in Brazil's spread leads to a 0.24% increase in Argentina's spread. A 1% increase in Russia's spread leads to a 0.13% increase in Argentina's spread. The Brazil's spread is statistically significant ($t_{\hat{\beta}_5} = 2.82$), while the Russia's spread is not statistically significant ($t_{\hat{\beta}_6} = 1.14$). This suggests that contagion effects are more likely to occur between countries with similarities.

The previous period spread and IMF bailout expectations also have significant effects on Argentina's country risk spread. A 1% increase in the previous period spread leads to a 0.84% increase in the current period spread and this effect is very statistically significant ($t_{\hat{\beta}_7} = 12.12$). This indicates that foreign investors' memory plays an important role in determining the country risk spread. The coefficient on the variable, IMFbtex, is -0.18, meaning that with IMF bailout expectation, the country risk spread is lower by 18% than that without IMF bailout expectation. The variable IMF btex is statistically significant ($t_{\hat{\beta}_9} = -3.01$), indicating that investors' moral hazard does exist in the international financial market. The coefficient of the US Treasury bill rate has a positive sign and it is marginally statistically significant ($t_{\hat{\beta}_8} = 1.48$), which suggests that the substitution effect dominates the cost effect.

In summary, our estimation results suggest that factors affecting the default risk have nonneglible effects on the country risk spread. On the other hand, factors which are not related to the default risk also play a significant role in determining of the country risk spread.

To ensure that the regression results in Table 3.1 is not a spurious regression; we first conduct unit roots tests for all the variables and find that except for the external debt to GDP ratio, we cannot reject the null hypothesis that these variables have unit roots (see Appendix B). We then check the existence of a long-run relationship

Table 3.1 Spreads Function Estimation 1998-2006

Variable	coefficient	t-statistic	probability
log(exdt/GDP)	0.63 (0.2794)	2.25	0.026
log(imp/GDP)	1.27 (0.4779)	2.66	0.009
GDPgr	0.058 (0.1916)	0.30	0.764
Infl	0.347 (0.2232)	1.55	0.124
log(Brazilsp)	0.24 (0.0849)	2.82	0.006
Log(Russiasp)	0.13 (0.1143)	1.14	0.255
log Sprds(t-1)	0.842 (0.0695)	12.12	0.000
log USTRB	0.426 (0.2877)	1.48	0.142
IMFbtex	- 0.195	- 3.01	0.003

between the dependent variable and the independent variables by using the Engle-Granger cointegration test. The t-statistic on the residual $\hat{u}_{t-1}$ is −7.345. It is less than the critical value −3.34 (5% significant level). Thus, we reject the null hypothesis that the dependent variable, *log sprdst*, and the independent variables are not cointegrated. In other words, our test verifies that the regression results reported in Table 1 represents a long-run relationship between the dependent variable and the independent variables.

In order to study the short-run dynamics in the relationship between the dependent variable and its determinants, we estimate the following error correction model:

$$\Delta \log sprds_t = \alpha_0 + \delta \hat{u}_{t-1} + \gamma \Delta X_t + \varepsilon_t \qquad (2)$$

where X_t represents all the independent variables except the dummy variable *IMFbtex.* ε_t is an independently identically distributed error. $\hat{u}_{t-1}$ is the one period lag residual obtained from the estimation of equation (1). $\delta \hat{u}_{t-1}$ is the error correction term. It is expected that δ to be negative so that when the dependent variable, $\log Sprds$ in the previous period has been above the equilibrium level, i.e. $\hat{u}_{t-1}$ >0, the error correction term works to push *logSprds* back towards the equilibrium. Similarly, when logSprds in the previous period has been below the equilibrium level, i.e. $\hat{u}_{t-1}$ <0, the error correction term induces a positive change in *logSprds* back towards the equilibrium. Table 3.2 reports the estimation results. As expected, the error correction coefficient is a negative number, -0.96, and it is statistically significant. This means that if the dependent variable, *logSprds,* in the previous period is above the equilibrium by 1%, then 0.96% of the gap is closed in one month.

Table 3.2 Error Correction Model Estimation

Variable	coefficient	t-statistic	probability
$\hat{u}_{t-1}$	- 0.96	- 3.69	0.000
	(0.2626)		
Δlog(exdt/GDP)	- 0.117	- 0.08	0.938
	(1.4927)		
Δlog(imp/GDP)	0.866	0.34	0.735
	(2.549)		
Δ(GDPgr)	- 0.357	- 0.65	0.518
	(.55)		
Δinfl	- 0.637	- 1.09	0.277
	(0.5829)		
ΔlogBrazilsp	0.388	1.81	0.073
	(0.214)		
ΔlogRussiasp	0.195	0.98	0.332
	(0.199)		
ΔlogUSTRB	0.406	0.9	0.373
	(0.453)		
Cons	0.015	0.64	0.523
	(0.023)		

4. Conclusion

In this paper, we use monthly data during the period 1998-2006 to study the determinants of the country risk spread in Argentina. We find that the country risk spread is not a perfect measure of the default risk. Our estimation results suggest that factors affecting the default risk have nonneglible effects on the country risk spread. On the other hand, factors which are not related to the default risk also play a significant role in determining the country risk spread.

Our analysis implies several potential ways to reduce the country risk spread. If increases in the external debt or imports have the externality of increasing the country risk spread, then imposing external debt tax or import tax are expected to reduce the country risk spread. Moreover, given the significant effects of contagion and memory on the country risk spread, a more transparent information revelation on the performance of emerging economies will be helpful for foreign investors to access the default risk appropriately.

Appendix A: Data Sources

Data Sources (I)

	Quarters	HPI
Emerging Economies		
Argentina	1994Q1-2006Q4	EcoWin (GPR)
Korea	1994Q1-2005Q1	the Bank of Korea
Malaysia	1999Q1-2006Q4	Ministry of Finance
Mexico	1994Q1-2006Q4	OECD
Slovak	1995Q1-2006Q4	OECD
Thailand	1994Q1-2003Q4	Bank of Thailand
Turkey	1994Q1-2006Q1	Central Bank of Turkey
Developed Economies		
Austria	1994Q1-2006Q4	Oesterreichische National Bank
Australia	1994Q1-2006Q4	Australia Bereau of Statistics
Canada	1994Q1-2006Q4	Statistics Canada
Denmark	1994Q1-2006Q4	Statbank Denmark
Netherlands	1994Q1-2006Q4	NVM
New Zealand	1994Q1-2006Q4	Reserve Bank of New Zealand
Sweden	1994Q1-2004Q4	Statistics Sweden

Notes: RVD = Ratings and Valuation Department

NVM = Nederlandse Vereniging van Makelaars

Data Sources (II)

	Quarters	Interest rate	GDP	GDP deflator	CPI
Emerging Economies					
Argentina	1994Q1-2006Q4	EMBI	IFS	IFS	IFS
Korea	1994Q1-2005Q1	EMBI	OECD	IFS	IFS
Malaysia	1999Q1-2006Q4	CBM	IFS	IFS	IFS
Mexico	1994Q1-2006Q4	EMBI	OECD	IFS	IFS
Slovak	1995Q1-2006Q4	IFS	IFS	IFS	IFS
Thailand	1994Q1-2003Q4	EMBI	IFS	IFS	IFS
Turkey	1994Q1-2006Q1	IFS	CBT	IFS	IFS
Developed Economies					
Austria	1994Q1-2006Q4	OECD	OECD	IFS	IFS
Australia	1994Q1-2006Q4	OECD	OECD	IFS	IFS
Canada	1994Q1-2006Q4	OECD	OECD	IFS	IFS
Denmark	1994Q1-2006Q4	OECD	OECD	IFS	IFS
Netherlands	1994Q1-2006Q4	OECD	OECD	IFS	IFS
New Zealand	1994Q1-2006Q4	OECD	OECD	IFS	IFS
Sweden	1994Q1-2006Q4	OECD	OECD	IFS	IFS

Notes

IFS = International Financial Statistics (IMF)

EMBI = J.P. Morgan Emerging Market Bond Index

CBM = Central Bank of Malaysia CBT = Central Bank of Turkey

Data Sources (III)

Countries	Periods	Bank Balance Sheet Data
Argentina	2003m9-2007m12	Banco Central De La Republic Argentina
Korea	1999Q2-2006Q1	Monthly Financial Statistics Bulletin
		Korea Financial Supervisory Service
Malaysia	2004m1-2007m12	Bank Negara Malaysia
Mexico	2001m1-2007m12	Bank of Mexico
Slovak	2003m1-2007m12	National Bank of Slovakia
Thailand	1997m1-2003m12	Bank of Thailand
Turkey	1994m1-2006m12	Quarterly Bulletin
		Central Bank of the Republic of Turkey

Notes:

(1) For Argentina, bank balance sheet data is drawn from "Private Banks' Balance Sheet". The item "Net Worth" is regarded as capital.

(2) For Korea, bank balance sheet data is drawn from "Summarized Balance Sheet of Bank Account of Commercial Banks". The item "Loans and Discounts in Won" is regarded as loans. The item "Total Shareholders' Equity " is regarded as capital.

(3) For Malaysia, bank balance sheet data is drawn from "Commercial Banks' Statement of Assets and Liabilities". The item "Capital and Reserves" is regarded as capital.

is regarded as loans. The item "Other Liabilities and Capital, Net from Other Assets" is regarded as capital.

(5) For Slovak, bank balance sheet data is drawn from "Monthly Report on Balance Sheet Items of Credit Institutions".

(6) For Thailand, bank balance sheet data is drawn from "All Commercial Banks' Assets and Liabilities (1997-2003)". The item "Credits" is regarded as loans. The item "Stockholders' equity" is regarded as capital.

(7) For Turkey, bank balance sheet data is drawn from "Deposit Money Banks Balance Sheet". The item "Credits" is regarded as loans.

Appendix B. The Steady State

We normalize the steady state real estate price to q = 1.

The steady state is described by the following equations:

$$\frac{y'}{c'} = \frac{1 + (1-R)\sigma \dfrac{\varphi}{1-\beta-(\beta R-1)\beta\sigma}}{1-\mu-\nu} \tag{28}$$

$$\frac{h'}{c'} = \frac{\varphi}{1-\beta-(\beta R-1)\beta\sigma} \tag{29}$$

$$\frac{h}{h'} = \frac{(\frac{1}{R}-\gamma)R\sigma(1-\frac{m_F}{m_H}) + \gamma\nu\frac{y}{h'}}{1-(\frac{1}{R}-\gamma)m_F - \gamma} \tag{30}$$

$$h + h' = 1 \tag{31}$$

$$\alpha = \frac{R\sigma\, h'}{h} \tag{32}$$

$$RB^H = \alpha\, m^H h \tag{33}$$

$$RB^F = (1-\alpha)m_F h \tag{34}$$

$$\omega\, n = (1-\mu-\nu)y \tag{35}$$

$$1 = \gamma(\mu\frac{y}{k} + 1 - \delta) \tag{36}$$

$$y + B^H + B^F = c + \delta k + RB^H + RB^F + \omega n \tag{37}$$

$$B' = \sigma\, h' \tag{38}$$

$$c' + B' = RB' + \omega\, n \tag{39}$$

Appendix C. Loglinearized Equations

$$\gamma v \frac{y}{qh}(\hat{y}_{t+1} - \hat{h}_t) - (\gamma v \frac{y}{qh} - \alpha m_H \gamma - (1-\alpha) m_F \gamma + \gamma)\,\hat{c}_{t+1} - (-1 + \frac{\alpha m_H}{R} + \frac{(1-\alpha) m_F}{R})\hat{c}_t$$
$$+ (m_H - m_F)(\frac{\alpha}{R} - \gamma\alpha)\hat{\alpha}_t - (\frac{\alpha m_H}{R} + \frac{(1-\alpha) m_F}{R})\hat{R}_t - q_t - (m_H \alpha\gamma + (1-\alpha) m_F \gamma - \frac{\alpha m_H}{R}$$
$$- \frac{(1-\alpha) m_F}{R} - \gamma)\hat{q}_{t+1} = 0 \tag{40}$$

$$\hat{R}_t + \hat{B}_t{}^H - \hat{\alpha}_t - \hat{q}_{t+1} - \hat{h}_t = 0 \tag{41}$$

$$\hat{R}_t + \hat{B}^F{}_t - \frac{\alpha}{1-\alpha}\hat{\alpha}_t - \hat{q}_{t+1} - \hat{h}_t = 0 \tag{42}$$

$$\hat{\alpha}_t + \hat{q}_{t+1} + \hat{h}_t - \hat{q}_t - \hat{h}'_{t-1} - \hat{R}_t = 0 \tag{43}$$

$$c\hat{c}_t + k\hat{k}_t - (1-\delta)k\hat{k}_{t-1} + qh\hat{h}_t - qh\hat{h}_{t-1} + RB^H \hat{B}_{t-1}{}^H + RB^H \hat{R}_{t-1} + RB^F \hat{B}_{t-1}{}^F$$
$$+ RB^F \hat{R}_{t-1} + \omega n\,\hat{n}_t + \omega n\,\hat{\omega}_t - y\hat{y}_t - B^H \hat{B}_t{}^H - B^F \hat{B}_t{}^F = 0 \tag{44}$$

$$\hat{y}_t - \hat{\omega}_t - \hat{n}_t = 0 \tag{45}$$

$$-\hat{c}_{t+1} + \hat{c}_t + \frac{1}{\mu\frac{y}{k} + 1 - \delta}\frac{\mu y}{k}\hat{y}_{t+1} - \frac{1}{\mu\frac{y}{k} + 1 - \delta}\frac{\mu y}{k}\hat{k}_t = 0 \tag{46}$$

$$-\frac{\varphi}{h'}\hat{h}'_t+\frac{q}{c'}(\hat{c}'_t-\beta\hat{c}'_{t+1})-\frac{q}{c'}\hat{q}_t+\frac{\beta q}{c'}\hat{q}_{t+1}+\beta\lambda'\sigma q\hat{q}'_{t+1}+\beta\lambda'\sigma q\hat{\lambda}'_{t+1}=0 \quad (47)$$

$$\hat{c}'_{t+1}-\hat{R}_t-\frac{1}{1+\lambda'c'}\hat{c}'_t+\frac{\lambda'c'}{1+\lambda'c'}\hat{\lambda}'_t=0 \quad (48)$$

$$\hat{\omega}_t-\hat{c}'_t-(\eta-1)\hat{n}_t=0 \quad (49)$$

$$\hat{q}_t+\hat{h}'_{t-1}-\hat{B}_t'=0 \quad (50)$$

$$RB'B_{t-1}'+RB'R_{t-1}+\omega n\hat{\omega}_t+\omega n\hat{n}_t-c'\hat{c}'_t-qh'\hat{h}_t'+qh'\hat{h}'_{t-1}-B'\hat{B}'_t=0 \quad (51)$$

$$h\hat{h}_t+h'\hat{h}_t'=0 \quad (52)$$

$$\hat{A}_t+\mu\hat{k}_{t-1}+\nu\hat{h}_{t-1}+(1-\mu-\nu)\hat{n}_t-\hat{y}_t=0 \quad (53)$$

$$\hat{A}_t=\rho_A\hat{A}_{t-1}+\varepsilon_{A,t} \quad (54)$$

$$\hat{R}_t^{\,w}=\rho_{Rw}\hat{R}_{t-1}^{\,w}+\varepsilon_{Rw,t} \quad (55)$$

$$\hat{R}_t=\hat{R}^w{}_t-\overline{\eta}E_t\hat{A}_{t+1}+\varepsilon_{D,t} \quad (56)$$

Appendix D Serial Correlation Test

We test the serial correlation for the error terms in two steps:

Step 1: Run the OLS regression of $\log(sprds)_t$ on $\log(exdt/GDP)_t$, $\log(imp/GDP)_t$, $(GDPgr)_t$, $Infl_t$, $\log(Brazilsp)_t$, $\log(Russiasp)_t$, $\log Sprds_{t-1}$, $\log USTRB_t$, $\text{IMF}btex_t$ and obtain the OLS residuals $\hat{u}_t$ for all t = 1, 2….n.

Step 2: Run the regression of $\hat{u}_t$ on $\log(exdt/GDP)_t$, $\log(imp/GDP)_t$, $(GDPgr)_t$, $\inf l_t$, $\log(Brazilsp)_t$, $\log(Russiasp)_t$, $\log Sprds_{t-1}$, $\log USTRB_t$, $IMFbtex_t$, $\hat{u}_{t-1}$ for all t = 2, 3, ……n .

The t-statistic for the coefficient on $\hat{u}_{t-1}$ is 3.58. Hence, we reject the null hypothesis that the coefficient on $\hat{u}_{t-1}$ is 0, which means that the error terms follows AR(1) serial correlation.

Appendix E Unit Roots Tests

We conduct Augmented Dickey-Fuller (ADF) test for all the variables to check whether these variables contain unit roots. Since we don't find significant trends for all the variables, we use ADF test based on the following specification:

$$\Delta y_t = \alpha + \theta y_{t-1} + \sum_{j=1}^{n} \gamma_j \Delta y_{t-j} + \varepsilon_t$$

Table 3.3 shows the results

Table 3.3 Unit Roots Tests

Variable	optimal lags	t-value ($H_0 : \theta = 0$)
log(sprds)	1	- 1.32
log(exdt/GDP)	4	- 8.81
log(imp/GDP)	5	- 2.11
GDPgr	4	- 1.62
Infl	5	- 1.99
log(Brazilsp)	1	- 1.15
log(Russiasp)	1	- 0.79
log(sprds(t-1))	2	- 1.14
log(USTRB)	2	- 1.8

(1) The critical value at 5% level is - 2.89.

(2) The optimal lags are chosen by examining the t statistic value for lagged variables. If the lagged variables are insignificant, we drop them.

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