FEDERAL RESERVE BANK *of* ATLANTA

Business Cycles and Monetary Regimes in Emerging Economies: A Role for a Monopolistic Banking Sector

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Working Paper 2006-17
October 2006

WORKING PAPER SERIES

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Abstract: Starting from a variant of the New Keynesian model for a small open economy, I extend the standard credit channel framework to show that the presence of imperfect competition in the banking system propagates external shocks and amplifies the business cycle. This novel modeling of the banking system captures various well-documented facts in developing economies. I show that strategic limit pricing, aimed at protecting retail niches from potential competitors, generates countercyclical bank markups. Markup increments, as a consequence of sudden capital outflows, end up increasing borrowing costs for firms as well as damaging the financial position of firms' balance sheets. The recognition of monopoly power in banking allows the model to account for the relatively high investment volatility registered in emerging countries, even in the presence of debt that is fully denominated in local currency and flexible exchange rates.

JEL classification: E32, F41, G15, G21, L12

Key words: countercyclical bank markups, limit pricing, small open economies, exchange rate regimes

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The author thanks Fabio Ghironi, Peter Ireland, and Fabio Schiantarelli for invaluable guidance. He also thanks Ingela Alger, Luisa Lambertini, Hideo Konishi, Julio Rotemberg, Richard Tresch, seminar participants at the Ninth World Congress of the Econometric Society, and colleagues at the New York Fed, the Atlanta Fed, the R@BC workshop at Boston College, Universidad Nacional de la Plata, Universidad del CEMA, the University of Torcuado Di Tella, Universidad de San Andrés, and the central bank of Argentina for helpful comments. The views expressed here are the author's and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System. Any remaining errors are the author's responsibility.

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Business Cycles and Monetary Regimes in Emerging Economies: A Role for a Monopolistic Banking Sector.

1 Introduction

Although there is a vast literature on monopolistic power in product and factor markets, and also credit market imperfections, practically there is no research that considers the possibility of monopoly power in financial markets in a business cycle context.[1] This possibility is particularly relevant in developing economies, for three reasons. Firstly, banking remains a primary source of funds for entrepreneurs in those countries.[2] Secondly, consolidation of the banking sector has been spurred by the liberalization of financial markets worldwide in the last decades. Making use of large economies of scale, international banks have taken over established banks in relatively small financial markets. Finally, empirical evidence in real goods markets shows that markups are countercyclical. [3] If bank markups are also countercyclical, this gives rise to a bank-supply channel that extends the credit channel to reinforce the same vicious circle: Credit is more expensive during recessions, so that firms and households postpone investment, work, and consumption decisions and thereby deepen the recession. But while the standard version of the credit channel relies on the external finance problem that induces banks to charge a premium to cover the increase in expected bankruptcy costs during recessions, the bank-supply channel is solely the result of imperfect competition in the banking system.

I set up a New Keynesian small open economy model with imperfect competition in the banking system and countercyclical bank markups that amplifies and propagates both real and nominal external shocks. Following

[1] Olivero (2004) considers the presence of a "global" oligopolistic banking sector, and assumes an *ad-hoc* procyclical price elasticity of the demand for credit to solve the "consumption-output" and "quantity" anomaly.

[2] See, for instance, empirical evidence in Rojas-Suares and Weisbrod (1994) and Catena (1996).

[3] For instance, see Rotemberg and Woodford (1992) and Chevallier and Sharfstein (1996) among others. Pigou (1927) and Keynes (1939) were the first ones to suggest that markups were countercyclical in real goods markets.

empirical evidence in Mandelman (2005), limit pricing strategies are the origin of these countercyclical bank markups. Limit pricing is the practice of setting prices at the limit level that deters entry. As shown in Bain (1956), the price level in an industry strongly influences firms contemplating entry. Thus, temporary low interest rates may not be the result of changes in the banking structure but just the optimal entry-deterrence strategy for the incumbents. In this scenario, the threat of entry is the only reason to avoid profit maximization.

It is well-documented that bank penetration commonly takes place in the wholesale banking market initially and then expands to the retail market.[4] The penetration into the retail sector is obstructed, however, by the requirement of incurring large sunk entry costs (for instance, large advertising expenditures or the construction of a network of branches and ATMs required to accommodate small transactions). This implies that banks need to enter at a minimum-efficient-scale (MES) to justify the sunk costs incurred. Also, they must capture a large enough fraction of the market right after entering to make the constructed network profitable. This is particularly difficult in the banking industry, in which the markets are segmented into regional or sectorial niches.[5] In this scenario, the size of the market constitutes a barrier to entry. If the financial market is small or underdeveloped there is space for only a few incumbents operating at an efficient scale. Thus, boom periods lead to an expansion of the financial system that attracts potential competitors who see the possibility of operating at an efficient scale. In this situation, contestable markets force incumbents to charge markups well below short-run profit maximizing levels so as to avoid entry. In contrast, the competitive pressure decreases during recessions and the banks in the local financial system are able to exert their monopolistic power by charging high markups.

To judge the empirical relevance of the setup, I conduct a quantitative exercise aimed at replicating the volatility in real variables for a set of emerging economies in which bank markups are sizable. The model succeeds at accounting for the high volatility of investment registered in these countries, even in a context of flexible exchange rates and liabilities denominated in local currency. Such "safeguards" are able to absorb the impact of external shocks in models that have only the standard credit channel (i.e. balance-

[4]See evidence in Claessens et al (2001).

[5]See evidence in Petersen and Rajan (1994).

sheet effect), which fails to deliver any amplification mechanism.

The paper is organized as follows. In section 2, I discuss the empirical evidence and proceed with a literature review. In section 3, I introduce the model. In section 4, I present the parameterization of the model and the solution method. I then describe the transmission mechanism and undertake a welfare analysis. Concluding remarks are in section 5.

2 Literature Review and Empirical Evidence

There exists a lengthy literature on the effect of balance sheets on borrower spending that works to propagate external shocks as well as financial crises in emerging economies. Examples include: Aghion et al (2000), Céspedes et al (2000), Caballero and Krishnamurty (2000), Devereux and Lane (2003), Faia and Monacelli (2002), Christiano et al (2002). These contributions aim to capture an old idea of Keynes and Fisher who originally recognized the imperfect nature of financial markets. This is that, deteriorating credit market conditions like deflation-originated real debt burden increments and collapsing asset prices (that alter collateral valuations and default costs) are not only simply consequences of a declining economy, but actually a major cause of the decline. My baseline model is closer to Gertler et al (2003), who extend the standard New Keynesian small open economy framework to include the credit channel as originally developed by Bernanke et al (2000). In addition, the introduction of nominal rigidities allows for exchange rate policy evaluation. Nonetheless, the internal propagation mechanism in these papers relies on either fixed exchange rate regimes or the presence of firms' liabilities denominated in foreign currency. With fixed exchange rates, the rise in either the country risk premium or foreign interest rates causes an immediate rise in domestic interest rates. As a consequence, asset (and collateral) values plummet and external finance risk premia rise, leading to a fall in investment that propagates the shock to the economy. A different approach to the role of leverage positions is based on the "fear of floating" perspective that argues in favor of fixed exchange rates schemes. Liabilities are assumed to be mostly dollarized and the exchange rate pass-trough rapid.[6] Although flexible exchange rates offset the macroeconomic impact trough an immediate

[6]See for instance Calvo and Mendoza (2000), and Calvo and Reinhart (2002).

depreciation of the local currency, liabilities denominated in foreign currency and revenues denominated in domestic currency boost firms' leverage ratio and increase the risk premia.

Regarding the study of the bank-supply channel to be introduced here, the first step is to find a proper measure for markups in the banking industry data. A simple approach is to consider the ex-ante (posted) spread or difference between lending and deposit rates, as a proxy for financial markups. The difficulty here is that the spread also includes a premium to cover the expected borrowers' bankruptcy costs, which is the core of the standard credit channel.

The so-called risk premium has the sole intention of covering these expected bankruptcy costs. We expect that, in the long run, aggregate bank income obtained from such risk premia charges actually match banks' loan default costs. Therefore, I consider annual banks' balance sheet ex-post data that accounts for defaulted loans to proxy for net markups. In particular, I will use net interest margins (NIM), equal to bank's total interest income minus interest expense divided by total assets after subtracting defaulted loans. As explained in Demirguc-Kunt and Huizinga (1998), bank interest margins can be seen as an indicator of the pure inefficiency of the banking system.[7] Table 1 presents some descriptive statistics on ex-post margins for a selected group of emerging and developed economies. A lower degree of financial development not only results in much greater average interest margins for the former group (as expected) but also in more volatile margins both in absolute and relative terms.

Practically all the evidence on cyclicality is focused on ex-ante spreads.[8] An exception is Mandelman (2005), in which dynamic panel estimates show that in emerging countries ex-post margins are strongly countercyclical, even after controlling for financial development, banking concentration, operating costs, inflation, and simultaneity or reverse causation. In emerging economies, this countercyclical pattern is explained by the entry of foreign banks that occurs during booms. Entry, which mostly happens at wholesale level, signals the intention to enter later into the retail niches and, as I understand, triggers limit pricing strategies in concentrated financial mar-

[7] For more details, see Mandelman (2005).

[8] See, for instance, Hannan and Berger (1991) and Edwards and Vegh (1997) and Olivero (2004). Similarly, Angelini and Cetorelli (2000) use GDP growth as a control variable in the estimation of Lerner indexes. However, none of these studies settles the issue of causality and endogeneity.

kets. This evidence motivates the modeling of the banking system presented in Mandelman (2005), and is the source of the bank-supply channel in this paper.

3 The Model

I start from a standard small open economy framework with monopolistic competition and nominal rigidities, in the spirit of Obstfeld and Rogoff (1999) and Svensson (2000), and include the financial accelerator mechanism that links the condition of the borrower balance sheets to the terms of credit as developed in Gertler et al (2003). The novel feature of my setup is the inclusion of an imperfectly competitive domestic banking system, which acts as an intermediary between the households' savings and the wholesalers' financial requirements.

Within the home economy there are households, firms, a banking sector and a monetary authority. Foreign variables are considered to be exogenous. Households work, save, and consume two groups of tradable goods that are produced at home and abroad and are imperfect substitutes.

There are three types of home firms: wholesalers, capital producers and retailers. Due to imperfections in financial markets, the wholesalers' demand for capital depends on their respective financial positions. This capital is used with labor to produce raw output. Banks serve as the sole source of funds to finance capital acquisition. Competitive capital producers manufacture new capital and adjustment costs lead to a variable price of capital. Finally, retailers package wholesale goods together to produce final output. They are monopolistically competitive and set nominal prices on a staggered schedule. The role of the retail sector is simply to provide the source of nominal price stickiness.

3.1 Households

The household sector is conventional. There is a continuum of households of unit mass. Each household works, consumes, and invests its savings in regular deposits and foreign bonds denominated in foreign currency.

The representative household maximizes:

$$E_t \sum_{t=0}^{\infty} \beta^t \left[\frac{1}{1-\gamma} C_t^{1-\gamma} - \frac{a_n}{1+\gamma_n} H_t^{1+\gamma_n} \right] \tag{1}$$

Subject to the budget constraint:

$$C_t = \frac{W_t}{P_t} H_t + \Pi_t - \frac{D_{t+1} - (1+i_{t-1}) D_t}{P_t} - \frac{S_t B_{t+1}^* - S_t \Phi_t (1+i_{t-1}^*) B_t^*}{P_t}. \tag{2}$$

With $\gamma > 0$, and $\gamma_n \geq 0$. C_t is a composite of tradable final consumption goods; H_t is labor supply; W_t denotes the nominal wage; P_t is the consumer price index (CPI); Π_t are real dividend payments (from ownership of commercial banks and retail firms); D_t are deposits in local currency held at commercial banks; B_t^* are foreign nominal bonds denominated in foreign currency; S_t the nominal exchange rate. $(1+i_t)$ and $(1+i_t^*)$ are the gross domestic and foreign nominal interest rates. Φ_t is the gross borrowing premium that domestic residents must pay to obtain funds from abroad. I assume that the country's borrowing premium depends on foreign indebtness, that is $\Phi_t = f(-B_t^*)$. The elasticity of Φ_t with respect to $-B_t^*$ is positive to avoid non-stationarity of the stock of foreign liabilities. However, it is set close to zero to avoid altering the high-frequency dynamics of the model. Since I assume that the intermediary cannot distinguish a household from a risky entrepreneur, all household deposits are redirected to entrepreneurs. The household can dissave by holding negative positions of foreign bonds.

Consumption Composites The household's preferences over home consumption, C_t^H, and foreign consumption, C_t^F are defined by a CES index:

$$C_t = \left[(\gamma_c)^{\frac{1}{\rho}} \left(C_t^H \right)^{\frac{\rho-1}{\rho}} + (1-\gamma_c)^{\frac{1}{\rho}} \left(C_t^F \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}. \tag{3}$$

The corresponding consumer price index, P_t, is:

$$P_t = \left[\gamma_c \left(P_t^H \right)^{1-\rho} + (1-\gamma_c) \left(P_t^F \right)^{1-\rho} \right]^{\frac{1}{1-\rho}}. \tag{4}$$

Optimality Conditions Household behavior obeys:

Consumption allocation:

$$\frac{C_t^H}{C_t^F} = \frac{\gamma_c}{1-\gamma_c}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho}. \tag{5}$$

Labor allocation:

$$\frac{W_t}{P_t} C_t^{-\gamma} = a_n H_t^{\gamma_n}. \tag{6}$$

Consumption and saving intertemporal allocation:

$$1 = \beta E_t \left\{ \left(\frac{C_t}{C_{t+1}}\right)^{\gamma} (1+i_t) \frac{P_t}{P_{t+1}} \right\}. \tag{7}$$

Finally, the optimality condition governing the choice of foreign bonds, combined with (7), yields the following uncovered interest parity condition:

$$E_t \left\{ C_{t+1}^{-\gamma} \frac{P_t}{P_{t+1}} \left[(1+i_t) - \Phi_t (1+i_t^*) \frac{S_{t+1}}{S_t} \right] \right\} = 0. \tag{8}$$

3.2 Firms

3.2.1 Wholesalers

Wholesalers are risk neutral and acquire capital in each period for use in the subsequent period. I assume that they have a finite expected horizon. This assumption is aimed to capture the phenomenon of ongoing births and deaths of firms, as well as to discard the possibility that wholesalers will ultimately accumulate enough wealth to be fully self-financing. The probability of surviving to the next period is ζ. In other words, the expected horizon is $\frac{1}{1-\zeta}$.

I assume the birth rate of wholesalers to be such that the fraction of agents who are wholesalers is constant. To ensure that new wholesalers have funds available when starting out, I follow Bernanke et al (2000) and assume that each wholesaler is endowed with H_t^e units of labor which is supplied inelastically as a managerial input to production. W_t^e is received in compensation. Capital is used in combination with labor to produce wholesale goods. The labor input L_t is assumed to be a composite of household and managerial labor: $L_t = H_t^{\Omega} H_t^{e(1-\Omega)}$. $(1-\Omega)$ is positive but negligible in size. I normalize H_t^e to unity.

The project is subject to an idiosyncratic shock, ω_t, that affects both the production of new goods and the effective quantity of the capital in use. The shock ω_t may be regarded as a measure of the overall quality of the capital investment. I assume that ω_t is an i.i.d. random variable, distributed continuously with $E\{\omega_t\} = 1$. I also assume Cobb-Douglas technology. The last two assumptions allow me to express the aggregate production function as:

$$Y_t = A_t K_{t-1}^{\alpha} L_t^{1-\alpha}, \tag{9}$$

where Y_t is the aggregate output of wholesale goods, K_{t-1} is the aggregate amount of capital purchased by wholesalers in period $t-1$, L_t is labor input, and A_t is an exogenous technology shock.

Let $P_{W,t}$, be nominal price of wholesale goods. Then, labor demand satisfies,

$$(1-\alpha)\Omega \frac{Y_t}{H_t} P_{W,t} = W_t, \tag{10}$$

and

$$(1-\alpha)(1-\Omega)\frac{Y_t}{H_t^e} P_{W,t} = W_t^e. \tag{11}$$

Demand of New Capital The wholesalers finance the acquisition of capital partly with their own net worth available at the end of period t and partly with the bank credit redirected from household deposits, D_{t+1}. Capital financing is split between net worth, N_t, and credit:

$$Q_t K_t = N_t + \frac{D_{t+1}}{P_t}. \tag{12}$$

Q_t is the real market price of capital in units of the household consumption composite. Net worth may be interpreted as the equity of the firm. I assume that new equity and bond issues are prohibitively expensive, or not available for local firms, so that all external finance is done with bank credit. I ignore the possible existence of retained reserves, so that the overall amount of credit in the economy must be equal to the overall amount of household deposits. As previously remarked, all credit is in units of domestic currency.

Due to constant returns to scale, the marginal return to capital equals its average return. Jointly with the assumptions on the idiosyncratic shock, ω_t, we can write the expected gross return to holding a unit of capital from t to $t+1$ as:

$$E_t(1 + r_{t+1}^k) = E_t\left[\frac{\frac{P_{W,t+1}}{P_{t+1}}\frac{\alpha Y_{t+1}}{K_t} + Q_{t+1}(1-\delta)}{Q_t}\right]. \tag{13}$$

Supply of New Capital The marginal cost of funds to the wholesaler depends on the financial conditions and the banking structure. Following Bernanke et al (2000) , I assume the existence of an external finance problem that makes uncollateralized external finance more expensive. As in Gale and Hellwig (1985), I assume the existence of a costly state verification problem. In this case, the idiosyncratic shock ω_t, is private information for the entrepreneur. A detailed explanation of the agency problem for a monopolistic bank is in Appendix A. It is shown there that the external finance risk premium, ψ_t, may be expressed as an increasing function of the leverage ratio. Essentially, the external finance risk premium varies inversely with the wholesaler's net worth. The greater the share of capital that can be self-financed, the smaller the expected bankruptcy costs, and thus the smaller the risk premium:

$$\psi_t(.) = \psi\left(\frac{\frac{D_{t+1}}{P_t}}{N_t}\right), \tag{14}$$

$$\psi'(.) > 0, \quad \psi(0) = 0, \ \psi(\infty) = \infty.$$

Notice that $\psi_t(.)$ depends exclusively on the aggregate leverage ratio and not on any wholesaler-specific variable. In equilibrium, all entrepreneurs choose the same leverage ratio, which is the result of both constant returns to scale in production and risk neutrality (for details, see Carlstrom and Fuerst, 1997). Equation (14) is the basis of the standard credit channel (also referred to as the balance-sheet-effect). It links movements in the wholesalers' balance sheet positions to the marginal cost of credit and, thus, to the demand of capital. As stressed in Kiyotaki and Moore (1997), endogenous fluctuations in the price of capital, Q_t, may have significant effects on the leverage ratio, $\frac{D_{t+1}}{P_t}/N_t = \frac{D_{t+1}}{P_t}/\left(Q_t K_t - \frac{D_{t+1}}{P_t}\right)$.

Finally, in equilibrium, the allocation of new capital satisfies the following optimality condition:

$$E_t\left(1 + r_{t+1}^k\right) = (1 + \Xi_{t+1})\,\psi_t(.)\,E_t\left\{(1 + i_t)\frac{P_t}{P_{t+1}}\right\}. \tag{15}$$

Equation (15) is the critical component of my model. The wholesalers' overall marginal ex-ante cost of funds is the product of three different terms. $E_t\left\{(1 + i_t)\frac{P_t}{P_{t+1}}\right\} = (1 + r_{t+1})$ indicates the bank's gross cost of funds (i.e. the real interest rate paid to depositors), $\psi_t(.)$ is the premium aimed to cover expected bankruptcy costs, and $(1 + \Xi_{t+1})$ is the gross financial markup an intermediary bank with monopoly power charges for carrying and executing the contract. If such markup were zero , the bank would earn a return equal to the safe rate that households receive for their deposits (see Appendix A for details). Net interest margins proxy for Ξ_{t+1} in the data and reflect the disintermediation generated by the banking system. The bank spread proxies for the combined effects of $\psi_t(.)$ and $(1+\Xi_{t+1})$.

To define the evolution of entrepreneurial aggregate net worth, let V_t denote the value of the ex-post real return on capital net of ex-post borrowing costs:

$$V_t = (1+r_t^k)Q_{t-1}K_{t-1} - \left[(1+\Xi_t)\psi_{t-1}(.)\,(1+i_{t-1})\,\frac{P_{t-1}}{P_t}\right]\frac{D_t}{P_{t-1}}. \tag{16}$$

While unforecastable variation in assets prices, Q_t, is the main source of unanticipated returns, unexpected CPI variation plays the same role for the liabilities. Finally, aggregate net worth is the result of a linear combination of V_t and the managerial wage:

$$N_t = \zeta V_t + W_t^e/P_t. \tag{17}$$

Exiting wholesalers in period t consume their remaining resources: $C_t^e = (1-\zeta)V_t$. I assume that wholesalers have preferences over domestic and foreign goods identical to household's preferences.

3.2.2 Capital Producers

The construction of new capital requires as input an investment good, I_t, that is a composite of domestic and foreign final goods:

$$I_t = \left[(\gamma_I)^{\frac{1}{\rho_I}}\left(I_t^H\right)^{\frac{\rho_I-1}{\rho_I}} + (1-\gamma_I)^{\frac{1}{\rho_I}}\left(I_t^F\right)^{\frac{\rho_I-1}{\rho_I}}\right]^{\frac{\rho_I}{\rho_I-1}}. \tag{18}$$

Competitive capital producers choose the optimal mix of foreign and domestic inputs according to the intra-temporal first-order-condition:

$$\frac{I_t^H}{I_t^F} = \frac{\gamma_I}{1-\gamma_I}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_I}. \tag{19}$$

Therefore, the investment price index, $P_{I,t}$, is given by

$$P_{I,t} = \left[\gamma_I \left(P_t^H\right)^{1-\rho_I} + (1-\gamma_I)\left(P_t^F\right)^{1-\rho_I}\right]^{\frac{1}{1-\rho_I}}. \tag{20}$$

I assume that there are increasing marginal adjustment costs in the production of capital. Capital producers operate a constant returns to scale technology that yields a gross output of new capital goods $\Psi\left(\frac{I_t}{K_{t-1}}\right)K_{t-1}$, for an aggregate investment expenditure of I_t. $\Psi(.)$ is increasing and concave. K_{t-1} is the second input in capital production. Capital producers rent this capital after it has been used to produce final output within the period. Let r_t^l denote the rental rate for the existent capital. Then profits equal:

$$Q_t\Psi\left(\frac{I_t}{K_{t-1}}\right)K_{t-1} - \frac{P_{I,t}}{P_t}I_t - r_t^l K_t. \tag{21}$$

In order to capture the delayed response of investment observed in the data, I follow Bernanke et al (2000) and assume that capital producers make their plans to produce new capital one period in advance. Therefore, the optimality conditions for the choices of I_t and K_{t-1} yields:

$$E_{t-1}\left\{Q_t\Psi'\left(\frac{I_t}{K_{t-1}}\right) - \frac{P_{I,t}}{P_t}\right\} = 0, \tag{22}$$

$$E_{t-1}\left\{Q_t\left[\Psi\left(\frac{I_t}{K_{t-1}}\right) - \Psi'\left(\frac{I_t}{K_{t-1}}\right)\frac{I_t}{K_{t-1}}\right]\right\} = r_t^l. \tag{23}$$

There are no adjustment costs in the steady state, so that $\Psi\left(\frac{I}{K}\right) = \frac{I}{K}$ and $\Psi'\left(\frac{I}{K}\right) = 1$. It also follows that Q is normalized to one and, hence, rental payments are second order and negligible in terms of both steady-state and model dynamics. Equation (22) implies that Q_t increases in $\frac{I_t}{K_{t-1}}$ as predicted by standard Q theory of investment. The adjustment costs generate a variable price of capital, crucial for the balance-sheet-effect.

The resulting economy wide capital accumulation is:

$$K_t = \Psi\left(\frac{I_t}{K_{t-1}}\right)K_{t-1} + (1-\delta)K_{t-1}, \tag{24}$$

where δ is the depreciation rate.

3.2.3 The Retail Sector and Price Setting

Monopolistic competition occurs at the retail level. Retailers buy wholesale goods and differentiate products by packaging them together and adding a brand name.

Let $Y_t^H(z)$ be the good sold by retailer z. Final good domestic output is a CES composite of individual retail goods:

$$Y_t^H = \left[\int_0^1 Y_t^H(z)^{\frac{\xi-1}{\xi}} dz\right]^{\frac{\xi}{\xi-1}}. \tag{25}$$

The price of the composite final domestic good, P_t^H, is given by:

$$P_t^H = \left[\int_0^1 P_t^H(z)^{1-\xi} dz\right]^{\frac{1}{1-\xi}}. \tag{26}$$

Domestic households, capital producers, and the foreign country buy final goods from retailers. Cost minimization results in an isoelastic demand for each retailer:

$$Y_t^H(z) = \left(\frac{P_t^H(z)}{P_t^H}\right)^{-\xi} Y_t^H. \tag{27}$$

To introduce price inertia, I assume that the retailer is free to change its price in a given period only with probability $1-\theta$, following Calvo (1983). Let $P_{o,t}^H$ denote the home production price set by retailers that are able to change prices at t, and $Y_{o,t}^H(z)$ the resulting demand at this price level. Retailer z chooses her price to maximize expected discounted profits, given by:

$$\sum_{k=0}^{\infty} \theta^k E_t \left[\Lambda_{t,k} \frac{P_{o,t}^H - P_{W,t+k}}{P_{t+k}^H} Y_{o,t+k}^H(z)\right]. \tag{28}$$

The discount rate $\Lambda_{t,k} = \beta^k \left(\frac{C_t}{C_{t+k}}\right)^{\gamma}$ is the household or "shareholder" intertemporal marginal rate of substitution. Because the price may be fixed for some time, retailers set prices based on the expected future path of marginal cost. The optimal price, $P_{o,t}^H$ satisfies:

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ \Lambda_{t,k} \left(\frac{P_{o,t}^H}{P_{t+k}^H} \right)^{-\xi} Y_{o,t+k}^H(z) \left[P_{o,t}^H - \left(\frac{\xi}{\xi - 1} P_{W,t} \right) \right] \right\} = 0, \tag{29}$$

where $\frac{\xi}{\xi-1}$ is the retailers' desired gross markup over wholesale prices. Given that a fraction θ of retailers do not change their price in period t the domestic price index evolves according to:

$$P_t^H = \left[\theta \left(P_{t-1}^H \right)^{1-\xi} + (1-\theta) \left(P_{o,t}^H \right)^{1-\xi} \right]^{\frac{1}{1-\xi}}. \tag{30}$$

By combining the last two equations, and then log-linearizing, it is possible to obtain the familiar optimization-based Phillips curve that arises from an environment of time-dependent staggered price setting.

I assume that the law of one price holds for foreign goods sold in the domestic market:

$$P_t^F = S_t P_t^*. \tag{31}$$

Then, it is possible to obtain an economy-wide inflation, combining equation (4) with the results above.

In Appendix B, I consider the case in which local currency pricing results in a delay in the exchange rate pass-through mechanism. There, I simply assume that imported goods prices are adjusted in the same manner as prices in the domestic sector.

3.3 The Banking System

I assume that the banking system is highly segmented into a large number, n, of sectors or regions (niches). The size of each niche is the same, and each of them is served by an established bank (incumbent), l, that possesses a local monopoly and therefore finances an equal fraction $\frac{\frac{D_{t+1}}{P_t}}{n}$ of the total entrepreneurial capital acquisition. Each incumbent can serve only its own niche because of an implicit collusion agreement that is described later. This intermediary chooses a net markup for its niche, Ξ_{t+1}, at the beginning of period t. I assume that the cost of serving the niche for each bank l is:

$$\upsilon_l \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau}. \tag{32}$$

The constant υ_l is the cost-efficiency level, and captures any idiosyncratic operational (in)efficiency and information (dis)advantages any bank may have. I assume that υ_l is drawn from a common uniform distribution $U(\upsilon)$ with support on $[0, \lambda]$ at the beginning of the bank operations. υ_l is private information and is unknown to banks outside the niche. The cost of serving depends on the amount of credit financed (the size of the market). In addition, the banking system possesses operational economies of scope and scale over operating costs. Thus, I assume that $0 < \tau < 1$.

For notational ease, I assume that the operational costs depend on the real amount of credit financed at t (i.e. $\frac{D_{t+1}}{P_t}$), but are effectively incurred at the time profits are realized. Therefore in period $t+1$ the bank obtains the following ex-post real profits for carrying and monitoring the bank contract (between depositors and entrepreneurs) at period t :

$$\pi_{l,t+1} = (1+\Xi_{t+1})(1+i_t) \left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n} \right) - \left[(1+i_t) \left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n} \right) + \upsilon_l \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} \right]. \tag{33}$$

The first term are the entrepreneur payments net of bankruptcy costs and the term in brackets captures the cost of funds (i.e. payments to depositors) plus operating costs. Using the fact that the ex-post real rate is $(1+r_{t+1}) = (1+i_t)\frac{P_t}{P_{t+1}}$, and that $\Xi_{t+1} r_{t+1} \approx 0$ for the parameter values I consider, we can express (33) as:

$$\pi_{l,t+1} = \Xi_{t+1} \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right) - \upsilon_l \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} . \tag{34}$$

Entry and mergers I assume that entry is possible in this banking system, but that it occurs in successive stages. Entrants in the "banking system" at time t only start competing in the "niche" at time $t+1$, which introduces a one-period time-to-build lag in the model. Right after the entry decision is effectively taken (i.e. when the sunk costs are incurred), the entrant is already inside the banking system, but only at the "wholesale level". Hence, in principle, during period t it is able to temporarily serve any of the n niches until it is finally established in one of them in $t+1$. The aim is to capture the idea of entry taking place in the wholesale market first with the ultimate goal of spreading later to the retail segment (niches).[9]

The entry stages are as follows:

(A) At the beginning of period t, a potential competitor, j, attempts to enter the banking system. At no cost, it draws its cost-efficiency level, υ_j, from the same common uniform distribution $U(\upsilon)$.

(B) After learning its own υ_j, the potential competitor chooses whether to enter the banking system and fight for one of the niches next period or to withdraw from the banking system. The closer υ_j is to zero, the more efficient the potential entrant is, and the easier to take over a niche. I assume that the number of total draws is large enough that at least some potential competitors enter the banking system every period.

(C) To enter the banking system (and eventually fight for one of the niches) an outsider has to incur fixed sunk entry costs, m_t, at the beginning of period t.[10] m_t is exogenous and measured in units of the consumption composite. We can also interpret changes in m_t as changes in entry regulations.

(D) In principle, during period t, entrants are able to temporarily serve any (or even all) of the n niches at the "wholesale level" until finally estab-

[9] Additionally, we could say that entrants need to incur in one-period learning process to make their idiosyncratic cost-efficiency level effective at the regional level.

[10] As mentioned above, we can include in them advertisement costs or the costs of constructing a network of branches and ATMs.

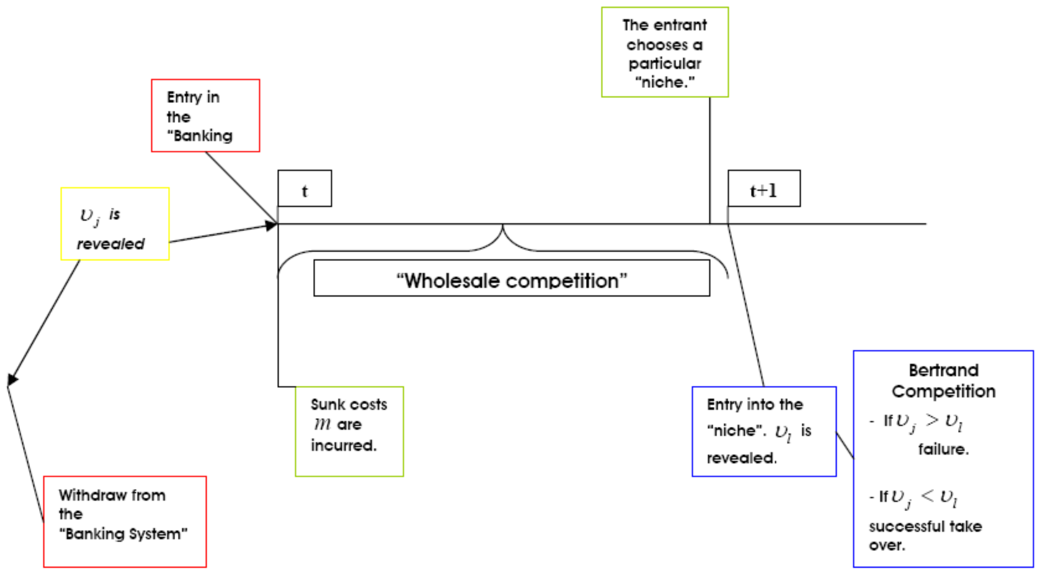

Figure 1: Entry Stages

lished in one of them. The cost of serving other niches at the wholesale level is:

$$\lambda \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau}, \tag{35}$$

where $\lambda \geq \upsilon_l$ for every l; given the common uniform distribution $U(\upsilon)$ with support on $[0, \lambda]$. As in Petersen and Rajan (1994), I assume that retail banks that are physically closer to their customers have lower costs of transacting with both firms and depositors.

(E) For simplicity, I assume that any entrant is able to enter only one of the niches (i.e. multi-sectorial entry is not possible). The collusion agreement implies that the potential competitor knows the cost-efficiency distribution of the banking system, $U(\upsilon)$, but cannot infer the particular $\upsilon_l' s$ of each incumbent. So that, entrants are indifferent about the niche to fight for.

I assume that once inside the banking system they randomly choose which particular niche to enter at the end of period t.

(F) At the very beginning of period $t+1$, the entrant is inside the niche and is able to learn the incumbent's υ_l. Bertrand competition occurs and the following proposition holds:

PROPOSITION 1 *Under Bertrand competition, only two possible outcomes are possible. If $\upsilon_j > \upsilon_l$, the entrant fails and is forced to merge. If $\upsilon_j < \upsilon_l$ the entrant successfully displaces the incumbent and forces it to merge. The optimal strategy for the loser is to merge immediately and not to compete. The only visible outcome is the possible change of the incumbent at the very beginning of $t+1$.*[11]

Proof. See Appendix C.

(G) If successful the new incumbent keeps the niche until it is hit by an exit-inducing shock that occurs with probability $\delta_D \in (0,1)$ in every period. For simplicity, I do not model endogenous exit that is not driven by the afore mentioned Bertrand competition. The "death" shock is independent of the bank's efficiency level. I assume that the empty niche left by every dead bank is immediately filled by an entrant. Right after drawing an efficiency level, the entrant is able to use the existent network left by the dead bank (avoiding any sunk costs as well as the time-to-build lag). The number of banks and the frequency of "death" is high enough so that $E(\upsilon_l) = \frac{\lambda}{2}$, and $U(\upsilon)$ describes the cost-efficiency distribution of all incumbents in the financial system.

Implicit Collusion Agreement and Limit Pricing I assume that entrants are liquidity constrained and cannot make looses after incurring sunk costs. In these circumstances, the pricing strategy, Ξ_{t+1}, must ensure that none of the new competitors at the wholesale level can obtain any expected positive profits if they decide to offer a net markup below Ξ_{t+1} and serve the niche.[12] That is:

[11] By definition the point likelihood of $\upsilon_j = \upsilon_l$ is null.

[12] By assumption, the customers remain loyal to the local incumbent bank if the level of the markup offered is the same.

$$\Xi_{t+1}\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right) \leq \lambda\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right)^{1-\tau} \tag{36}$$

Notice, however, that low cost-efficiency incumbents have the incentive to "signal" their idiosyncratic efficiency to new entrants by offering a markup below the level that makes (36) hold as an equality (hereafter, the binding limit). From (34), entrants in the banking system know that only more efficient incumbents can offer a markup, Ξ_{t+1}, well below $\lambda\left(\frac{D_{t+1}}{P_t}/n\right)^{-\tau}$ and still make profits. Therefore, these incumbents have incentives to offer markups levels somewhat below the binding limit in (36) to influence and redirect entrants' decisions toward less-efficient niches. The higher is the amount of entry in the banking system, the higher the incentives to protect the niche by lowering current markups and profits. In this scenario, incumbents "compete" to deter entry in their own niches. Instead, I assume that there exists an implicit collusion agreement among the incumbents that enforces the secrecy of the idiosyncratic cost-efficiency levels.

I assume that any implicit collusion agreement must necessarily satisfy all the incumbents to be possible. Consequently, a cartel markup below the binding limit in (36) does not work. The uniform distribution with support on $[0, \lambda]$, and the assumption that n is very large, implies that such cartel markup level can result in losses for members with cost-efficiency levels in the neighborhood of λ. The negative profits force defections from the agreement; defections that actually reveal the high cost-efficiency level of those defectors.[13] Therefore, the arrangement must consist of a markup equal to the binding limit in (36):

$$\Xi_{t+1}\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right) = \lambda\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right)^{1-\tau} \tag{37}$$

If any of the banks attempt to charge a markup below the binding limit, one of the members of the cartel immediately serves such niche at the wholesale level. The punishment consists of establishing a markup just below the

[13] I assume that a single defector can transform the tacit agreement into an explicit one. As in Rotemberg and Woodford (1992), such scenario carries incommensurable legal sanctions for the members of the cartel.

one chosen by the defector, $\Xi_{t+1}^{def} - \varepsilon$ (ε is negligible in size). The resulting negative profits for serving the niche under this condition are equally distributed among the members of the cartel. That is,

$$\frac{\left(\Xi_{t+1}^{def} - \varepsilon\right)\left(\frac{D_{t+1}}{P_t}/n\right) - \lambda\left(\frac{D_{t+1}}{P_t}/n\right)^{1-\tau}}{n-1} < 0. \tag{38}$$

I assume that, in principle, such punishment would take place only if there is a single monopolistic bank serving the niche (so that Proposition 1 holds). In other words, the cartel allows Bertrand competition to occur inside the niche to guarantee a monopolistic structure in which the number of banks in the banking system never exceeds n (one bank per niche). Finally, I assume that the amount of entry and the exogenous exit inducing shock (positively associated with the discount factor) is high enough so that incumbents are better off when committing to the collusive level in (37).

As a result, the pricing decision is exactly the same in all niches. Since all the niches are of the same size, we can interpret this relationship as the pricing decision taken by the representative bank of this economy.

Hence, for every period t, expected profits for each incumbent l are:

$$\pi_{l,t+1} = (\lambda - \upsilon_l)\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right)^{1-\tau} > 0. \tag{39}$$

Equations (37) and (39) can be interpreted as follows: The greater the aggregate investment, the bigger the size of all niches, and the higher the competitive pressure of the new entrants. In turn, this forces the incumbent to offer lower markups. These countercyclical markups, jointly with the standard balance-sheet-effect, constitute the "broad" financial accelerator at work in equation (15). Relative to the standard credit channel, this "broad" accelerator magnifies the propagation and amplification of shocks to the economy.

Entry decision Banks are forward looking and correctly anticipate their expected stream of profits. After drawing a υ_j, a potential entrant decides to enter the banking system only if the expected post-entry present discounted net value of the expected stream of profits $\{\pi_{j,t}\}_{t=1}^{\infty}$ is positive:

$$V_{j,t}=\left\{E_t\sum_{s=t}^{\infty}\left[\beta\left(1-\delta_D\right)\right]^{s-t}\left(\frac{C_{s+1}}{C_s}\right)^{-\gamma}\pi_{j,s+1}\right\}\left(1-\frac{\upsilon_j}{\lambda}\right)-m_s>0. \quad (40)$$

Banks discount future profits using the household's stochastic discount factor, adjusted for the probability of survival. The pre-entry probability of defeating the incumbent and taking-over the niche is $1-\frac{\upsilon_j}{\lambda}=\Pr(\upsilon_j<E(\upsilon_l))$. Equations (40) and (39) imply that entry is procyclical (i.e. entry increases when the amount of credit, purchase of new capital and the economic activity are high). The larger the discount factor and the probability of the exit-inducing shock, the stronger the procyclicality.

Entry is affected by market regulation that alters the value of m_t.[14] Equation (40) implies that the higher is m_t, the lower the resulting entry threshold value of υ_j, and thus the lower the amount of entry in the banking system (and vice versa). But, the higher is m_t, the more likely entries are successful when fighting for the niche. These results are in line with the empirical evidence that entry exerts a sizable impact in small, underdeveloped, and regulated markets.

The government can effectively prohibit entry in the banking system by setting $m_t\to\infty$. In this case, countercyclical limit pricing is not necessary, and incumbents are able to establish a standard collusive agreement.

3.4 The Foreign Sector

The small open economy takes all foreign variables as given. I use a very simple foreign demand for the home tradable, or exports, C_t^{H*} with an inertia component given by $\left[C_{t-1}^{H*}\right]^{1-\varpi}$. Following Gertler et al (2003), I postulate an empirically sensible reduced-form export demand curve:

$$C_t^{H*}=\left[\left(\frac{P_t^H}{S_tP_t^*}\right)^{-\chi}Y_t^*\right]^{\varpi}\left[C_{t-1}^{H*}\right]^{1-\varpi}, \qquad 0\le\varpi\le 1, \qquad (41)$$

[14] As in Ghironi and Melitz (2005), changes in sunk entry costs alter the free-entry condition.

P_t^* is the nominal price of the foreign tradable good (in units of the foreign currency) and Y_t^* is real foreign output. I assume balanced trade in the steady state and normalize the steady-state terms of trade at unity.

3.5 The Resource Constraint

The resource constraint for the domestic traded good sector is:

$$Y_t^H = C_t^H + C_t^{eH} + C_t^{H*} + I_t^H. \tag{42}$$

3.6 Monetary Policy Rules

I first consider shocks to the economy under a floating exchange rate regime, in which the central bank manages the nominal interest rate according to a Taylor rule. In this case, the policy instrument is the nominal interest rate. The central bank adopts a flexible inflation targeting rule that has the nominal interest rate adjust to deviations of CPI inflation and domestic output from their respective target values. Let Y^0 denote the steady-state level of output. The feedback rule is given by:

$$(1 + i_t) = (1 + r)\left(\frac{P_t}{P_{t-1}}\right)^{\gamma_\pi}\left(\frac{Y_t^H}{Y^0}\right)^{\gamma_y} \tag{43}$$

with $\gamma_\pi > 1$ and $\gamma_y > 0$, and where $(1 + r)$ is the steady-state gross real interest rate. The target net rate of inflation is assumed to be zero. The central bank therefore adjusts the interest rate to ensure that over time the economy meets the inflation target, but with flexibility in the short run so as to meet stabilization objectives. I assume that the central bank is able to credibly commit to the Taylor rule.

I then consider a pure fixed exchange rate regime in which the central bank simply keeps the nominal exchange rate pegged at a predetermined level, i.e.

$$S_t = \bar{S}, \text{ for all } t. \tag{44}$$

With the description of the monetary policy, the specification of the model is complete. The distinctive aspect of this general equilibrium model relative to a benchmark small open economy (SOE) setup with nominal rigidities and monopolistic competition in real goods markets is characterized by equations (37), (17) and (15). The first one determines the limit pricing strategy chosen by the incumbent banks, the second one characterizes the evolution of net worth, and the last one describes how the combined feedback effect of these two events influences capital demand. If we restrict the net financial markup, Ξ_{t+1}, to zero in (15), we effectively shut off the bank-supply channel and the model reverts to a SOE model with the conventional financial accelerator included (i.e. with only the standard balance-sheet-effect). Similarly, this last effect may be turned off by restricting ψ_t to one in (15).

4 Solution of the Model

4.1 Model parameterization

The quantitative analysis aims to capture the broad features of a representative emerging economy for which financial frictions are relevant. I set the world interest rate to 4 percent annually, an number commonly used in the literature, which also pins down the quarterly discount factor β at 0.99. I follow Galí and Monacelli (2005) and set the Frisch intertemporal elasticity of substitution in labor supply, $\frac{1}{\gamma_n}$, at 3. Average hours worked relative to total hours available are fixed at $\frac{1}{3}$ in steady state, which is the standard value in the Real Business Cycle (RBC) literature. Empirical evidence establishes low sensitivity of expected consumption growth to real interest rates in emerging economies. Therefore I fix $\gamma = 4$, which is in line with intertemporal elasticity estimates found in Reinhart and Vegh (1993) and Uribe (1997).

I set the intratemporal elasticity of substitution for the consumption composite, ρ, at 0.5. Since consumption goods are thought to have a higher degree of substitution than intermediate or investment goods, I mimic Gertler et al (2003) and fix the intratemporal elasticity of substitution for the investment composite, ρ_I, at 0.25. Finally, I follow Céspedes et al (2000) and assume that the share of domestic goods in the consumption and investment tradable composites, γ_C and γ_I, are both 0.6, consistent with observed shares.

I assign the conventional values of 0.35 and 0.025 to the capital share, α, and the steady state quarterly depreciation rate, δ, respectively. As in Galí and Monacelli (2005), I set the steady-state markup in the tradable goods markets at 1.2. The elasticity of the price of capital with respect to the investment capital ratio is taken to be 2, which is the estimate that King and Wolman (1996) found using aggregate data. As common in the literature on Calvo pricing, I assume that the probability of the price not adjusting, θ, is 0.75. The ratio of capital to net worth in the steady state is set at 2 (or equivalently, a leverage ratio of 0.5). This steady-state leverage ratio is the one chosen in Bernanke et al (2000) and is also in line with new estimations Kamil (2004) found for a set of emerging economies. I assume a low degree of financial development with high bankruptcy and monitoring costs, therefore I set the steady-state annual external finance risk premium at 4.5%, roughly 250 basis points higher than U.S. historical data. Following, Bernanke et al (2000), I choose the elasticity of the external finance premium with respect the leverage ratio, η, to be 0.051 and the entrepreneurs' death rate, $(1-\zeta)$ equal to 0.0272. I also fix the entrepreneurial labor share of the total wage bill at a negligible 0.01%. In order to assess the quantitative relevance of the monopolistic banking setup, I replicate the data in Table 1. Thus, I set the steady-state annual value of the net financial markup at 380 basis points and then calibrate τ so that its standard deviation (as a percent deviation from the steady-state value) is around 23%.

Regarding the parameters of the reduced-form export demand function, I set the elasticity χ equal to 0.3 and the inertia parameter, ϖ, equal to 0.25 which is the same value as in Gertler et al (2003). The steady-state ratio of exports to domestic output is set equal to 0.3.

The Taylor Rule coefficients on CPI inflation and domestic output gap, γ_π and γ_y, are set equal to 2 and 0.75, respectively, in line with a range of standard estimates.

4.2 Foreign interest rate shock

I first analyze the transmission mechanism of this setup. In order to capture a sudden capital outflow, I consider an unanticipated one hundred basis point increase in the foreign nominal interest rate that obeys a first order autocorrelation process that persists at the rate of 0.9 per quarter.

The model cannot be solved analytically so I employ numeric methods. I find the rational expectations equilibrium of the log-linear approximation around the steady state and obtain the recursive equilibrium law of motion using the method of undetermined coefficients.

In Figure 2, I plot the response of twelve key variables assuming perfect competition in the banking system under flexible exchange rates. I consider both the standard SOE model (dashed line) and the same model with the conventional financial accelerator included (solid line). In other words, bank markups remain at zero throughout the experiment. In this case, the domestic nominal interest rate is not tied to the foreign interest rate, and is instead governed by the feedback rule in equation (43). The rise in the foreign interest rate produces an immediate depreciation in the domestic currency which in turn prompts an increase in the foreign demand for home production. Household consumption falls owing to the increased cost of imported goods following the depreciation. Incomplete substitution causes consumption in domestic goods to fall, as well as the price of domestic goods. However, consumption of domestic goods falls by less than consumption of imported goods which, jointly with higher exports, moderates the overall effect on local output. The counteracting effects of lower domestic prices but more expensive imports causes the overall CPI inflation rate to increase only slightly. Given the Taylor rule specification, a small output drop jointly with moderate inflation dictates a negligible change in the real interest rate. Negligible changes in real rates and modest changes in the inflation rate imply that neither asset prices nor the real value of the liabilities are significantly altered. With the critical assumption of liabilities exclusively denominated in local currency, such behavior of the balance sheets implies that the balance-sheet-effect is negligible and the external finance premium wholesalers face is insignificant. Consequently, the drop in investment is moderate, and reflects only a lower price for capital as a result of the recessive outlook and a relatively more expensive foreign investment good composite.[15]

Therefore, the standard financial accelerator fails to deliver any amplification and propagation mechanism in this context. In principle, flexible exchange rates and liabilities fully denominated in local currency allow the

[15]The eslasticity of substitution for the investment good is relatively low. Therefore it becomes signficantly more expensive after the depreciation of the local currency.

economy to isolate itself from foreign interest rate shocks. Existent models are forced to include liabilities mostly denominated in foreign currency to improve upon their empirical performance.

The results are different if we also recognize the presence of monopoly power in the banking system. See Figure 3. The fall in investment causes the financial market to shrink and the banking markups to increase. Higher financial markups are reflected not only in a direct increment in the real cost of borrowing for entrepreneurs, but also in lower asset prices that deteriorate the position of balance sheets (and indirectly increase borrowing costs). Therefore, investment is significantly affected. The "broad" financial accelerator propagates financial disturbances, amplifies the business cycle, and alters the evolution of the capital stock throughout the experiment. As a result, real wages fall significantly, for two reasons. Firstly, a less capital intensive technology affects the marginal productivity of labor. Secondly the recessive pattern of the cycle increase ex-post markups in the real goods market and thus affects wages. Lower wages are associated with lower labor effort and output. Permanent income theory applies: The combined effect of lower wages and work effort affects household income and causes consumption to remain relatively lower. To ameliorate the negative impact these events have on domestic output, the central bank is forced to be less aggressive when increasing the interest rates. Lower rates moderate the fall in consumption and deliver a more robust depreciation that improves the international position of the economy.

In Figure 5, I plot the response of key variables in a scenario in which the monetary authority is committed to defend a fixed nominal exchange rate peg. In the baseline scenario with the bank-supply channel turned-off (dashed line), the domestic nominal interest rate rises to match the increase in the foreign interest rate so that (8) holds. Due to nominal price rigidities, there is also a significant increase in the real interest rate that in turns induces a contraction in output. The fall in the demand for domestic goods causes domestic prices to fall, but in this case foreign goods prices remain unaffected. The economy enters a deflationary spiral in which much higher real interest rates generate a sharp fall in household consumption and asset valuation. The dual presence of a negative debt-deflation impact on the liability side on the one hand, and lower assets prices on the other hand, severely damage the financial position of firms. Hence, immediately after the shock, the conventional financial accelerator starts working by raising the leverage ratio and the external finance premium, thereby magnifying the investment drop. Even if the nominal exchange rate does not change in this experiment, the economy improves its international position (with higher exports and greater import substitution) as a result of the local recession and the deflationary spiral.

With monopolistic competition in the banking sector, the amplification mechanism is even more robust (see the solid line). A shrinking financial market causes bank markups to increase and asset prices to fall, contributing to a further deterioration of balance sheets. The feedback mechanism behind the two channels of this "broad" financial accelerator increases borrowing costs for entrepreneurs, amplifying the response of investment and other real variables.

For completeness, in Fig 6 and 7, I show the balance-sheet and the bank-supply channels acting independently. In both figures, the dashed line refers to the SOE model without financial frictions. In this baseline setup the real cost of borrowing for wholesalers is just the real interest rate paid to depositors. We can observe, that the two channels work in the same direction and contribute independently to the same phenomenon. However, the internal propagation mechanism is more robust when they interact together in the complete model. See Figure 8.

4.3 Macroeconomic Variability

To assess the quantitative relevance of the model, in Table 2 I display theoretical second moments (as percent deviations from steady state values) obtained though the frequency domain technique depicted in Uhlig (1999) for the parametrization already described. To get the estimates, I set the standard deviation of the productivity innovations at 0.00712, in line with the RBC literature, and the standard deviation of the foreign interest rate shock equal to 0.0065, which is also well within the range used in the literature (see Batini et al 2001, and Nelson and Neiss, 2001). The empirical moments for the relevant variables are taken from the series used in Aguiar and Gopinath (2004). Output is real GDP, investment is gross fixed capital formation and household consumption is private consumption. These series are deseasonalized. For comparison purposes, both empirical and theoretical series are HP filtered with a smoothness parameter of 1600 so that only the cyclical component remains.

Notice that I purposely selected countries that *de facto* kept their exchange rates fixed during most of the span of the data available. Following Reinhart and Rogoff (2002), I consider periods in which there is either a *de facto* peg or at least a *de facto* crawling band that never exceeds the +/- 5% range. I proceed in this way for two reasons. Although some countries effectively allowed the exchange rate to float, it is difficult to determine whether they actually committed to a Taylor Rule in the period under consideration. Besides, the model assumes that liabilities are denominated in domestic currency, but in fact, most of the emerging economies have at least a fraction of firms' liabilities denominated in foreign currency.[16] In principle, it could be the case that some of the accounted volatility simply reflects firms' leverage ratios responding to changes in the exchange rate. In summary, the specification that assumes a floating exchange rate may not be suitable for making historical comparisons with the data available.

Sample averages of the empirical moments for the eight emerging economies depicted in Table 1 are reported in the last column of Table 2. The standard deviations for output, consumption and investment are 2.79, 3.60 and 10.75 respectively. The first four columns report four different theoretical scenarios: baseline SOE model, only monopolistic banking sector added, only balance-sheet-effect added, and both interacting together. Neither the standard credit channel nor the sole presence of a monopolistic banking can capture the historic investment volatility. In each case, the standard deviation for investment is 6.79 and 6.41 respectively. The fourth column displaying the results of the complete model with the "broad" financial accelerator shows that the richer model is actually the best one at replicating the actual volatility of real variables found in the data. In this case, the output and investment standard deviations are 2.28 and 10.90, respectively.

4.4 Welfare Analysis

Now I consider how the welfare of the representative household is affected by the presence of monopoly power in the banking system. The welfare criterion

[16]The model can be easily extended to consider the case of liabilities heavily denominated in foreign (hard) currency. Depending on the calibration, the impact of a exchange rate depreciation under flexible exchange rates maybe less or more damaging than the contraction in asset prices under fixed exchange rates.

is based on a second-order Taylor expansion of the representative household's expected utility function (1), around the deterministic steady-state:

$$W_t = \frac{1}{1-\gamma}C^{1-\gamma} - \frac{a_n}{1+\gamma_n}H^{1+\gamma_n} - \frac{1}{2}\gamma C^{1-\gamma} var(\hat{C}_t) - \frac{1}{2}\gamma_n a_n N^{1+\gamma_n} var(\hat{H}_t). \tag{45}$$

Variables with hats denote the percent deviation from the steady state, and variables without time subscripts denote steady-state values. The welfare results for the main scenarios previously discussed are listed in Table 3. In each case, I report the percent increase in steady-state consumption that makes the household as well off as it would be in a baseline scenario with flexible exchange rates and perfect competition in the banking system. The results confirm that the representative household is better off in the baseline scenario. In principle, households would be willing to accept a monopolistic banking system if steady-state consumption is 6.43% higher. If they are also forced to accept fixed exchange rates, the required increment is 7.20%. Monopolistic financial intermediaries affect welfare through two different channels. First, the bank markup generates a permanent disintermediation between borrowers and entrepreneurs that results in lower steady-state levels of capital accumulation, output, and hence consumption. Second, the countercyclical pattern of such markups increases the volatility of real variables, amplifies the business cycle, and thus reduces welfare. Finally, the transmission mechanism implies a much larger propagation of external shocks under a fixed exchange rate regime.

5 Conclusions

The modeling of the banking system captures several features of the empirical evidence observed in emerging economies. Entry occurs at the wholesale level and spreads later into a highly segmented retail market. If banking markets are underdeveloped, small, and regulated, only lower-cost banks attempt to enter the market and compete. However, their chances of a successful take over are higher than in a highly developed banking system. Although changes in the market structure do not affect the markups, entry threats force incumbents to set lower markups to deter the competitive pressure. Economies of scale facilitate entry in boom periods, and vice versa, generating countercyclical markups.

At a general equilibrium level, I show that this behavior of the banking system generates a bank-supply channel that interacts with the evolution of the firms' balance sheets to reinforce the credit channel: Credit is more expensive during recessions, and firms and households postpone investment and work decisions, leading to a deeper recession. Thus, market power in the banking system increases the volatility of real variables, amplifies the business cycle, and reduces welfare.

In the calibration of the model for a representative small open developing economy, I showed that the inclusion of imperfect competition in the banking system helps to explain the relatively large investment volatility typically experienced in these countries. These conclusions are robust to different monetary regimes. First, I consider the case of a monetary authority able to commit to a Taylor-type rule under floating rates. Then, I allow for the possibility of a central bank in a position of having to defend a fixed exchange rate peg. In either case, I show that the monetary authority is unable to avoid a sizable decrease in investment after a negative external shock. The results hold even if the speed with which exchange rate adjustments feed through to the consumer price index is slow and liabilities are fully denominated in local currency. In contrast, the sole presence of the standard balance-sheet channel fails to deliver any internal propagation mechanism in this context.

There are several extensions of the analysis that can be pursued in future work. The model may contribute to explaining the observed decline in real variables during financial crisis episodes. It could be easily modified to study the impact of currency depreciation when liabilities are heavily denominated in foreign currency. Additionally, the model may also be extended to capture the consequences of long-term relationships between banks and their customers. Regional banks in developing economies are usually engaged in long-term relationships with small domestic entrepreneurs who otherwise would have no access to the credit markets. Therefore, entry threats, which force low profit margins, can increase the degree of financial fragility and disrupt these relationships.

Appendix A: The Monopolistic Bank Contract.

In this appendix, I add monopoly power to the partial equilibrium contracting problem in the non-stochastic steady-state developed in Bernanke et al (2000).

Let profits per unit of capital equal ωR^k, where $\omega \epsilon [0, \infty)$ is an idiosyncractic shock with $E(\omega) = 1$. I assume $F(x) = \Pr[\omega < x]$ is a continuous probability distribution with $F(0) = 0$. I denote $f(\omega)$ the pdf of ω. Let variables without time subscripts denote steady-state values. The entrepreneur borrows $QK - N$ to invest K units of capital in a project. The total return on capital is thus $\omega R^k QK$. I assume that ω is unknown to both the entrepreneur and the lender prior to the investment decision. After the investment decision is made, the lender can only observe ω by paying monitoring costs $\mu \omega R^k QK$, where $0 < \mu < 1$. The "required" return on lending for the bank equals the cost of funds (deposit rate), R, times the steady-state gross bank markup, i.e. $(1 + \Xi)R$.

The optimal bank contract specifies a cutoff value $\bar{\omega}$ such that if $\omega \geq \bar{\omega}$, the borrower pays the lender the fixed amount $\bar{\omega} R^k QK$, and keeps the equity $(\omega - \bar{\omega}) R^k QK$. If $\omega < \bar{\omega}$, the borrower receives nothing, while the bank monitors the borrower and receives $(1 - \mu)\omega R^k QK$ in residual claims net of monitoring costs. In equilibrium, the bank earns an expected return equal to the "required" return $(1 + \Xi)R$, implying:

$$\left(\int_0^{\bar{\omega}} \omega f(\omega) d\omega + \bar{\omega} \int_{\bar{\omega}}^{\infty} \omega f(\omega) d\omega - \mu \int_0^{\bar{\omega}} \omega f(\omega) d\omega \right) \bar{R}^k QK = (1+\Xi) R (QK - N). \tag{46}$$

The optimal contract maximizes the payoff to the entrepreneur subject to the bank earning the "required" rate of return:

$$\max_{K, \bar{\omega}} \left(\int_{\bar{\omega}}^{\infty} \omega f(\omega) d\omega \right) \bar{R}^k QK \tag{47}$$

subject to equation (46).

Given constant returns to scale, the cutoff $\bar{\omega}$ determines the division of expected gross profits $R^k QK$ between the bank and lender. The expected gross share of profits going to the bank, $\Gamma(\bar{\omega})$, is:

$$\Gamma(\bar{\omega}) \equiv \int_0^{\bar{\omega}} \omega f(\omega) d\omega + \bar{\omega} \int_{\bar{\omega}}^{\infty} \omega f(\omega) d\omega. \tag{48}$$

Similarly, I define the expected monitoring costs , $\mu G(\bar{\omega})$ as:

$$\mu G(\bar{\omega}) \equiv \mu \int_0^{\bar{\omega}} \omega f(\omega) d\omega. \tag{49}$$

The net share of profits going to the bank is $\Gamma(\bar{\omega}) - \mu G(\bar{\omega})$, and the share going to the entrepreneur is $1 - \Gamma(\bar{\omega})$. By definition, $\Gamma(\bar{\omega})$ satisfies $0 \leq \Gamma(\bar{\omega}) \leq 1$.

The optimal contracting problem with non-stochastic monitoring may now be written as:

$$\max_{K,\bar{\omega}} (1 - \Gamma(\bar{\omega})) R^k QK \tag{50}$$

subject to:

$$\left[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})\right] R^k QK = (1 + \Xi) R(QK - N). \tag{51}$$

Let $s = \frac{R^k}{(1+\Xi)R}$, denote the risk premium on external funds and $k = \frac{QK}{N} = \frac{K}{N}$, the steady-state ratio of capital to net worth. Defining ι as the Lagrange multiplier on the constraint that the banks earn their "required" rate of return in expectation, the first order conditions for an interior solution to the contracting problem imply that:

$$s(\bar{\omega}) \equiv \frac{\iota(\bar{\omega})}{\Upsilon(\bar{\omega})}, \tag{52}$$

$$k(\bar{\omega}) \equiv \frac{\Upsilon(\bar{\omega})}{1 - \Gamma(\bar{\omega})}, \tag{53}$$

and

$$\iota(\bar{\omega}) \equiv \frac{\Gamma'(\bar{\omega})}{\Gamma'(\bar{\omega}) - \mu G'(\bar{\omega})}. \tag{54}$$

Where

$$\Upsilon(\bar{\omega}) = 1 - \Gamma(\bar{\omega}) + \iota(\bar{\omega})\left[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})\right]. \tag{55}$$

Equations (52) and (53) provide an implicit relationship between capital expenditures per unit of net worth $k(\bar{\omega})$ and the risk premium on external funds that is the basis of equation (14).

$$k(\bar{\omega}) = \kappa(s(\bar{\omega})) \qquad\qquad \kappa'(s) > 0. \tag{56}$$

Notice, finally, that the set up of this contracting problem allows us to express V_t in equation (16) as:

$$V_t = R_t^k Q_{t-1}K_{t-1} - \left[R_t(1+\Xi_t)\frac{D_t}{P_{t-1}} + \mu\int_0^{\bar{\omega}} \omega R_t^k Q_{t-1}K_{t-1}f(\omega)d\omega\right]. \tag{57}$$

The first term in the right hand side, $R_t^k Q_{t-1}K_{t-1}$, is the average return on capital and the expression in brackets is the aggregate ex-post costs of borrowing for the entrepreneurs. That is, $R_t(1+\Xi_t)\frac{D_{t+1}}{P_t}$ is the net payment banks receive and $\mu\int_0^{\bar{\omega}} \omega R_t^k Q_{t-1}K_{t-1}f(\omega)d\omega$ are aggregate default costs paid by the entrepreneurs. The default costs are captured by the external finance risk premium. (57) may be used in order to express (17) in log-linear form as:

$$\hat{N}_t = \zeta(1+\Xi)\frac{K}{N}(\hat{R}_t^k - \hat{R}_t) + \zeta(1+\Xi)(\hat{R}_t + \hat{N}_{t-1}) + \zeta\Xi\left(1 - \frac{K}{N}\right)\hat{\Xi}_t + \xi_t^{\hat{N}_t}. \tag{58}$$

Where hats denote percent deviations from the steady-state and $\xi_t^{\hat{N}_t} = \frac{(1-\alpha)(1-\Omega)Y}{N}\frac{\vartheta-1}{\vartheta}(\hat{Y}_t - \hat{P}_{t+1} - \hat{P}_{W,t})$ a collection of terms of second order importance.

Appendix B: Local Currency Pricing and Incomplete Pass-through.

The speed by which exchange rate adjustments feed through to the consumer price index in emerging markets has received widespread attention in the last few years.[17] The aim of this section is both to highlight the importance of this issue in the construction of monetary policy rules and to proceed with a sensitivity analysis. In the baseline model, I assumed complete pass-through; here I allow for the possibility that there is some delay between movements in the exchange rate and the adjustment of imported good prices. To introduce price inertia, I consider the case in which monopolistic competition also occurs among foreign goods retailers that face the same degree of price rigidity as domestic goods retailers.

In this case, the law of one price holds only at the wholesale level. Let $P_{W,t}^F$ be the wholesale price of foreign goods in the domestic currency. The law of one price then implies $P_{W,t}^F = S_t P_t^*$. Instead, the optimal price set by retailers that are able to change prices at t, $P_{o,t}^F$, is:

$$\sum_{k=0}^{\infty} \theta^k E_t \left\{ \Lambda_{t,k} \left(\frac{P_{o,t}^F}{P_{t+k}^F} \right)^{-\xi} Y_{o,t+k}^F(z) \left[P_{o,t}^F - \left(\frac{\xi}{\xi - 1} P_{W,t}^F \right) \right] \right\} = 0. \qquad (59)$$

Therefore, the foreign price index evolves according to:

$$P_t^F = \left[\theta \left(P_{t-1}^F \right)^{1-\xi} + (1-\theta) \left(P_{o,t}^F \right)^{1-\xi} \right]^{\frac{1}{1-\xi}}, \qquad (60)$$

which replaces (31) in the baseline setup. As a sensitivity analysis, I analyze the transmission mechanism of this alternative setup. As before, I consider an unanticipated one hundred basis point increase in the foreign nominal interest rate.

In the baseline case with full-pass-through, the Taylor rule specification dictates that the central bank must always prevent a large exchange rate depreciation in order to control CPI inflation. See Figure 3 again. Although the nominal interest rate is not tied to the foreign interest rate (as in the

[17] See for instance, Calvo and Reinhart (2002) and Devereaux and Lane (2003).

case of fixed exchange rates), a large depreciation is prevented through a moderate increment in the nominal interest rate. The policy prescription in this scenario resembles the case of a "dirty" float exchange rate regime.

Results differ in the case of incomplete-pass-through. See Figure 4. Here, the monetary authority is able to decrease nominal interest rates while permitting a large currency depreciation. However, CPI inflation reacts very sluggishly because of the price rigidities among foreign goods retailers. The lower real interest rates, together with a large exchange rate depreciation, improves both the country's ability to absorb the negative shock and its international position. Therefore, the decrease in output is even more moderate and very short lasting.

Nonetheless, even in this scenario, which resembles a "pure" floating exchange rate regime, the decline in investment is sizeable in the presence of imperfect competition in the banking system.

Appendix C: Proof of Proposition 1.

Define the break-even level of markups θ_l and θ_j for the incumbent and the entrant. The break-even level is equal to the value of the net markup that provides them zero profits when serving the niche. That is:

$$\pi_{l,t} = \theta_l \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right) - \upsilon_l \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} = 0, \text{ and } \qquad \pi_{j,t} = \theta_j \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right) - \upsilon_j \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} = 0. \tag{A.1}$$

Now, let's analyze the case in which $\upsilon_j > \upsilon_l$, and thus $\theta_j > \theta_l$. Consider for example, $\Xi^l_{t+1} > \Xi^j_{t+1} > \theta_j$. The bank l has no demand and its profits are zero. But, if bank l charges $\Xi^l_{t+1} = \Xi^j_{t+1} - \varepsilon$ (where ε is positive but nil), it gets the entire niche and has a positive profit $\Xi^j_{t+1} - \varepsilon - \theta_l > 0$.

Therefore bank j cannot be acting in its own interest by charging Ξ^j_{t+1}. Now suppose $\Xi^l_{t+1} = \Xi^j_{t+1} > \theta_j$. In that case they share the niche, and each one serves half of it. But if bank j reduces its price slightly to $\Xi^j_{t+1} - \varepsilon$, it gets all the niche. Nonetheless, bank j will never charge $\Xi^j_{t+1} < \theta_j$, because it would make a negative profit. It follows that bank l can charge $\Xi^l_{t+1} = \theta_j - \varepsilon$ and guarantee for itself all the niche while obtaining a positive profit $\theta_j - \varepsilon - \theta_l > 0$.

Therefore bank j is indifferent between staying or leaving the niche, since will not be able to serve it. If bank l offers bank j a negligible but positive amount of output ε so as to merge, it is in the best interest of bank j to accept it. A symmetric analysis holds when $\upsilon_j < \upsilon_l$.■

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Table 1: Net Interest Margins Statistics.

DEVELOPED ECONOMIES / EMERGING ECONOMIES

COUNTRY	MEAN	ST DEV(1)	STDEV(2)	COUNTRY	MEAN	STDEV(1)	ST DEV(2)
United Kingdom	0.020	0.003	15.8	Argentina	0.070	0.031	44.2
Luxembourg	0.008	0.002	25.0	Israel	0.030	0.005	15.9
Ireland	0.013	0.003	18.8	South Korea	0.022	0.003	14.9
Japan	0.019	0.003	15.8	Malaysia	0.028	0.004	13.8
Switzerland	0.017	0.003	15.8	Mexico	0.054	0.010	19.0
Germany	0.026	0.004	14.1	Philippines	0.040	0.008	20.3
USA	0.040	0.003	6.2	Slovak Rep	0.031	0.009	28.6
				Thailand	0.025	0.008	32.3
Sample Average	**0.020**	**-------**	**15.9**	**Sample Average**	**0.038**	**------**	**23.6**

Notes: The variable in consideration is Net Interest Margins (Bank Markups) for the period 1991-2000. Sample Mean, Standard Deviation (1), and Standard Deviation as a percentage deviation from individual mean values (2) are reported. Source: Database on Bank Structure, World Bank Research Department (1999 and 2003 editions).

Table 2: Standard Deviation

VARIABLE	SOE	MBS	BS	**BS+MBS**	**DATA**
Output	1.50	1.89	1.83	**2.28**	**2.79**
Consumption	2.45	2.68	2.56	**2.67**	**3.60**
Investment	3.87	6.41	6.79	**10.90**	**10.75**
Bank Markup (Net Interest Margin)	-----	11.69	------	**23.03**	**23.09**

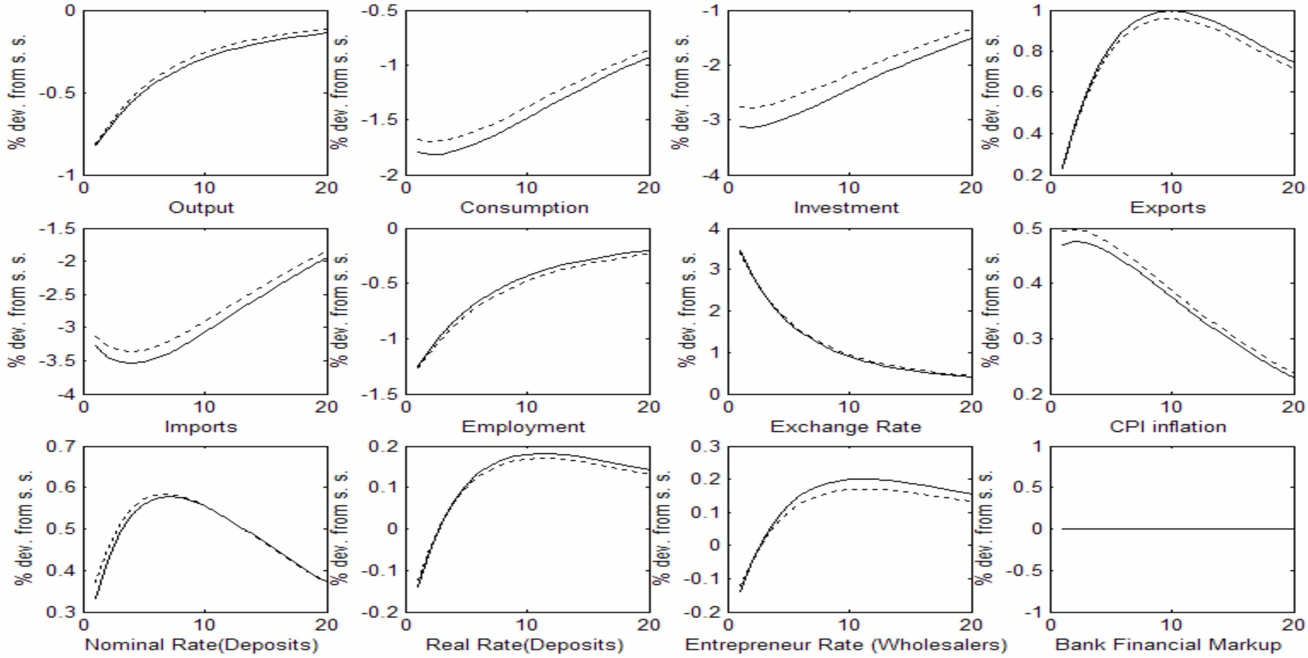
Notes: Observed and Theoretical second moments (as percent deviation from steady state values) are reported.
-Theoretical Moments: SOE is the baseline small open economy model with nominal rigidities. BS adds the standard balance-sheet-effect to the previous specification; instead, MBS adds the Monopolistic Banking System setup. Finally, BS+MBS adds the "broad" financial accelerator (i.e. the combined effect of both). The method used was the frequency domain technique depicted in Uhlig (1999).
-Empirical Moments: Observed Statistics for the selected sample of eight developing economies are based in seasonally adjusted quarterly data. Following Reinhart and Rogoff (2002), in the computations, I consider periods in which there is either a de facto peg or at least a de facto crawling band that never exceeds +/- 5 % range. Variables, except interest rates are transformed in logarithms.
-For comparison purposes, both Empirical and Theoretical series are H-P filtered with a smoothness parameter of 1600 so that only the cyclical component remains.

Table 3: Welfare Analysis

	BALANCE SHEETS ONLY	BALANCE SHEETS + MONOPOLISTIC BANKING
FLEXIBLE EXCHANGE RATES	**------**	**6.43%**
FIXED EXCHANGE RATES	**0.54%**	**7.20%**

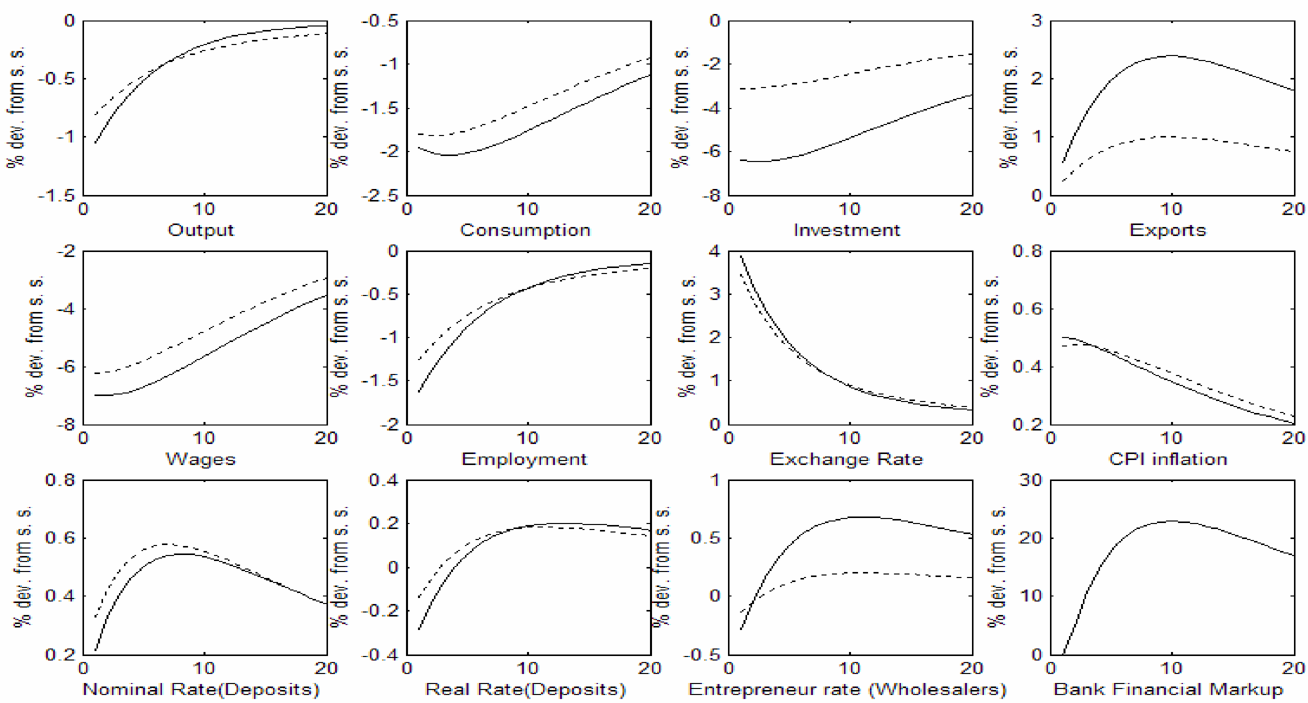
Notes: The welfare criteria considered here is based on a second-order Taylor expansion of the representative household's expected utility function (provided the parameterization specified in the paper). I report the percent increase in steady-state consumption that makes the household as well off than it would be in the baseline scenario.

FIGURE 2 - FLEXIBLE EXCHANGE RATE AND PERFECT COMPETITION IN THE BANKING SYSTEM



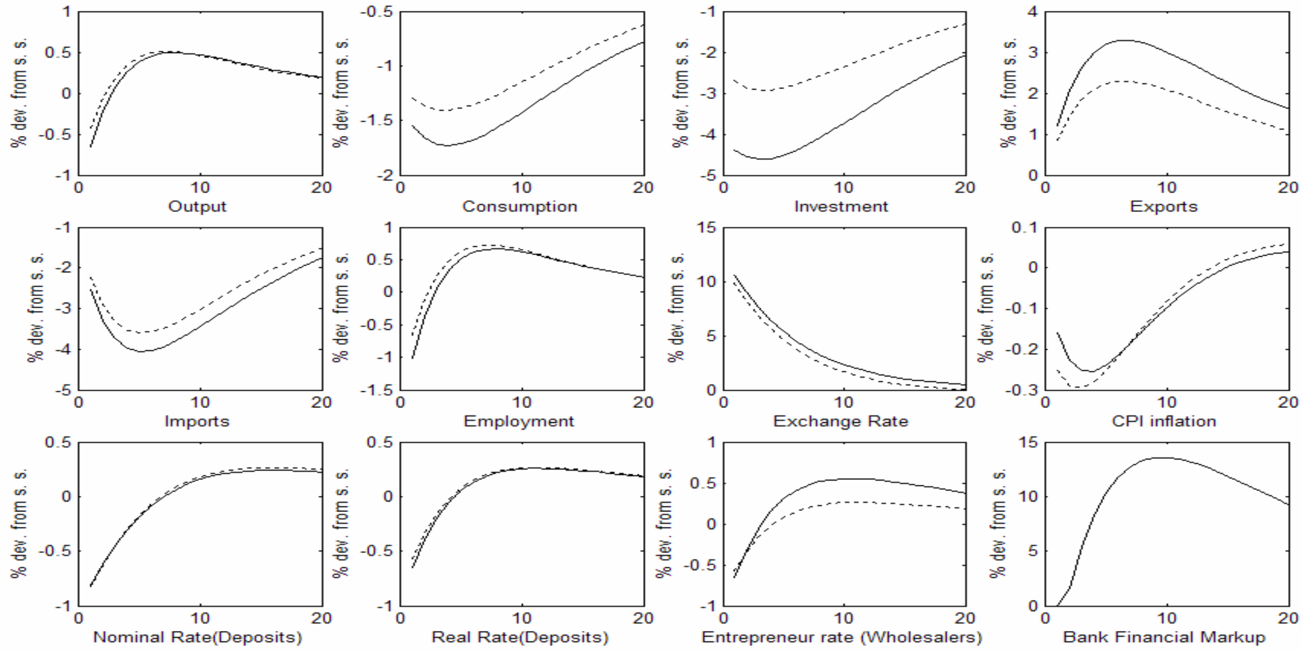
Percent point response of the standard "balance-sheet" (Solid Line), and the standard small open economy (SOE) with nominal rigidities (Dashed Line) models' to an unanticipated one hundred basis point increase in the foreign interest rate.

FIGURE 3 - FLEXIBLE EXCHANGE RATE AND MONOPOLISTIC BANKING SYSTEM



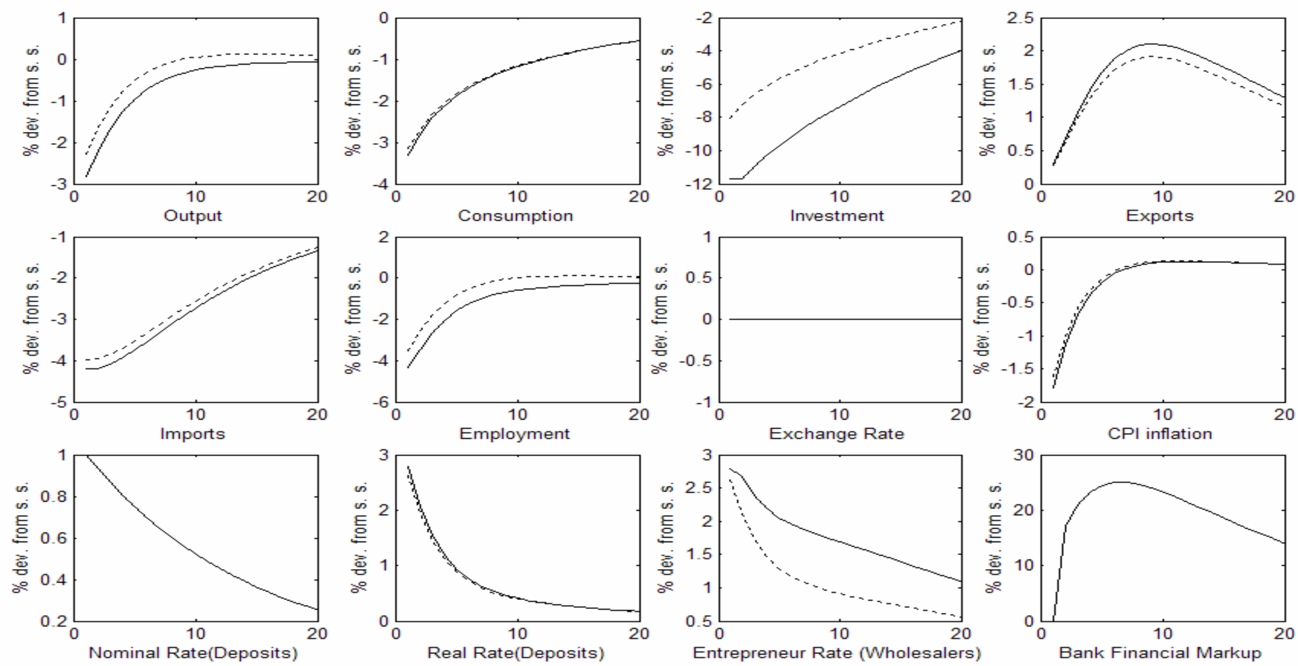
Percent point response of the complete (solid line), and the standard "balance-sheet" (dashed line) models' to an unanticipated one hundred basis point increase in the foreign interest rate.

FIGURE 4 · LOCAL CURRENCY PRICING AND INCOMPLETE PASS-THROUGH



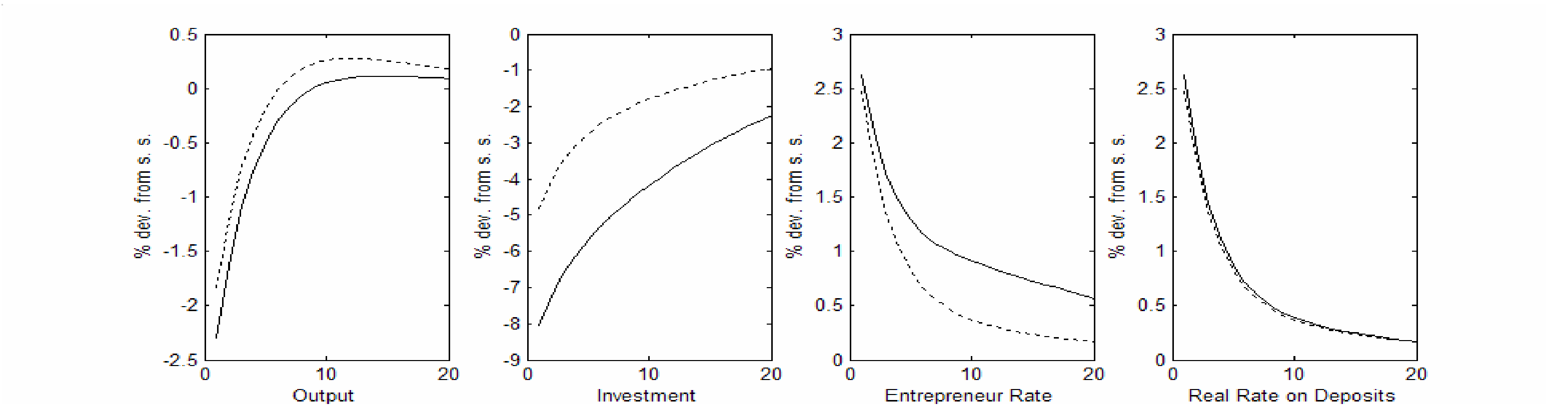
Percent point response of the complete (solid line), and the standard "balance-sheet" (dashed line) models' to an unanticipated one hundred basis point increase in the foreign interest rate. I assume that price adjustment in the foreign goods' sector follows the specification described in Appendix B.

FIGURE 5- FIXED EXCHANGE RATE AND MONOPOLISTIC BANKING SYSTEM



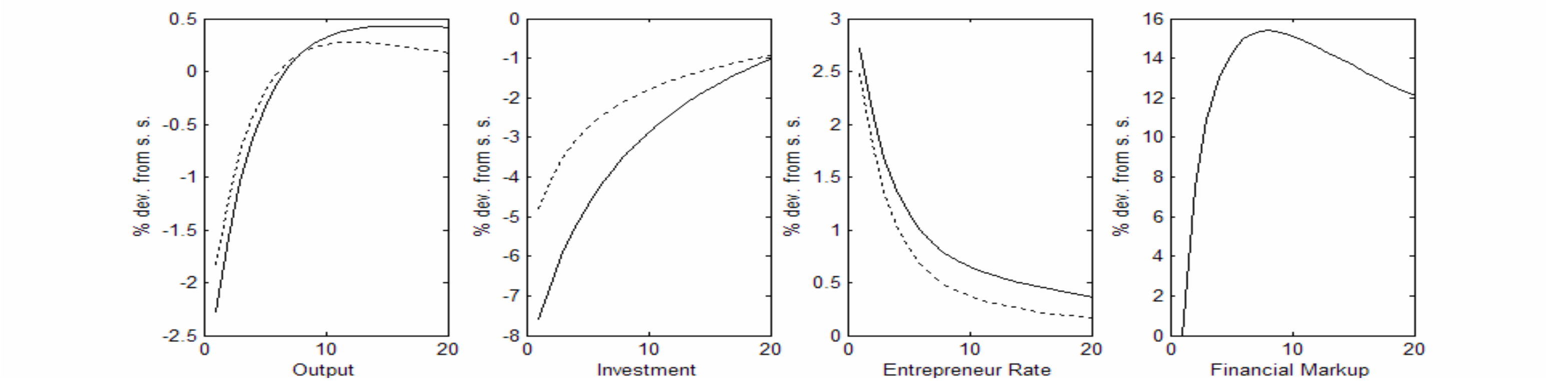
Percent point response of the complete (solid line), and the standard "balance-sheet" (dashed line) models' to an unanticipated one hundred basis point increase in the foreign interest rate. I assume the presence of a fixed exchange rate regime.

FIGURE 6- THE "BALANCE-SHEET-EFFECT."



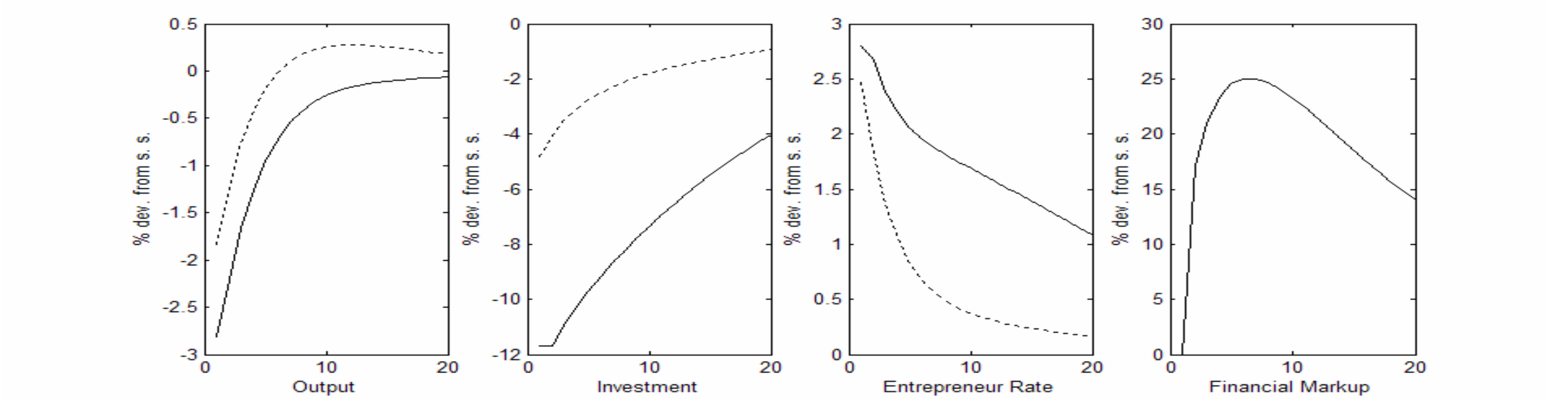
Percent point response of the standard "balance-sheet" (solid line), and the standard SOE with nominal rigidities (Dashed Line) models' to an unanticipated one hundred basis point increase in the foreign interest rate. I assume the presence of a fixed exchange rate regime and perfect competition in the banking system.

FIGURE 7- THE "BANK-SUPPLY CHANNEL."



Percent point response of the monopolistic banking system (solid line), and the standard SOE with nominal rigidities (Dashed Line) models' to an unanticipated one hundred basis point increase in the foreign interest rate. I assume the presence of a fixed exchange rate regime and no balance-sheet effects.

FIGURE 8- THE "BROAD" FINANCIAL ACCELERATOR.



Percent point response of the complete (solid line), and the standard SOE with nominal rigidities (Dashed Line) models' to an unanticipated one hundred basis point increase in the foreign interest rate. I assume the presence of a fixed exchange rate regime.