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**Automatic Stabilizer Feature of Fixed Exchange Rate Regimes
in Emerging Markets**

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Abstract

This paper shows that countries characterized by a financial accelerator mechanism may reverse the usual finding of the literature – flexible exchange rate regimes do a worse job of insulating open economies from external shocks. I obtain this result with a calibrated small open economy model that endogenizes foreign interest rates by linking them to the banking sector's foreign currency leverage. This relationship renders exchange rate policy more important compared to the usual exogeneity assumption. I find empirical support for this prediction using the Local Projections method. Finally, 2nd order approximation to the model finds larger welfare losses under flexible regimes.

Journal of Economic Literature Classification: E44, F31, F41

Keywords: accelerator, balance sheets, welfare, EMBI

1 Introduction

Over the past 15 years, emerging market countries have faced severe financial crises, resulting in large costs of bank restructuring, extended periods of contraction and high unemployment. Theoretical and empirical studies have blamed the inability of pegged regimes to withstand speculative attacks, especially with rapidly growing international financial activity during this period. Advocates of this view have advised countries to float their currency. Despite these developments, emerging market economies have been reluctant to float due to several reasons¹. Among these are the lack of central bank credibility, large terms of trade shocks, high inflation due to exchange rate pass through and liability dollarization.

The effect of liability dollarization has been analyzed by the “Balance Sheet Effects” literature². These studies argue that the chance of a financial crisis increases with high levels of foreign currency denominated liabilities, maturity mismatches and bad loans³. Despite the benefits of tight exchange rate regimes in limiting the fluctuations of the foreign liability component of bank balance sheets, consensus in the literature is that the involuntary interest rate adjustments under these regimes in response to external shocks exacerbate the financial distress and outweigh the positive effects on balance sheets.

This paper compares the relative strength of the two effects mentioned above and measures the performance of different exchange rate regimes⁴. It formulates a small open economy dynamic stochastic general equilibrium

¹ Countries that declared their commitment to floating regimes have not allowed their currency to float freely. The literature has analyzed this concept under the “Fear of Floating” heading.

² See Chang and Velasco (1998), Calvo (2001), Eichengreen and Hausman (1999), Cepedes Chang and Velasco (2001), Scheider and Tornell (2004).

³ Table 1 reports the change in exchange rates and real GDP for the period before and after the crises together with the foreign currency leverage of the banking sector for countries that have had financial crisis and countries that have financial and trade linkages with these countries. The important observation is that in most of the cases large depreciations coupled with high bank leverage have caused a decline in output, whereas countries that have banking sectors with low or negative leverage like Uruguay, Philippines, Vietnam and Mexico have recorded either an increase or a mild drop in output after the crises.

⁴ Different exchange rate regimes correspond to Taylor rules with different exponents of the exchange rate term. Empirical studies suggest that interest rates are sufficiently important instruments in exchange rate manipulation in emerging markets, Calvo and Reinhart (2000).

(DSGE) model where terms of foreign credit depends on the balance sheet of domestic banks and there is a financial accelerator mechanism.

The financial accelerator framework of Bernanke, Gertler and Gilchrist (1998) (BGG) is a convenient starting point for the purposes mentioned above for two reasons. First, it allows for the effects of the shocks to be amplified through its effects on the balance sheets of the firms in the economy, which in turn provides a better fit of the model's output to the actual data⁵. Second, the model includes a domestic financial sector enabling the analysis of balance sheet effects and foreign creditor behavior when the contract between the domestic banking sector and the foreign sector is defined.

Gertler, Gilchrist and Natalucci (2001) (GGN) extend this model to a small open economy setting and show as mentioned above, how the central bank has to peg the interest rates to the foreign rates under a fixed regime and thereby cause a hike in real interest rates in response to adverse external shocks. The recession caused by these shocks is less profound under flexible regimes where a part of the negative effect of the external shock is absorbed by the depreciation of the currency. Furthermore, this contrast between the performance of different exchange rate regimes becomes more apparent when the financial accelerator mechanism is included due to its implicit amplification mechanism.

Analysis in this paper alters the framework of GGN in two ways. First, domestic banks are only able to diversify the idiosyncratic shocks but are vulnerable to systematic ones. In the GGN model, the banks are able to diversify the aggregate risk and always collect the market rate of return by integrating the shock into an ex-post contract with the firm. This alteration provides a better representation of the actual functioning of the market and also allows banks' net worth to fluctuate over time, which in turn plays a crucial role in foreign interest premium⁶.

Second, instead of assuming foreign interest rates are purely exogenous, the role of the foreign sector is defined more rigorously by deriving the relationship between the balance sheets of domestic banks and the interest rate charged on loans by foreign creditors. This in turn is governed by a financial accelerator mechanism similar to the one between the domestic banks and firms⁷. More specifically, the contract between the domestic banks and foreign creditors is such that if the banks become more leveraged, the interest rates charged by the foreign creditors

⁵ BGG use this model to create the large amplification mechanism missing in the standard RBC models.

⁶ The terms of the ex-ante contract in this paper are determined before the realization of the technology or foreign interest rate shock the next period. The terms of the contract in BGG on the other hand change with the level of the technology shock the following period.

⁷ GGN assume that the foreign interest rates are exogenous.

increase. Furthermore, the assumption of one hundred percent foreign currency denominated debt used in this paper renders central bank exchange rate policy more important since exchange rate fluctuations have a direct impact on the translational exposure of the domestic banks and thus the foreign rates in this setting.

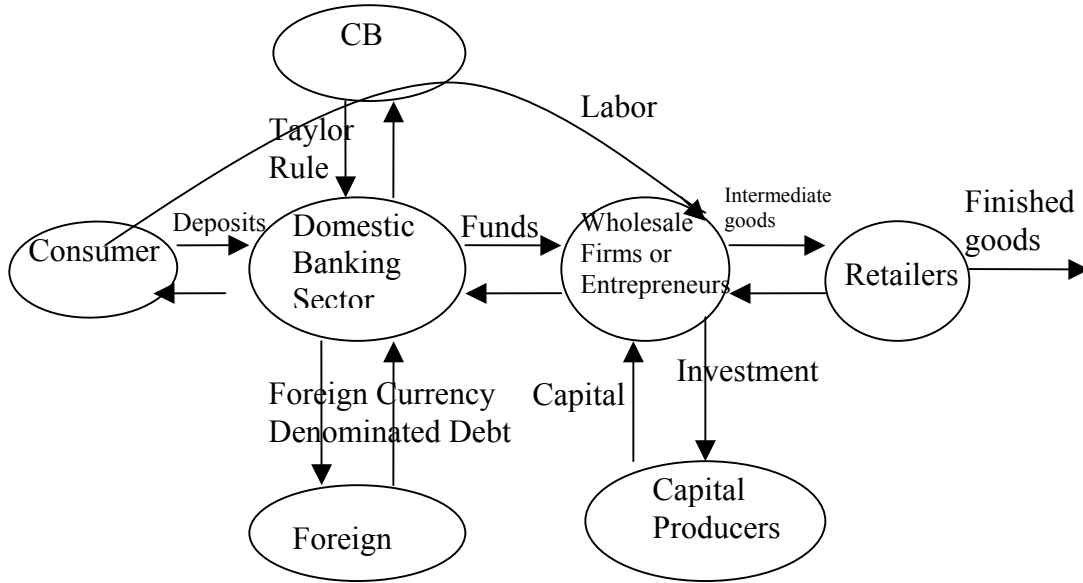
Impulse responses obtained from the calibrated and linearized model show, contrary to the majority of the literature, that external shocks and technology shocks lead to greater output volatility under flexible regimes when a country risk premium mechanism is included in the model. The results exhibit how economies become highly leveraged when asset prices increase, and how price fluctuations increase (decrease) the amplitude of output response under flexible (fixed) regimes when faced with aggregate technology and external shocks⁸. It is important to state that these findings do not imply the superiority of pegged regimes. A better interpretation would be that for countries in need of foreign finance to develop, a stable domestic financial market is essential, and that a clean float exchange rate regime is not appropriate in this setting. This model should be construed as a non crisis framework since the linearization technique employed is not suitable to capture the dynamics governing crisis periods. Despite this fact, the comparison of exchange rate regimes, within this framework has crisis implications provided that the deteriorating domestic financial conditions eventually initiate large capital reversals.

First order approximation methods used to solve the model are not capable of capturing the effect of risk on the behavior of agents. To measure the significance of the country risk premium on the economy, a welfare analysis with unconditional moments is conducted using the second order approximation algorithm of Schmitt-Grohe and Uribe. The results are in line with the first order approximation findings and show that tight exchange rate regimes reduce, flexible regimes increase welfare cost when the country risk premium is included. Hence, this risk premium constitutes an automatic stabilizer under fixed regimes and dampens the effect of an initial shock. Welfare effects are also measured using conditional moments because unconditional computations do not account for the welfare effects during the transition period from one steady state to another. Finally, the paper investigates if there is empirical support for the theoretical results using the Local Projections method of obtaining impulse responses. This model includes Emerging Market Bond Indices (EMBI) instead of advanced country lending rate averages as a proxy for foreign interest rates. Results show that output responses to external shocks are smaller with relatively fixed regimes. Following the literature, I also include a weighted average of advanced country lending rates and fail to distinguish the difference in output responses under the two regimes. The remainder of the paper is organized as follows. Section 2 explains the model. Section 3 describes the effects of the financial accelerator mechanism and

⁸ Leverage is defined as net foreign liabilities divided by the net worth of the domestic banks.

different exchange rate regimes, defines the foreign sector and the contract with the banks, and shows how the results differ from a replicated version of GGN. Section 4 discusses the methodology and the results of the welfare analysis. Section 5 provides the empirical support. Section 6 concludes.

2 The Model



The framework utilized is a small open economy DSGE model with price rigidities. The households in the economy consume domestic and foreign goods, supply labor and save. The production side of the economy has three types of agents: the capital producers, the perfectly competitive entrepreneurs, and the monopolistically competitive retailers. Entrepreneurs purchase capital from capital producers, hire labor and produce identical wholesale goods, which are in turn sold to the retailers. Retailers package wholesale goods at no resource cost and sell the final output. Retailers are the source of price stickiness and their pricing scheme follows that of Calvo.

The financial side of the economy consists of three different agents: domestic banking sector, foreign creditors and the central bank. The domestic banking sector-firm relationship is characterized by the financial accelerator mechanism by which the demand for capital depends on the net worth of the entrepreneurs and capital investment affects the net worth of the entrepreneurs by altering asset prices.

The foreign creditors lend to the domestic banking sector. The interest rates charged by these agents have an endogenously determined component, which depends negatively on the net worth of the domestic banking sector and positively on foreign debt stock, and an exogenous component.

The central bank's goal is to stabilize output and prices. For this purpose the bank conducts monetary policy governed by a Taylor rule. The following sections describe the economy more rigorously.

2.1 Households

Households consume a composite good, C_t which is a CES aggregation of domestic and foreign goods represented by C_t^H and C_t^F respectively where, C_t^H is a composite of the goods sold by the retailers.

$$C_t = \left[(\gamma)^{\frac{1}{p}} \left(C_t^H \right)^{\frac{p-1}{p}} + (1-\gamma)^{\frac{1}{p}} \left(C_t^F \right)^{\frac{p-1}{p}} \right]^{\frac{p}{p-1}} \quad (1)$$

the corresponding price index is given by,

$$P_t = \left[(\gamma) \left(P_t^H \right)^{1-p} + (1-\gamma) \left(P_t^F \right)^{1-p} \right]^{\frac{1}{p-1}} \quad (2)$$

Households which exhibit habit formation maximize,

$$E_t \left[\sum_{i=0}^{\infty} \beta^i \left[\frac{(C_{t+i} - bC_{t+i-1})^{1-\Omega}}{1-\Omega} + x \ln \left(\frac{M_{t+i}}{P_{t+i}} \right) - k \ln(1 - L_{t+i}) \right] \right] \quad (3)$$

subject to,

$$C_t + \frac{M_t}{P_t} + D_{t+1} + e_t D_{t+1}^* = \frac{W_t}{P_t} L_t + \frac{M_{t-1}}{P_t} + (1 + R_{t-1}) D_t + (1 + R_{t-1}^*) e_t D_t^* + \Pi_t \quad (4)$$

Consumers buy goods, hold money, M_t and save using their wages, W_t , profits received from the retailers, Π_t , the returns on deposits, and their money holdings. Returns on domestic and foreign deposits are denoted as $(1 + R_{t-1}) D_t$ and $(1 + R_{t-1}^*) e_t D_t^*$ respectively, where e_t , R_{t-1} and R_{t-1}^* represent the exchange rate, domestic and foreign interest rates respectively. The first order conditions are as follows:

Consumption allocation;

$$\frac{C_t^H}{C_t^F} = \frac{\gamma}{1-\gamma} \left(\frac{P_t^H}{P_t^F} \right)^{-p} \quad (5)$$

intratemporal efficiency;

$$\lambda_t \frac{W_t}{P_t} = k \frac{1}{1 - L_t} \quad (6)$$

marginal utility of consumption;

$$\lambda_t = (C_t - bC_{t-1})^{-\Omega} - \beta b (C_{t+1} - bC_t)^{-\Omega} \quad (7)$$

intertemporal efficiency;

$$\lambda_t = \beta E_t \left(\lambda_{t+1} (1 + R_t) \frac{P_t}{P_{t+1}} \right) \quad (8)$$

uncovered interest parity condition;

$$E_t \left(\lambda_{t+1} \frac{P_t}{P_{t+1}} \left[(1 + R_t) - (1 + R_t^*) \frac{e_{t+1}}{e_t} \right] \right) = 0 \quad (9)$$

It will be assumed that the law of one price holds;

$$P_t^H = e_t P_t^{H*} \quad (10)$$

$$P_t^F = e_t P_t^{F*} \quad (11)$$

where P_t^{H*} and P_t^{F*} are foreign price of home and foreign goods⁹. Foreign demand for home goods is:

$$C_t^{H*} = \left(\frac{P_t^{H*}}{P_t^*} \right)^{-\varepsilon} Y_t^* \quad (12)$$

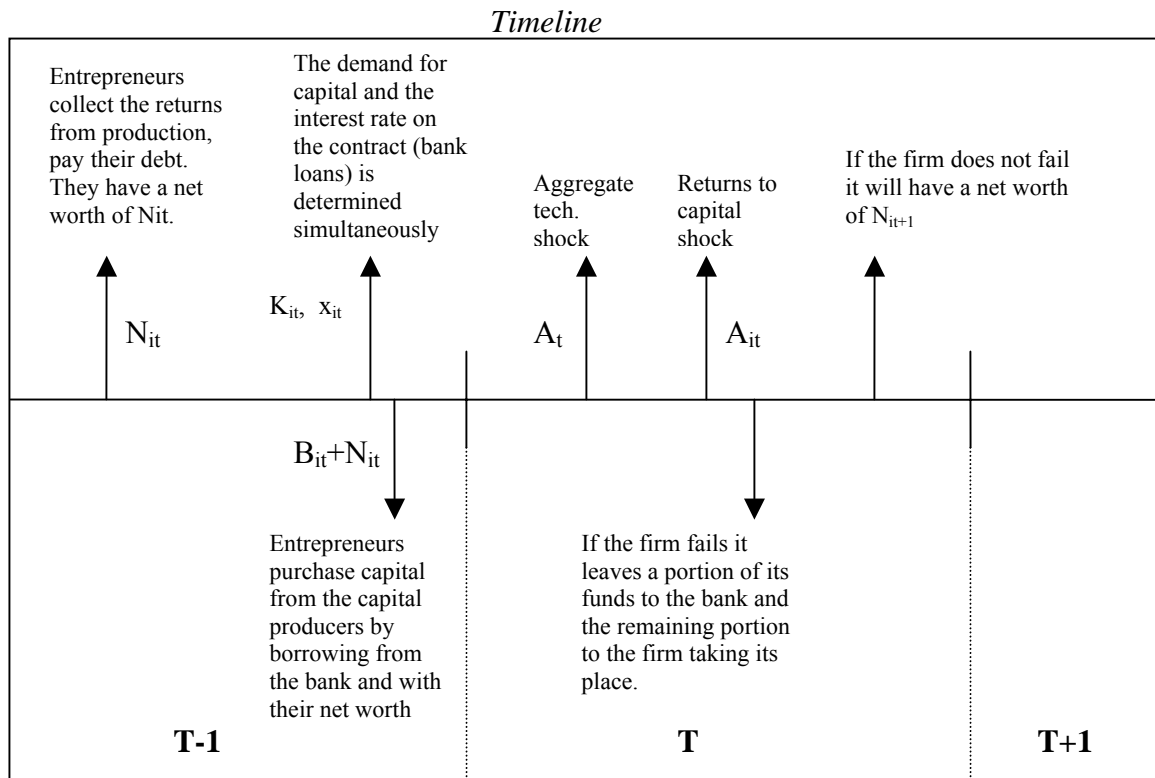
where foreign income Y_t^* and foreign aggregate price level P_t^* will be taken as given.

2.2 Wholesale Firms

Wholesale firms are managed by entrepreneurs with constant returns to scale production function.

$$Y_{it} = A_t K_{it}^\alpha L_{it}^{1-\alpha} \quad (13)$$

where A_t is an iid aggregate productivity shock.



⁹ In my analysis P_t^{F*} is equal to one, for every period.

Capital expenditures are financed by the banks and entrepreneurs' net worth¹⁰.

$$Q_{t-1}K_{it} = N_{it} + B_{it} \quad (14)$$

where N_{it} is the net worth of the firm at the end of period t-1 and at the beginning of period t, B_{it} denotes the funds borrowed from the banks and finally Q_{t-1} is the price of assets in period t-1.

In addition to the economy wide technology shock, entrepreneurs face idiosyncratic shocks. Real returns to capital are composed of the idiosyncratic iid shock, A_{it} , and the real aggregate return to capital, R_t^k ¹¹.

$$R_{it}^k = A_{it} \left(\frac{\alpha \frac{P_t^w A_t K_t^{\alpha-1} L_t^{1-\alpha}}{P_t} + (1-\delta) \frac{Q_t}{P_t}}{\frac{Q_{t-1}}{P_{t-1}}} \right) = A_{it} R_t^k \quad (15)$$

P_t^w is the price of the wholesale goods produced by the firms and P_t is the aggregate price level.

2.2.1 The contract between the banking sector and the firm

The interest rate premium on loans is determined by the following contract.

$$\left[1 - F(\bar{A}_{it}) \right] (1 + R_{t-1} + x_{it}) B_{it} + (1 - \mu) \left[\int_0^{\bar{A}_{it}} A_{it} \left(\frac{\alpha A_t P_t^w K_t^{\alpha-1} L_t^{1-\alpha}}{Q_{t-1}} + (1-\delta) Q_t \right) Q_{t-1} K_{it} \delta F(A_{it}) \right] = (1 + R_{t-1}) B_{it} \quad (16)$$

\bar{A}_{it} , is the expected cutoff value of the firm specific shock below which the firm is unable to pay back its debt to the banks. x_{it} is the interest rate charged to the firm, μ is the monitoring cost coefficient and R_{t-1} is the prime interest rate in the economy determined by the central bank.

The above equation illustrates how banks equate expected revenues to opportunity costs. The first term on the left hand side represents the principal and the interest collected from the firm if it does not fail. If the firm fails, the banks acquire the returns to capital but have to pay a monitoring cost; this is reflected in the second term. The right hand side is the opportunity cost of the banking sector.

\bar{A}_{it} and the risk premium x_{it} together with equation (16) are determined simultaneously from,

$$\bar{A}_{it} E_{t-1} \left(R_t^k \right) Q_{t-1} K_{it} = (1 + R_{t-1} + x_{it}) B_{it} \quad (17)$$

¹⁰ Here I am using entrepreneurs and wholesale firms interchangeably since the entrepreneurs make the production decisions.

¹¹ Gross return averaged across firms.

According to this equation, if A_{it} is less than \bar{A}_{it} then the firm is expected to default. Since there is a continuum of firms, banks are able to diversify the firm specific risk and receive the market rate of return when there is no aggregate shock to output.

It is essential to mention that the banks do not include the aggregate technology shock in the contract since I would like the banks to experience financial problems due to aggregate shocks. This assumption is different from the BGG framework where as a part of the ex-post contract, the aggregate shock is incorporated in the interest premium and possible losses or gains are passed on to the entrepreneurs who are risk neutral. This deviation does not create a problem in terms of the interest rate charged or the relationship (18) shown below or any other component of the financial accelerator mechanism. This stems from the fact that the firms make their decisions on expected terms and the contract is built on expectations, therefore the equations that constitute the financial accelerator mechanism are independent of the realization of the aggregate shock.

\bar{A}_{it} is the contract value of the shock and is different from the actual cutoff value of \bar{A}_{it}^* which will be discussed in the foreign creditors-domestic banking sector relationship section below. From the revenue maximization problem of the firm, subject to the contract equation (16), it can be shown as in BGG that,

$$Q_{t-1}K_{it} = \varphi(s_t)N_{it} \quad \varphi'(\bullet) > 0 \quad (18)$$

where $s_t = \frac{E_{t-1}[R_t^k]}{1 + R_{t-1}}$

This equation is an important part of the financial accelerator mechanism; it shows that as the returns to capital increase relative to the market interest rate, firms become more leveraged by taking out more loans and investing more. Another observation pertaining to this equation is that since the relative returns to capital are the same for every firm, the leverage of these firms will also be the same, which in turn is useful for aggregation purposes.

The equation can be inverted as,

$$E_{t-1}[R_t^k] = v\left(\frac{N_{it}}{Q_{t-1}K_{it}}\right)(1 + R_t) \quad v'(\bullet) < 0 \quad (19)$$

This equation on the other hand shows that the banks will charge an interest premium equal to $v(\bullet)$ based on the leverage ratio, which in turn can be thought of as the supply of capital relation. As the firms become more leveraged the banks will charge a higher premium and $v(\bullet)$ will increase.

¹² see BGG (1998).

The demand for capital in the economy is obtained from the aggregation of demand over all entrepreneurs.

$$Q_{t-1}K_t = v \left(\frac{E_{t-1}(R_t^k)}{1 + R_{t-1}} \right) N_t \quad (20)$$

Firms will base their investment decisions on the expected rate of return on capital and the market interest rate as implied by equation (19). Furthermore, given the fact that the interest rate premium is independent of idiosyncratic variables every entrepreneur will be leveraged by the same amount.

2.2.2 Evolution of the Entrepreneur's Net Worth

The net worth of the entrepreneurial sector evolves according to the following equation,

$$N_{t+1} = \gamma V_{it} + (1 - \gamma) D_{it} \quad (21)$$

where returns to capital net of borrowing costs, V_{it} is given by,

$$V_{it} = \left(\int_{\bar{A}_{it}^*}^{\infty} A_{it} R_t^k Q_{t-1} K_{it} df(A_{it}) \right) - [1 - F(\bar{A}_{it}^*)] \bar{A}_{it} E_{t-1} [R_t^k] Q_{t-1} K_{it} \quad (22)$$

\bar{A}_{it}^* is the actual cutoff value of the firm specific shock. I am assuming that the firm specific shock occurs after the aggregate technology shock. Therefore the cutoff value of the firm specific shock will depend on the realization of the aggregate technology shock.

The first term on the right hand side is the entrepreneur's return from capital given that the firm does not go bankrupt. The second term is the expected debt payment. γ is the probability of survival of the entrepreneur. This variable is needed to prevent the entrepreneurs from building up enough net worth and avoid borrowing from the banks¹³. D_{it} is the portion of net worth left to the firm that replaces the one that goes out of business.

Net worth is composed of the net returns to capital if the firm stays in business and what it begins with (D_{it}) if it goes out of business. The actual cutoff value \bar{A}_{it}^* is derived from the following relationship;

$$\bar{A}_{it}^* R_t^k Q_{t-1} K_{it} = (1 + R_{t-1} + x_{it}) B_{it} = \bar{A}_{it} E_{t-1} [R_t^k] Q_{t-1} K_{it} \quad (23)$$

$$\text{as, } \bar{A}_{it}^* = \frac{\bar{A}_{it} E_{t-1} [R_t^k]}{R_t^k} \quad (24)$$

¹³ Since internal finance is cheaper.

\bar{A}_{it}^* represents the value of the firm specific shock that is needed for the firm to pay back its debt. This value depends on the aggregate technology shock. If the aggregate technology shock is low then R_t^k would decrease and the firm would need higher returns to capital shock to stay afloat.

Since \bar{A}_{it} and A_t are the same for every firm \bar{A}_{it}^* is also the same for every firm. Thus equation (22) can be aggregated and the evolution of the total net worth could be derived as follows.

$$V_t = \left(\int_{\bar{A}_{it}^*}^{\infty} A_{it} R_t^k Q_{t-1} K_t dF(A_{it}) \right) - [1 - F(\bar{A}_{it}^*)] \bar{A}_{it} E_{t-1} [R_t^k] Q_{t-1} K_t \quad (25)$$

Equation (25) together with equation (21) defines the second part of the financial accelerator mechanism. More specifically, if there is an increase in asset prices hiking up the returns to capital then the total net worth of the firms will increase¹⁴.

If the entrepreneurs do not survive, they consume the returns to capital net of debt payments.

$$C_t^e = (1 - \gamma) V_t \quad (26)$$

where C_t^e is the entrepreneur's consumption. The firms will hire labor according to:

$$(1 - \alpha) \frac{Y_t}{L_t} = \mu_1 \frac{W_t}{P_t} \quad (27)$$

where μ_1 is the markup on wholesale goods or the relative price of retail goods.

2.3 Capital Producers

Capital evolves according to equation (28) where there are increasing marginal costs to capital production.

$$K_{t+1} = \Phi \left(\frac{I_t}{K_t} \right) K_t + (1 - \delta) K_t \quad (28)$$

Capital producers are perfect competitors. They use wholesale goods as inputs to produce capital according to the production function: $\Phi \left(\frac{I_t}{K_t} \right) K_t$. The price of capital goods is derived from the profit maximization of these firms.

$$E_{t-1} \left[\frac{Q_t}{P_t^w} - \left[\Phi' \left(\frac{I_t}{K_t} \right) \right]^{-1} \right] = 0, \quad \Phi'(\bullet) > 0 \quad (29)$$

Equation (29) is the final component of the accelerator mechanism. If the entrepreneurs experience a positive asset price shock, they will borrow more and demand more capital. Their expected net worth the following period will increase, and as investment increases, they'll put an upward pressure on asset prices and amplify the response.

¹⁴ Equation (20) can be used to show that, $\frac{dV_t}{dQ_t} > 0$.

2.4 Retail Firms

The retail firms are monopolistically competitive. They buy the wholesale goods and sell them after repackaging at no resource cost. The purpose of including these firms at this stage is to have a simple contract between the firm and the banking sector, whereas having a monopolistic firm would complicate the contract. The other benefit of this framework is that it allows for sticky prices and therefore an effective monetary policy. The demand for goods produced by retail firms is given by,

$$Y_t^H(z) = \left(\frac{P_t^H(z)}{P_t^H} \right)^{-\nu} Y_t^H \quad (30)$$

where,

$$Y_t^H = \left(\int_0^1 Y_t^H(z)^{\frac{\nu-1}{\nu}} dz \right)^{\frac{\nu}{\nu-1}} \quad (31)$$

Following the pricing scheme of Calvo, only a portion of the retailers change their prices in a specific period.

$$P_t^H = (P_{t-1}^H)^\theta (P_{t-1}^{*H})^{1-\theta} \quad (32)$$

Retailers maximize an intertemporal loss function and set their optimal price P_t^{*H} as follows,

$$P_t^{*H} = \mu_1 \prod_{i=0}^{\infty} P_{t+i}^{w(1-\beta\theta)(\beta\theta)^i} \quad (33)$$

where $\mu_1 = \frac{1}{1-1/\nu}$, is the desired gross mark up over wholesale prices. If equations (32) and (33) are combined, one

can solve for domestic inflation.

$$\frac{P_t^H}{P_{t-1}^H} = \left(\mu_1 \frac{P_t^w}{P_t^H} \right)^\lambda E_t \left(\frac{P_{t+1}^H}{P_t^H} \right)^\beta \quad (34)$$

where the first term is the marginal cost to the retailers and the second term is the expected inflation rate. The output for the domestic goods sector will equal demand

$$Y_t^H = C_t^H + C_t^{eH} + C_t^{H*} + I_t^H \quad (35)$$

2.5 Central Bank and Exchange Rate Regimes

The central bank will follow different exchange rate regimes according to the Taylor rule below. Under a fixed exchange regime γ_e will take on high values and will be set equal to zero for flexible regimes.

$$R_t = \left[(1 + rr^{ss}) \left(\frac{P_t}{P_{t-1}} \right)^{\gamma_\pi} \left(\frac{Y_t^H}{Y_t^{ss}} \right)^{\gamma_y} \left(\frac{e_t}{e^{ss}} \right)^{\gamma_e} \right]^{1-\tau} (R_{t-1})^\tau \quad (36)$$

The last item on the right hand side is the interest rate smoothing term. Y_t^{ss} , rr^{ss} and e^{ss} are the steady state levels of output, the real interest rate and the exchange rate respectively.

If the exchange rate is fixed, $R_t = R_t^*$ since the interest parity condition holds ($e_t = e_{t-1}$). Otherwise changes in the domestic rate affects the spot exchange rate through the uncovered interest parity condition (9) above.

The interest rates are determined after production takes place. Central bank has a direct effect on the net worth of the domestic banking sector by changing the value of foreign liabilities in domestic currency units. The exchange rate will also affect exports, imports and the profits accrued to the consumers through the change in relative prices of the domestic good.

2.6 Model Parameterization

The parameters utilized are taken from the analysis of Gertler, Gilchrist and Natalucci. In this respect, the quarterly discount factor β will be set equal to 0.99 initially. Habit persistence parameter b is assumed to be 0.6. Coefficient of relative risk aversion Ω is initially set equal to 1 to obtain the log form used in (GGN). While share parameter \mathcal{V} is adjusted such that in steady state trade balance is zero, steady state export output ratio is set to 0.2. The elasticity of substitution between home and foreign goods, ρ , is equal to 1.5 which together with the value of \mathcal{V} implies that domestic consumption share is 0.33. Parameter k in the utility function is determined such that, labor supply elasticity is 2 and average hours worked relative to total hours available is 0.333.

To calibrate technology and pricing, while capital share α , depreciation rate and steady state markup rate is set equal to 0.35, 0.025 and 1.2 respectively, investment capital ratio elasticity of the price of capital and the probability of the retailer not adjusting the price level is assumed to be 0.75. Fixing the monitoring cost coefficient to 0.12 and the survival rate of the entrepreneurs to 0.9728 equates the steady state risk spread, business failure rate and the leverage ratio to 320 basis points, 5.3 percent and 1 respectively.

For the central bank's policy rule in the benchmark model while the exponents on inflation and output or γ_π and γ_y take the values of 2 and 0.5 respectively, the exponent of the interest rate smoothing term τ is set equal to 0.9 for the benchmark case.

3 Including the Foreign Creditor, Domestic Banking Sector Relationship

3.1 Model Features

This section adds a foreign creditor-domestic banking sector relationship to the financial accelerator framework discussed above. The contract between the two agents is identical to the one between the domestic banks and the entrepreneurs, such that interest rate premium depends on the leverage of the domestic banking sector.

The foreign creditors have a perfectly diversified portfolio in the world, and have contracts with the countries, giving them an expected rate of return equal to the foreign interest rate. The budget constraint of the banking sector is given by,

$$Q_t K_{t+1} - N_{t+1} = B_{t+1} = NW_{t+1} + e_t F_{t+1} \quad (37)$$

Banks' net worth, NW_t is not sufficient and foreign funds are needed to finance the borrowing requirement of the real sector¹⁵. The net worth of the domestic banks is their net returns from the firms minus debt payments.

$$NW_{t+1} = VB_t - e_t (1 + R_t^* + h_{t-1}) F_t \quad (38)$$

where h_{t-1} is the risk premium and expected returns from the firms, VB_t is given by,

$$VB_t = \left[(1 - \mu) \left(\int_0^{\bar{A}_t^*} A_{it} f(A_{it}) dA_{it} \right) \right] R_t^k Q_{t-1} K_t + [1 - F(\bar{A}_t^*)] \bar{A}_{it}^* R_t^k Q_{t-1} K_t \quad (39)$$

It is assumed that if the banks' net worth falls below zero, then the banks fail to pay back their debt and the foreign banks receive the returns from the entrepreneurs and pay a monitoring cost similar to the domestic bank entrepreneur relationship above. Using this assumption and the relationships above one can solve for the critical value of the systematic technology shock below which the bank defaults.

$$VB_t(\bar{A}_t) = \left[(1 + R_{t-1}^* + h_{t-1}) F_t e_t \right] \quad (40)$$

Foreign banks set their expected returns from the loans to the domestic bank equal to what they can earn in the world at the foreign interest rate, R_{t-1}^* . Expected returns consist of principal and interest payments if the bank does not fail and returns from the firms net of monitoring costs if the banks fail to pay back their debt¹⁶.

¹⁵ All of the foreign funds are assumed to be foreign currency denominated.

¹⁶ If the banking sector fails foreign creditors still lend to them. As net worth equals zero foreign interest rate equals its upper limit in the linearized model.

$$[1 - F(\bar{A}_t)]VB_t(\bar{A}_t) + (1 - \mu) \int_0^{\bar{A}_t} VB_t(A_t) dF(A_t) = (1 + R_{t-1}^*)F_t e_t \quad (41)$$

This setup enables us to obtain a relationship between the country risk premium and bank leverage similar to the relationship between domestic finance premium and firm leverage discussed earlier. More specifically, using equation (40) and (41) one can show that there is a positive relationship between the country risk premium and the leverage of domestic banks¹⁷.

$$h_t = h\left(\frac{e_{t+1}F_{t+1}}{NW_{t+1}}\right) \quad h'(\bullet) > 0 \quad 18 \quad (42)$$

The intuition is as follows. As foreign borrowing increases, given a certain amount of net worth, the cutoff value of the technology shock would increase and the foreign creditors would charge higher interest rates to compensate for the higher probability of default. Also as net worth increases, the amount of required foreign borrowing would decrease together with the risk premium. On the other hand, since the contract is in terms of foreign currency, a depreciation of the domestic currency would increase leverage and thus the risk premium.

The additional parameter used in this section is the steady state level of foreign borrowing/GDP. This ratio is assumed to be 0.56 which is the GDP weighted average of 21 emerging market countries. This value generates a bank net worth to output and domestic credit to output ratio equal to 0.1 and 0.66 respectively and a country risk premium and probability of bank failure of 450 basis points and 1.3% respectively¹⁹.

3.2 Results

3.2.1 Model Characteristics

In this section the objective is to exclude the financial accelerator mechanism determining foreign interest rates or namely the country risk premium and to replicate the results of GGN²⁰.

Figures 1A and 1B show that the deviation of output from its steady level is greater under a fixed regime than under a flexible regime in the benchmark model²¹. When faced with a positive technology shock and an increase in output, the central bank is able to respond under a flexible regime and mitigate the effect of the shock by increasing

¹⁷ The derivation of this relationship is provided in appendix B.

¹⁸ A similar expression can be written in terms of VB_t .

¹⁹ Data source: IFS, Countries: Argentina, Brazil, Bulgaria, Colombia, Ecuador, Egypt, Korea, Malaysia, Mexico, Morocco, Nigeria, Panama, Peru, Poland, Qatar, Russia, S. Africa, Thailand, Turkey, Ukraine, Venezuela. EMBI index is used to calculate average risk premium.

²⁰ Comparison between exchange rate regimes and the significance of the financial accelerator mechanism under these regimes is conducted.

²¹ The GGN model.

interest rates. But under a fixed regime the interest rates cannot be adjusted, and hence the increase in output is higher.

Under a fixed regime, a positive shock to foreign interest rates is again fully absorbed by the change in the domestic interest rates. Since banks do not have foreign currency denominated obligations their balance sheets are not affected and the positive effect of having a fixed regime on balance sheets therefore is not realized. As the domestic interest rate rises investment falls. This drop in investment causes asset prices to decrease and the financial accelerator effect is observed. More specifically the decrease in asset prices shrinks the net worth of the production sector and induces the bank to charge a higher premium on its loans. This effect decreases investment further and the initial shock is amplified.

If the central bank adopts a flexible regime, it has the power to stimulate the economy when investment drops and there is lower inflation and a limited fall in output and investment. Furthermore increase in net exports due to a depreciating currency helps mitigate the fall in output. The output response graphs without the financial accelerator effect show that the difference in output volatility under different regimes is not as high when the mechanism is turned off by setting $\mu = 0$. This corresponds to the irresponsiveness of banks to the net worth position of the firms. Therefore the effect of the technology shock on output is limited.

3.2.2 Including the Foreign Sector

Figure 2 shows the responses to a positive technology shock under the two different exchange rate regimes for the model including the country risk premium discussed above.

As a result of the favorable technology shock, the cutoff value of the technology shock decreases and there is a decline in the proportion of firms that fail. Firms expand their production and the returns to the banks increase. The net worth of the banking sector improves as returns increase and the debt payments decrease due to an appreciating exchange rate.

The banks increase their foreign borrowing in order to meet the growing borrowing requirement of the production sector. Under a flexible exchange rate regime, despite the surge in foreign finance, exchange rate appreciation and a rise in net worth leads to a decrease in the country risk premium. With declining foreign interest rates, domestic interest rates are lowered to satisfy the interest rate parity condition and hence there is a further rise in output.

Therefore based on this model, with flexible exchange rates the presence of the country risk premium exerts an accelerator effect via the contract between the foreign creditor and domestic bank, similar to the contract between

the domestic bank and the entrepreneur in the BGG framework. Fixed rates are better in terms of controlling the balance sheets of the banks and hence the foreign interest premium. Under fixed rates the country risk premium increases, since the exchange rate does not change and foreign borrowing increases more than the net worth of the banks. This rising country premium exerts an upward pressure on interest rates which contracts the initial surge in output and helps mitigate the effect of the shock. The decline in net exports with flexible regimes due to appreciation is not large enough to alter the results.

To summarize, our findings imply that if a country risk premium is included, the results of GGN are reversed: the amplitude of the changes in output in response to technology or foreign interest shocks are greater with flexible regimes than with fixed regimes.

3.2.3 Foreign Interest Rate Shock

Foreign interest shock can be thought of as a change in the risk perception towards a country that is exclusive of bank balance sheets. The shock is assumed to follow a first order autoregressive process that persists at the rate of 0.95 per quarter. The results are depicted in figure 4 and point to similar observations.

Under a fixed regime, the country risk premium turns negative as foreign borrowing decreases more than the decrease in net worth, hence there is a decrease in leverage. With a flexible regime on the other hand, depreciation of the exchange rate, coupled with a decrease in bank net worth dominates the decrease in foreign borrowing and an increase in leverage is observed. The increase in leverage amplifies the decline in output under the flexible regime.

3.2.4 Sensitivity Analysis:

The fixed-flexible comparison so far was based on specific parameter values for the Taylor under flexible regimes. In this section, I perform a grid search to find the minimum output volatility under flexible regimes and compare this value with the volatility under fixed regimes. Furthermore, I also exclude habit persistence, lower price stickiness and lower foreign interest shock persistence and report conditional standard deviations of output in Table 2. I obtain the results assuming that the economy is hit by both technology and foreign interest rate shocks.²²

While the values under the benchmark model column agree with the impulse responses, optimal volatility under flexible regimes is higher than the volatility under fixed regimes. This observation is robust to lower price stickiness and foreign interest rate persistence, and to the exclusion of habit persistence. The results also show that,

²² The variance of the foreign interest rate shock is calibrated to $(0.032)^2$ which is obtained from a VAR model fit to 21 emerging market country averages using Blanchard-Quah restrictions. The variance of the technology shock is $(0.01)^2$.

the external constraints on monetary policy argument, is not robust to low habit persistence and low price stickiness²³. More specifically, output volatility is lower with fixed regimes even when country risk premium is excluded. This observation implies that the central bank policy is less affective with lower price stickiness and habit persistence and the advantages of independent monetary policy under flexible regimes is less pronounced.

Finally, I also find that incrementing the coefficient of relative risk aversion and lower persistence of foreign interest rates decrease the advantages under flexible regimes.

4. Welfare Analysis

The first order approximation technique employed in the previous parts is not appropriate for comparing welfare across different exchange rate regimes and different market structures. The commonplace practice in macroeconomic literature is to measure welfare effects using a second order approximation to the objective function and a linear approximation to the decision rules. Although this method can account for the effects of shocks on welfare through second order moments, it neglects the effects of these shocks on the unconditional and conditional means of the endogenous variables.

For these purposes, this section measures the welfare effect of the financial accelerator mechanism and the country risk premium by conducting a second order approximation to the objective function and the decision rules of the model. The coefficients of the system of equations, obtained by the second order approximation are found using the algorithm of Schmitt-Grohe and Uribe (2004).

4.1.1 Unconditional Welfare

Welfare effects are measured by computing the percent of steady state consumption consumers are willing to give up to avoid the effects of the underlying shocks²⁴.

The second order approximation to the utility function is of the form,²⁵

$$EU_t = \bar{C}^{1-\Omega}(1-b)^{1-\Omega} E(\hat{c}_t) - k \frac{\bar{L}}{1-\bar{L}} E(\hat{l}_t) - \frac{1}{2} \Omega(1-b)^{1-\Omega} \bar{C}^{1-\Omega} Var(\hat{c}_t) - \frac{1}{2} \frac{k\bar{L}^2}{(1-\bar{L})^2} var(\hat{l}_t) \quad (43)$$

where \hat{c}_t and \hat{l}_t denote the percent deviation of consumption and labor around the steady state levels and

$E(\hat{c}_t), E(\hat{l}_t), Var(\hat{c}_t), Var(\hat{l}_t)$ represent the unconditional means and variances of consumption and labor.

²³ I assume that entrepreneurs can adjust their prices every two quarters following recent literature. See Eichenbaum, Fisher, Martin (2004).

²⁴ Following Lucas (1987)

²⁵ Money is omitted from the utility function following the standard application of welfare literature.

The objective here is to find the percentage of consumption that consumers would give up to avoid the effects of shocks on the utility.

These effects can be separated into two parts, the impacts on the unconditional means, u^{mean} , and the impacts on the unconditional variances of consumption and labor, u^{var} . As mentioned above the commonplace application of conducting a linear approximation to the decision rules and taking a second order approximation to the utility function, while capturing the u^{var} fails to take account of u^{mean} . u^{mean} can be obtained from the following equality,

$$U((1+u^{mean})\bar{C}, \bar{L}) = \frac{((1+u^{mean})(1-b)\bar{C})^{1-\Omega}}{1-\Omega} - k \ln(1-\bar{L}) = \bar{U} + (\bar{C}(1-b))^{1-\Omega} E(\hat{c}_t) - \frac{k\bar{L}}{1-\bar{L}} E(\hat{l}_t) \quad (44)$$

where,

$$\bar{U} = \frac{((1-b)\bar{C})^{1-\Omega}}{1-\Omega} - k \ln(1-\bar{L}), \quad (45)$$

$$u^{mean} = \left(1 + (1-\Omega)E(\hat{c}_t) - \frac{kL}{1-L}(1-\Omega)(\bar{C}(1-b))^{1-\Omega} E(\hat{l}_t) \right)^{\frac{1}{1-\Omega}} - 1 \quad (46)$$

and similarly u^{var} can be obtained as follows,

$$\frac{((1+u^{var})(1-b)\bar{C})^{1-\Omega}}{1-\Omega} - k \ln(1-\bar{L}) = \bar{U} - \frac{1}{2}\Omega(1-b)^{1-\Omega}\bar{C}^{1-\Omega}Var(\hat{c}_t) - \frac{1}{2}\frac{k\bar{L}^2}{(1-\bar{L})^2}var(\hat{l}_t) \quad (47)$$

$$u^{var} = \left(1 - \frac{1}{2}(1-\Omega)\Omega\frac{1+b}{1-b}Var(\hat{c}_t) - \frac{1}{2}k\frac{\bar{L}^2}{(1-\bar{L})^2}(1-\Omega)\left[((1-b)\bar{C})^{\Omega-1}Var(\hat{l}_t) \right]^{\frac{1}{1-\Omega}} - 1 \right) \quad (48)$$

The additional calibration done in this section is to set technology shock variance to $(0.01)^2$ and the persistence of the technology shock to 0.9 following the literature.

4.1.2 Conditional Welfare

While the unconditional welfare calculation discussed above has been utilized extensively due to its straightforwardness, this method does not account for the welfare effects during the transitional period from one steady state to another after a change in policy variables. Hence, measuring welfare with a one period utility that includes unconditional moments in a dynamic setting with discounting, avoids the fact that earlier periods have higher weights. Therefore, if agents in the economy save more in earlier periods to attain the new level of steady state consumption, losses of welfare computed using conditional moments, would be more than those with

unconditional moments²⁶. To check the robustness of the results in table 3, a conditional welfare measure is constructed as follows,

$$V_o^{certain} = \sum_{t=0}^{\infty} \beta^t \left(\frac{((1-u)\bar{C}(1-b))^{1-\Omega}}{1-\Omega} - k \ln(1-\bar{L}) \right) = \frac{1}{1-\beta} \left(\frac{((1-u)\bar{C}(1-b))^{1-\Omega}}{1-\Omega} - k \ln(1-\bar{L}) \right) \quad (49)$$

where $V_o^{certain}$ represents the value function or the sum of discounted utilities when there is no source of variability.

Similarly one can derive the second order approximation to the value function to measure the sum of discounted utilities when there is variability in the model²⁷.

$$V_o' = \sum_{t=0}^{\infty} \beta^t \left(\bar{U} + \bar{C}^{1-\Omega}(1-b)^{-\Omega}(\tilde{c}_t - b\tilde{c}_{t-1}) + k \frac{\bar{L}}{1-\bar{L}} \tilde{l}_t - \frac{1}{2} \Omega \bar{C}^{1-\Omega}(1-b)^{-\Omega-1}(\tilde{c}_t^2 - b^2 \tilde{c}_{t-1}^2) + \frac{1}{2} k \frac{\bar{L}^2}{(1-\bar{L})^2} \tilde{l}_t^2 \right) \quad (50)$$

where \tilde{c}_t and \tilde{l}_t are the artificial model output of consumption and labor deviations from their steady state values.

Similar to the exercise above, u^{mean} and u^{var} are computed by measuring the level of steady state consumption needed to assume the effects of the risk through the first and second order terms respectively.

4.2 Results

I analyze four different models; the benchmark model, model with the financial accelerator (FA), model with country risk premium (CRP) and the model with FA and CRP simultaneously. The benchmark model mentioned here is the simple small open economy RBC model with price stickiness.

The results from unconditional welfare computations are displayed in Table 3. Three distinct results can be gleaned from this table. The first one is that the country risk premium mechanism discussed above lowers the effect of the shocks under a fixed regime but amplifies it under a flexible regime. Intuition behind this result is as follows. Under a flexible regime, exchange rate appreciation (depreciation) following a positive technology shock leads to an improvement (deterioration) in the balance sheets of the domestic bank and a decrease (increase) in leverage which in turn decreases (increases) foreign interest rates. Since the change in foreign interest rates has a similar effect on consumption and labor as the technology shock the original effect is amplified. Under a fixed regime, the exchange rate does not change and there is a detrimental (positive) effect on bank balance sheets following a positive technology shock because of higher foreign borrowing needed to support domestic credit. Therefore, the

²⁶ For example, Kim and Kim (2000) show that unconditional welfare measure can produce the paradoxical result that autarky generates higher level of welfare than complete markets.

²⁷ The source of uncertainty is the technology shock.

original effect of the technology shock is mitigated due to balance sheet effects under a fixed regime. The rows of Table 3 corresponding to CRP shows an improvement in welfare relative to the benchmark model under a fixed regime and a decline in welfare under a flexible regime.

The second result is that the financial accelerator mechanism is not as significant as the country risk premium and the presence of this mechanism decreases welfare more with a fixed exchange rate regime. This result is in line with the larger output response observed in part3 corresponding to a fixed exchange rate regime. While interest rates can adjust with a flexible regime and dampen the effect of the technology shock, they are fixed to the level of the foreign interest rate under a fixed regime. Hence I observe a 0.56 percent decline in welfare with a fixed regime in place and a 0.09 percent with a flexible one.

The final observation is that the inability of a first order approximation to the policy rules to pick up u^{mean} would conflict the literature and suggest that a fixed regime is better in terms of welfare under every specification. Table 4 illustrates the results from the conditional welfare computations. Despite to a lesser extent, the mitigating and amplifying effects of CRP on welfare under fixed and flexible regimes respectively is also observed with this different measure. Furthermore, most of the losses under both regimes are due to the effects on the conditional means, and the importance of the financial accelerator mechanism has increased with the new measure.

Bergin and Tchakarov (2003) using a similar analysis to this section find that welfare losses from exchange rate volatility can increase up to 4.5 percent of annual income when habit persistence is included in the model. My results support their findings and show how welfare losses can be further amplified with financial frictions.

5. Empirical Analysis

This part analyzes the implications of different exchange rate regimes on the real economy that faces external finance shocks within the framework of balance sheet effects. Different from the existing empirical literature, the methodology proposed uses the EMBI instead of a weighted average of advanced country lending rates as a measure of external finance cost. This approach accounts for the fact that the EMBI is a better measure of the external finance cost of an emerging market country, and that these countries are unable to borrow at advanced country lending rates. Using EMBI allows external finance costs to be affected by domestic economy variables in addition to their exogenously determined component.

In this context, I test if the balance sheet effects are strong enough to overturn the conventional wisdom. I also use a weighted average of foreign interest rates instead of EMBI following the literature and compare the results. The data set consists of monthly observations from 1998 to 2004 for the 13 countries listed in appendix C.

Structural VAR methods have been put under scrutiny by recent research. According to this literature two of the important short comings of these methods are that the misspecifications of VARs are large enough that they can lead to mistaken inferences and VARs which are designed to execute one period ahead forecasts, are subject to compounding misspecification errors with the forecast horizon. The latter shortcoming poses a problem for impulse responses which are functions of forecasts at distant horizons.

In this respect, Chari, Kehoe and McGrattan (2005) show that impulse responses using artificial data from a simple RBC model contradict the responses from the model itself. The authors argue that this misspecification stems from the inability of specifications involving few lags to capture the persistence in model data that come from the low rate of depreciation of capital.

Jorda (2004), proposes an alternative method for calculating impulse responses that is robust to the misspecification of the data generating process and uses projections local to each forecast horizon. More specifically, the following equation is estimated for each forecast horizon to obtain impulse responses,

$$y_{t+s} = \alpha^s + \beta_1^{s+1} y_{t-1} + \beta_2^{s+1} y_{t-2} + \dots + \beta_p^{s+1} y_{t-p} + u_{t+s}^s \quad s = 0, 1, 2, \dots, h \quad (11)$$

where h denotes the maximum forecast horizon, y is {Output, CPI, EMBI, R, E} and output denotes industrial production. Optimal p is determined at each horizon using the Akaike Information Criterion.

The impulse responses corresponding to equation (10) are calculated from,

$$IR(t, s, d_i) = \hat{\beta}_1 d_i \quad s = 0, 1, 2, \dots, h \quad (12)$$

where d_i represents the structural shock to the i^{th} element in y and corresponds to the i^{th} column of the D matrix obtained from the cholesky decomposition of the variance covariance matrix of the reduced form, Ω as follows:

$$\Omega = PP' \quad \text{and} \quad D = P^{-1}$$

A de facto classification is utilized to determine the countries that have followed a relatively tight and flexible exchange rate policy from 1998 to 2004²⁸. Crisis periods for Russia, Brazil, Turkey and Argentina are excluded from the analysis together with periods of high exchange rate volatility²⁹. Next, impulse responses are measured using the data from the two groups of countries in the model explained above.

The responses to a 1 standard deviation shock to EMBI are displayed in figure 4. There are three important observations. First, contrary to the literature, impulse responses point to higher output volatility under flexible regimes. Second, under fixed regimes central banks do not respond as aggressively. Finally, the response of EMBI under flexible regimes is much higher. These findings point to the significance of the destabilizing effect of creditor perception towards a country and imply that more controlled regimes are better for sustaining external shocks in emerging market countries. It is essential to point out again that the results should not be interpreted as a case for fixed exchange rate regimes but rather as a possible explanation for the fear of floating observed in these countries.

Next, I use an equally weighted average of the lending rates of U.S., U.K. and Japan instead of the EMBI. The results are illustrated in Figure 5 and point to the lack of evidence in favor of either of the two exchange rate regimes. Furthermore, the responses of the variables to foreign interest rate shocks are much smaller than the responses to EMBI³⁰ shocks. Hence, there is more sensitivity to external shocks that are related to the conditions in the economy than to those in the advanced countries.

6. Conclusion

Recent literature on exchange rate regimes in emerging markets has supported flexible rates as the superior regime, considering the vulnerability of fixed regimes to speculative attacks. Despite this fact countries have been observed to control their exchange rate fluctuations.

This paper has shown one reason for this so called “Fear of Floating”, as it links the balance sheet of the banks to the country risk premium. In this setting, exchange rate regimes that limit the effect of external shocks on bank balance sheets and hence on foreign interest rates are better in terms of limiting output volatility in emerging markets with high foreign currency exposure. The results should not be interpreted as a case for fixed regimes but rather a case against perfectly flexible regimes in emerging markets. This analysis suggests that countries with

²⁸ The two groups of countries are listed in Appendix C. The standard deviation over the average is used to measure the relative exchange rate volatility during the period.

²⁹ The crisis periods are obtained from Kaminsky (2003).

³⁰ These results are not sensitive to different weighting schemes. Weights favoring U.S., U.K. and Japan interest rates and weights based on the proximity of the emerging market economies to these countries have yielded similar results.

shallow financial markets that have foreign exchange vulnerabilities should limit exchange rate fluctuations until their markets are developed enough to sustain a flexible regime or shift towards a monetary union or even dollarization.

Further theoretical research in this area could analyze the effects of limiting foreign currency open position of the banks³¹ and the long run implications of a stable financial market³². Empirical and theoretical literature on maturity mismatches and the implications for monetary policy in emerging markets is scarce at this point. This is surprising since maturity mismatches played a crucial role in currency crises together with currency mismatches investigated in the literature. A framework similar to Chang and Velasco (1998), where there is a liquidation of long term assets when a country faces liquidity problems would be a suitable setup. This partial equilibrium framework could be built into a general equilibrium, simple RBC model to help explain the drops in output observed in the data after sudden stops.

³¹ This limitation would involve a compromise between foreign funds needed to grow and a more stable banking sector.

³² The effects of short term stability on capital and human capital accumulation.

Appendix A: Positive relationship between aggregate tech. shock, A_t and returns to the bank, VB_t .

$$VB_t = \left[(1-\mu) \left(\int_0^{\bar{A}_t^*} A_{it} f(A_{it}) dA_{it} \right) \right] R_t^k Q_{t-1} K_t + [1 - F(\bar{A}_t^*)] \bar{A}_t E_{t-1} [R_t^k] Q_{t-1} K_t \quad (A.1)$$

$$\bar{A}_t^* = \frac{\bar{A}_t E_{t-1} [R_t^k]}{\alpha \frac{A_t K_t^{\alpha-1} L_t^{1-\alpha}}{X_t} + \frac{(1-\delta) Q_t}{P_t}} \quad (A.2)$$

$$\begin{aligned} \frac{dVB_t}{dA_t} = & (1-\mu) A_{it}^* f(A_{it}^*) R_t^k Q_{t-1} K_t \frac{dA_{it}^*}{dA_t} + \left[(1-\mu) \left(\int_0^{\bar{A}_t^*} A_{it} f(A_{it}) dA_{it} \right) \right] Q_{t-1} K_t \frac{dR_t^k}{dA_t} \\ & - A_{it}^* f(A_{it}^*) R_t^k Q_{t-1} K_t \frac{dA_{it}^*}{dA_t} + [1 - F(A_{it}^*)] R_t^k Q_{t-1} K_t \frac{dA_{it}^*}{dA_t} + [1 - F(A_{it}^*)] A_{it}^* Q_{t-1} K_t \frac{dR_t^k}{dA_t} \end{aligned} \quad (A.3)$$

which can be simplified as,

$$\begin{aligned} \frac{dVB_t}{dA_t} = & -\mu A_{it}^* f(A_{it}^*) R_t^k Q_{t-1} K_t \frac{dA_{it}^*}{dA_t} + \left[(1-\mu) \left(\int_0^{\bar{A}_t^*} A_{it} f(A_{it}) dA_{it} \right) \right] Q_{t-1} K_t \frac{dR_t^k}{dA_t} \\ & + [1 - F(A_{it}^*)] R_t^k Q_{t-1} K_t \frac{dA_{it}^*}{dA_t} + [1 - F(A_{it}^*)] A_{it}^* Q_{t-1} K_t \frac{dR_t^k}{dA_t} \end{aligned} \quad (A.4)$$

Since we know that $\frac{dA_{it}^*}{dA_t} < 0$ and $\frac{dR_t^k}{dA_t} > 0$ every term except the third one on the right hand side is positive.

$$\frac{dA_{it}^*}{dA_t} = -\frac{1}{(R_t^k)^2} \bar{A}_t E_{t-1} [R_t^k] \frac{dR_t^k}{dA_t} \quad \text{and} \quad \frac{dA_{it}^*}{dA_t} = -\frac{1}{(R_t^k)^2} A_{it}^* [R_t^k] \frac{dR_t^k}{dA_t} \quad (A.5)$$

If we insert (A.5) for the same expression in $\frac{dVB_t}{dA_t}$ we can see that the third term cancels out the fourth and $\frac{dVB_t}{dA_t} > 0$.

Appendix B: Leverage-Country Risk Premium relationship

Leverage, risk premium relationship can be extracted from the bank, foreign creditor contract:

$$[1 - F(\bar{A}_t)] (1 + R_{t-1}^* + h_{t-1}) F_t e_t + (1-\mu) \int_0^{\bar{A}_t} VB(A_t) dF(A_t) = (R_{t-1}^*) F_t e_t \quad (B.1)$$

$$VB_t(\bar{A}_t) = [(1 + R_{t-1}^* + h_{t-1}) F_t e_t] \quad (B.2)$$

It is important to notice that foreign borrowing requirement F_t is predetermined before the contract according to equation (39) and that we are interested in the change in the risk premium foreign creditor charges as this borrowing requirement changes. For our purposes we have to find how the premium responds to changes in the cutoff value of the technology shock and how the cutoff value of the technology shock changes as foreign borrowing varies respectively. (B.2) and (B.1) can be used to obtain the following expression,

$$[1 - F(\bar{A}_t)] + \frac{(1-\mu) \int_0^{\bar{A}_t} VB(A_t) dF(A_t)}{VB_t(\bar{A}_t)} = \frac{1 + R_{t-1}^*}{1 + R_{t-1}^* + h_{t-1}} \quad (B.3)$$

From this relationship we can see a positive relationship between risk premium h_{t-1} and \bar{A}_t . As \bar{A}_t increases, both of the terms on the left decrease and h_{t-1} increases. The second term on the left decreases, since as \bar{A}_t

increases, the numerator doesn't increase as much as the denominator, as it's an expectation of VB_t with \bar{A}_t as the upper limit of the domain and VB_t is a strictly increasing function as shown in appendix A. Hence,

$$h_{t-1} = \Omega(\bar{A}_t) \quad \text{where } \Omega'(\bullet) > 0 \quad (\text{B.4})$$

This equation implies that as risk of default increases risk premium charged on foreign finance increases. Expression (B.3) can also be rewritten in terms of $e_t F_t$, \bar{A}_t and R_{t-1}^* as,

$$[1 - F(\bar{A}_t)]VB_t(\bar{A}_t) + (1 - \mu) \int_0^{\bar{A}_t} VB(A_t) df(A_t) = (1 + R_{t-1}^*) F_t e_t \quad (\text{B.5})$$

A positive relationship between F_t and \bar{A}_t exists if the following inequality obtained from the differentiation of (B.5) holds,

$$VB'(\bar{A}_t)(1 - F(\bar{A}_t)) - \mu f(\bar{A}_t)VB(\bar{A}_t) > 0 \quad (\text{B.6})$$

This expression is significantly greater than zero for values of \bar{A}_t within 3 standard deviations of its steady state value, consistent with 1.3% bank failure rate. Given that there is an increase in the right hand side of equation (B.5) due to a rise in foreign borrowing, cutoff value of the technology shock has to increase since the increase in VB_t together with the proceeds in case the bank fails, dominates the effects of increasing probability of default.

$$F_t = \varpi(\bar{A}_t) \quad \text{where } \varpi'(\bullet) > 0 \quad (\text{B.7})$$

Equation (B.7) together with (B.4) illustrate the positive relationship as follows,

$$F_t = \Lambda(h_{t-1}) \quad \text{where } \Lambda'(\bullet) > 0 \quad (\text{B.8})$$

This equation shows how given a certain net worth, as banks borrow more from abroad, risk premium increases due to higher probability of default. Furthermore, there is a negative relationship between risk premium and net worth since the banks would borrow less as their net worth increases leading to a decrease in risk premium. Finally since the contract is in terms of foreign currency, changes in the exchange rate will have an effect similar to changes in foreign borrowing such that as the domestic currency depreciates (appreciates), the country risk premium increases (decreases). Combining the implicit relationships mentioned above yields:

$$h_{t-1} = \Gamma\left(\frac{e_t F_t}{NW_t}\right) \quad \text{where } \Gamma'(\bullet) > 0 \quad (\text{B.9})$$

Appendix C: Monthly Panel Countries, Period: 1998-2004

		Standard Dev.(E-R) / Avg.(E/R)
Relatively Fixed E-R	Ukraine	1.44
	South Africa	1.48
	Ecuador	1.80
	Colombia	1.82
	Russia	2.50
	Brazil	2.81
	Philippines	2.87
	Poland	2.90
Relatively Flexible E-R	Mexico	3.28
	Argentina	3.96
	Turkey	8.47
	Bulgaria	9.04
	Malaysia	9.38

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Table 1:

		% Change in Exchange Rate (1)	Leverage (2)	GDP Growth (1)
1997 Asian Crisis	Malaysia	12.4	61.9	-4.5
	Philippines	14.6	-10.7	0.1
	Singapore	4.2	23.1	-1.2
	Thailand	25.8	136.3	-9.6
	Vietnam	5.8	-92.7	7.3
1994 Peso Crisis	Ecuador	16.7	37.7	-11.5
	Mexico	89.9	-30.7	-4.2
	Peru	2.3	-23.3	10.3
	Uruguay	26.0	-412.6	3.0
1998 Russian Default plus Brazil abandoning the band	Argentina	0.0	37.6	-4.0
	Chile	10.5	12.6	-1.6
	Colombia	23.2	42.9	-2.7
	Mexico	4.6	-155.1	2.4
	Panama	0.0	-101.4	3.5
	Peru	15.4	7.3	1.3
	Russia	153.6	26.5	-12.1
	Uruguay	8.3	-283.0	3.2
2001 Turkish Crisis	Turkey	96.0	41.1	-7.2
2002 Argentina Crisis	Argentina	206.0	122.1	-7.6

(1) % changes are over the year before and after the crisis

(2) Banking sector Net open foreign currency position over net worth (%).

Table 2: Conditional Standard Deviations of Output With Both Technology and External Shocks

		RBC	Without Habit Persistence $b = 0$	Non-logarithmic Utility Function $\Omega = 5$	Lower Price Stickiness $\theta = 0.5$	Low Foreign Interest Rate Shock Persistence Persistence=0.25
Benchmark	Fixed	0.0554	0.0384	0.0513	0.0215	0.0403
	Flexible ^T (1)	0.0494	0.0473	0.0506	0.0299	0.0393
	Flexible* (2)	0.0209	0.0203	0.0214	0.0226	0.0201
Financial Accelerator	Fixed	0.0722	0.0399	0.0646	0.0223	0.0409
	Flexible ^T (1)	0.0505	0.0491	0.0511	0.0319	0.0403
	Flexible* (2)	0.0217	0.0204	0.0219	0.0237	0.0281
Country Risk Premium	Fixed	0.0403	0.0384	0.0413	0.0211	0.0342
	Flexible ^T (1)	0.0549	0.0579	0.0611	0.0394	0.0537
	Flexible* (2)	0.0476	0.0438	0.0497	0.0342	0.0362
FA and CRP	Fixed	0.0409	0.0349	0.0414	0.0233	0.0354
	Flexible ^T (1)	0.0572	0.0582	0.0579	0.0374	0.0518
	Flexible* (2)	0.0483	0.0414	0.0452	0.0344	0.0384

(1) Flexible^T row shows the standard deviations of output corresponding to the benchmark Taylor rule.

(2) Flexible* row shows the minimum standard deviation of output obtained from a grid search of Taylor rule parameters.

Table 3: Unconditional Welfare Effects of Technology Shocks ⁽¹⁾

	Fixed		
	u-overall	u-variance	u-mean
Benchmark Model	-4.87	-0.73	-4.14
Financial Accelerator (FA)	-5.43	-0.72	-4.71
Country Risk Premium (CRP)	-2.47	-1.11	-1.36
FA and CRP	-2.73	-1.82	-0.09
	Flexible		
	u-overall	u-variance	u-mean
Benchmark Model	-3.85	-2.17	-1.68
Financial Accelerator (FA)	-3.94	-2.30	-1.64
Country Risk Premium (CRP)	-4.56	-4.05	-0.05
FA and CRP	-5.48	-3.53	-1.95

(1) The numbers are percent deviations from steady consumption that consumers are willing to give up to eliminate technology shocks

Table 4: Conditional Welfare Effects of Technology Shocks ⁽¹⁾

	Fixed		
	u-overall	u-variance	u-mean
Benchmark Model	-3.83	-0.36	-3.47
Financial Accelerator (FA)	-5.47	-0.55	-4.93
Country Risk Premium (CRP)	-3.44	-0.41	-3.03
FA and CRP	-5.08	-0.54	-4.55
	Flexible		
	u-overall	u-variance	u-mean
Benchmark Model	-3.68	-0.66	-3.02
Financial Accelerator (FA)	-4.96	-0.65	-4.31
Country Risk Premium (CRP)	-4.14	-0.88	-3.26
FA and CRP	-5.55	-0.67	-4.88

(1) The numbers are percent deviations from steady consumption that consumers are willing to give up to eliminate technology shocks

FIGURE 1A:
Benchmark Model, Output Response to a 1% Technology Shock

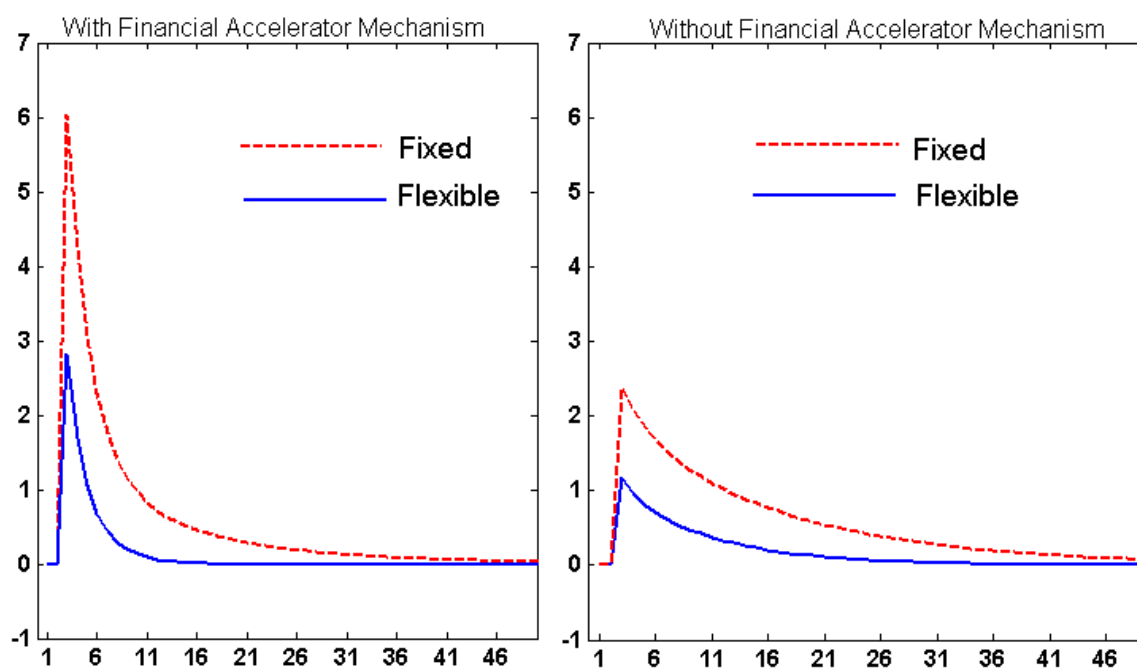


FIGURE 1B:
Benchmark Model, Output Response to a 1% Foreign Interest Rate Shock

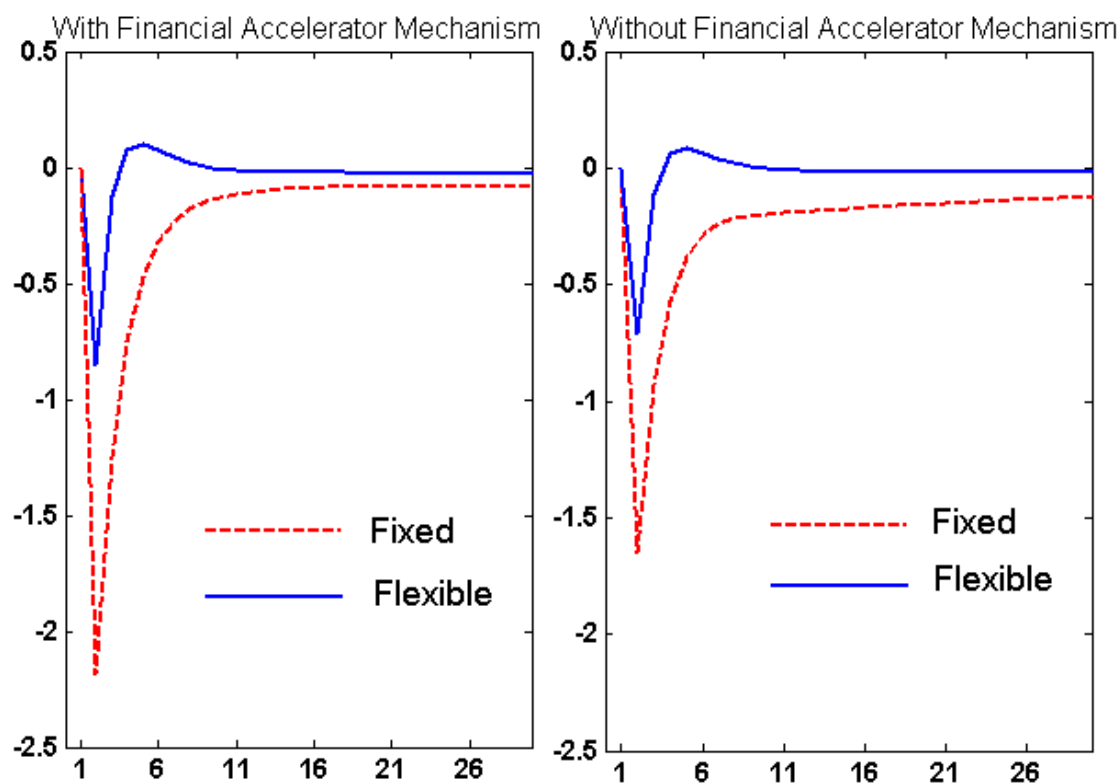


FIGURE 2:
Model Including Country Risk Premium, Response to a 1% Tech. Shock

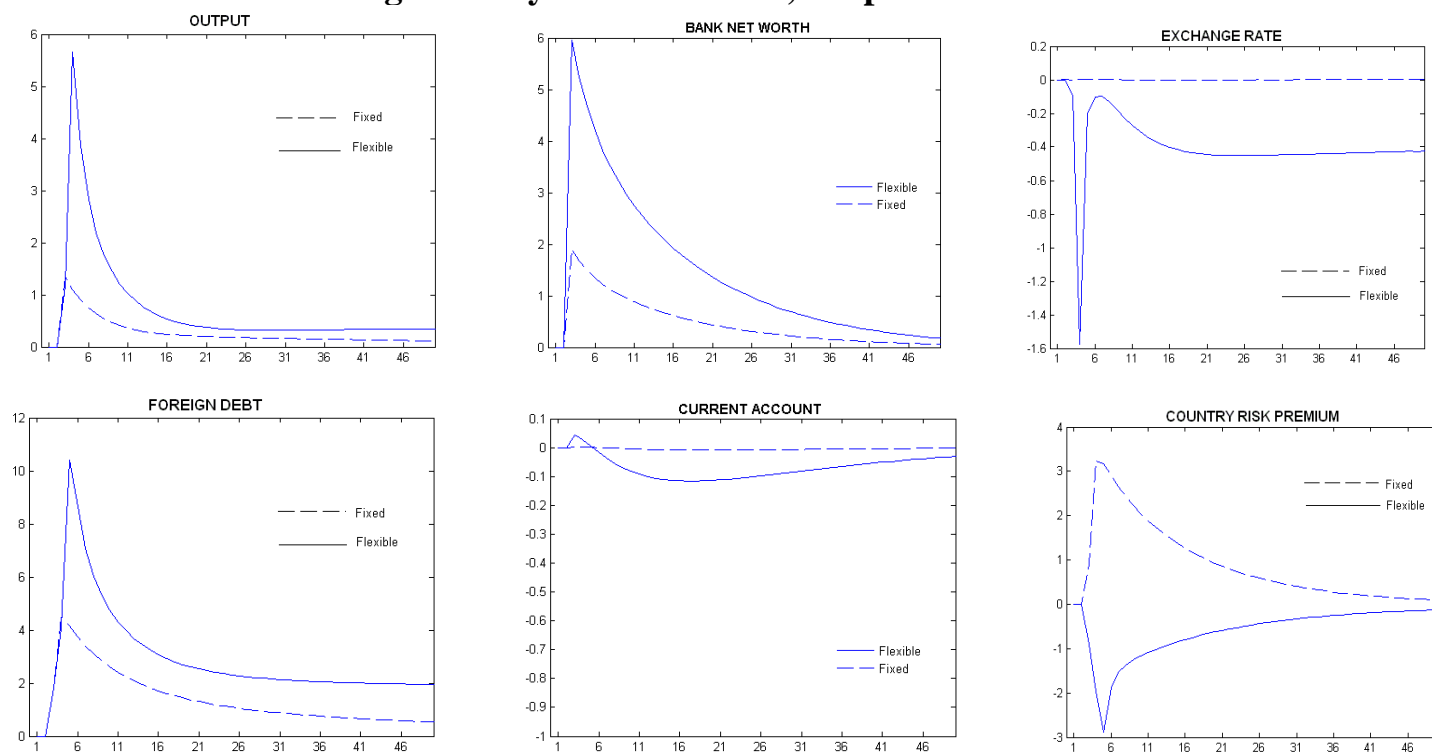


FIGURE 3:
Model With Country Risk Premium, Response to a 1% Foreign Interest Rate Shock.

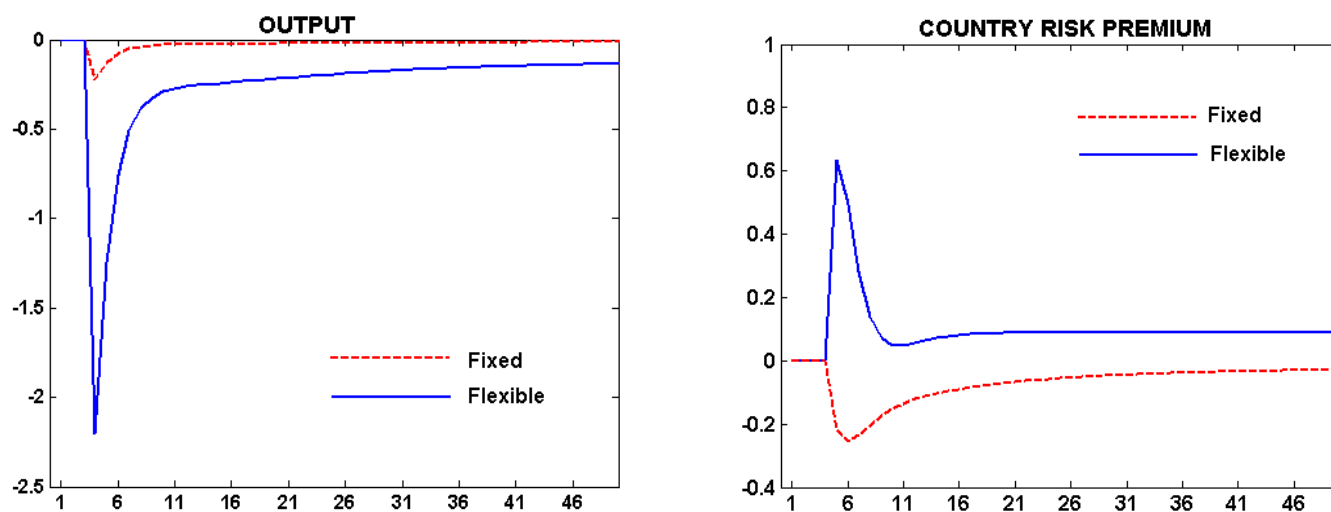


Figure 4: Panel Model Response to a Foreign Interest Rate Shock (EMBI, Monthly Data)

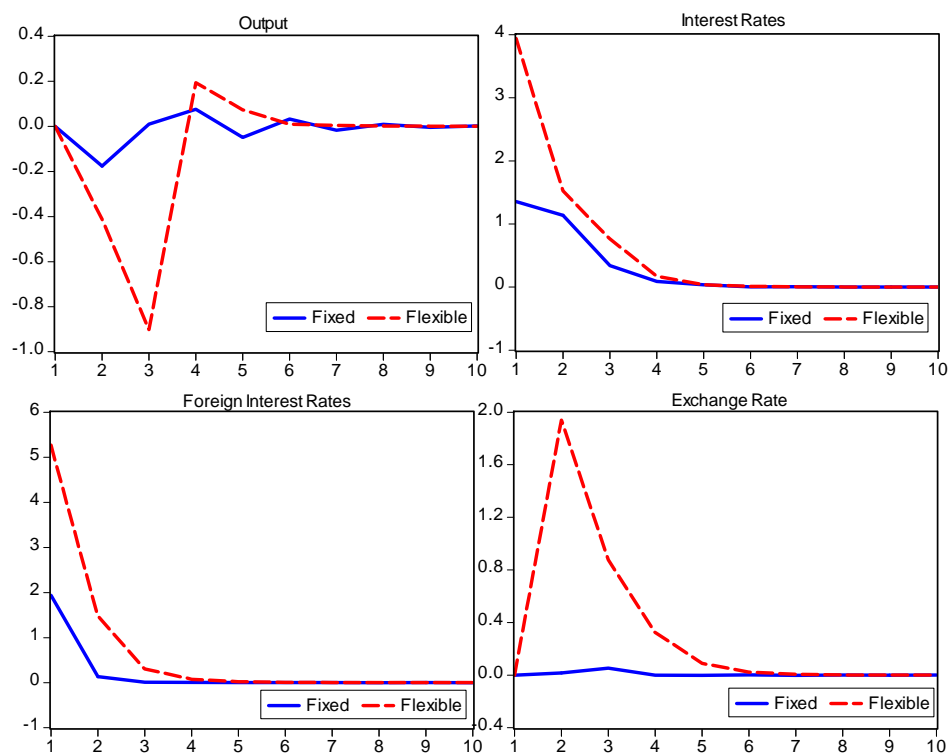


Figure 5: Panel Response to a Foreign Interest Rate Shock (Developed Country Average Interest Rates, Monthly Data)

