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Abstract: This study shows that the presence of imperfect competition in the banking system propagates external shocks and amplifies the business cycle. Strategic limit pricing, aimed at protecting retail niches from potential competitors, generates countercyclical bank markups. Markup increments during recessions directly increase borrowing costs for firms and indirectly damage the financial position of firms' balance sheets, increasing lenders' risk perception. I use Bayesian techniques and data from Argentina to show that the inclusion of monopolistic banking improves the fit of the New Keynesian small open economy model.

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

Key words: small open economy, countercylical bank markups, exchange rate regimes, Bayesian estimation, balance sheet effect

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1 Introduction

Although there is a vast literature on monopolistic power in product and factor markets, there is practically no research that considers this possibility in financial markets in a business cycle context. This possibility is particularly relevant in developing economies for three reasons. Firstly, banking remains a primary source of funds for entrepreneurs in those countries.[1] Secondly, a concentration of the banking sector has been spurred by the liberalization of financial markets worldwide in recent decades. Finally, a variety of theoretical models and ample empirical evidence in real goods markets show that markups are countercyclical.[2] If bank markups are also countercyclical, this would give rise to a bank-supply channel that extends the credit channel to reinforce the same vicious circle: credit is more expensive during recessions, so firms and households would postpone investment, work, and consumption decisions and thereby deepen the recession. There is also an important indirect effect: the lower the value of the borrower's liquid assets that serve as marketable collateral, the higher the resulting risk premium (phenomenon known as the balance-sheet channel). Higher bank markups, and therefore higher interest rates, are associated with lower asset prices, which damage borrowers' financial position, further increase the borrowing costs for entrepreneurs, and result in an even deeper recession. In sum, the novel bank-supply channel and the standard balance-sheet channel interact together and reinforce each other. As a result, they jointly constitute a "broad" financial accelerator that amplifies and propagates real and nominal shocks to the economy.

I set up a New Keynesian small open economy model that includes the balance-sheet channel and imperfect competition in the banking system. On the estimation side, I take the Bayesian approach and use macroeconomic and banking data from Argentina. Shocks are added to solve the singularity problem, and the marginal likelihood criterion is used to perform model comparisons and determine how much the inclusion of the bank-supply channel helps in explaining the data. Results of the model are best at matching the relative standard deviation of investment with respect to output.

The modeling of the banking system captures several features of the empirical evidence. Specifically, limit pricing strategies are the origin of the countercyclical bank markups. Thus, temporary low interest rates may not be the result of changes in the banking structure, but the optimal entry-deterrence strategy for incumbents. The model reflects well-documented evidence that bank penetration commonly takes

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

[2] For instance, see Rotemberg and Woodford (1992) and Chevallier and Scharfstein (1996) among others. Pigou (1927) and Keynes (1939) were the first ones to suggest that markups were countercyclical.

place in the wholesale banking market initially and then expands to the retail market.[3] In this scenario, however, penetration into the retail sector is obstructed by large sunk entry costs. These include, 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 to justify the sunk costs.[4] Also, banks must capture a large enough fraction of the market right after entering to make the constructed network workable. This is particularly difficult in the banking industry, in which the markets are segmented into regional or sectorial niches.[5] As a result, 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 deter 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.

The paper is organized as follows. Section 2 proceeds with a review of the literature. Section 3 introduces the model. Section 4 contains a short description of the data used. Section 5 presents the solution of the model which includes calibration of some parameters and choice of the prior distributions for the structural parameters that are estimated. Then, the empirical properties of the model are validated using autocovariance functions and unconditional moments. Section 6 discusses the role of the financial frictions in place. Section 7 provides an impulse response analysis. Section 8 explores the importance of various shocks in explaining the business cycle properties of the model. Concluding remarks are in section 9.

2 Literature Review and Empirical Evidence

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

The so-called risk premium has the sole purpose of covering these expected bankruptcy costs. It is expected that aggregate bank income obtained from such risk premia charges actually match banks' loan default costs. Therefore, I consider banks' balance sheet ex-post data that accounts for defaulted loans.

[3] See evidence in Claessens et al (2001).
[4] See Sutton (1992) for a detailed explanation and documented evidence.
[5] See evidence in Petersen and Rajan (1994).

In particular, I use net interest margins (NIM), a common proxy for net markups in the literature (see Demirguc-Kunt and Huizinga, 1998, for an explanation).

Practically all the existent literature on cyclicality is focused on ex-ante spreads. Remarkably, Hannan and Berger (1991) find that after a monetary contraction, spreads tend to increase more in US regional markets where the banking industry is concentrated. Aliaga-Díaz and Olivero (2006) show that net interest margins in the US banking sector are countercyclical. Similarly, Angelini and Cetorelli (2003) find a negative association between economic growth and market power in the Italian banking system. Mandelman (2006) uses data from 124 countries and dynamic panel techniques to show that ex-post margins are strongly countercyclical, even after controlling for banking concentration, operating costs, inflation, and reverse causation. I also find that such a countercyclical pattern is explained by the entry of foreign banks, which is more frequent during economic expansions. As discussed in Claessens et al (2001), foreign bank entry mostly happens at the wholesale level and signals the intention to enter later into the retail niches, being the impact of foreign banks "...felt immediately upon entry decision is taken rather than after they have gained substantial market share." Other studies show that banks that are exposed to potential competition register efficiency gains long before any change in the market structure occurs (See Berger et al, 2000, for a survey). Prominent examples in emerging economies include Spiller and Favaro (1984) and Ribon and Yosha (1999). Shaffer (1993) documents negative margins in banks exposed to competition and explains that such results are "...not consistent with known static and dynamic models of profit maximization." This evidence motivates the limit pricing modeling of the banking system which is the source of the bank-supply channel in this paper. The microfoundations are constructed in the spirit of the classic signaling limit-pricing setup (see Milgrom and Roberts, 1982). As in Athey et al (2004), a collusion agreement results in a unified price scheme that is independent of banks' idiosyncractic cost positions and facilitates aggregation.

There exists a lengthy literature on the effect of financial conditions on borrower spending that works to propagate external shocks.[6] 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 simply consequences of a declining economy, but actually a major cause of the decline. Nonetheless, the internal propagation mechanism in the existent literature relies on either fixed exchange rate regimes or firms' liabilities being denominated in foreign currency. With fixed exchange rates, the rise in either the country risk premium or foreign interest rates forces 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

[6] 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), Christiano et al (2007). Olivero (2006) considers the presence of a global oligopolistic banking sector, and assumes a procyclical price elasticity of the demand for credit and countercyclical bank markups to solve the quantity anomaly.

investment that propagates the shock to the economy.

However, flexible exchange rates offset the macroeconomic impact and lower domestic interest rates are consistent with the expenditure switching effects from the resulting depreciation of the currency. In this case, the balance-sheet setup provides some amplification mechanism only under the stringent assumption of sizable firm liabilities in foreign currency and revenues in domestic currency.[7] In other words, flexible exchange rates and firm liabilities in local currency are sufficient conditions to mute the standard financial accelerator. To the contrary, the inclusion of monopolistic banking breaks down this puzzle and restores the role that financial conditions have over the aggregate behavior.

3 The Model

I start from a standard small open economy framework with monopolistic competition and nominal rigidities, in the spirit of Galí and Monacelli (2005), 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 (2007). The novel feature 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 domestic 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 domestic firms: wholesalers, capital producers, and retailers. Due to imperfections within the 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:

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

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

Subject to the budget constraint:

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

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 $R_t^* = \Phi_t(1+i_t^*)$ 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: $\Phi_t = f(-B_t^*)\varepsilon_t^{i^*}$. 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. $\varepsilon_t^{i^*}$ is a foreign interest rate (country borrowing) shock. 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. Equation (1) contains a preference shock, ε_t^b, which represents a shock to the discount rate that affects the intertemporal substitution of households.

Consumption Composites The household's preferences over home consumption, C_t^H, and foreign consumption, C_t^F are defined by: $C_t = \left[(\gamma_C)^{\frac{1}{\rho_C}} \left(C_t^H\right)^{\frac{\rho_C - 1}{\rho_C}} + (1-\gamma_C)^{\frac{1}{\rho_C}} \left(C_t^F\right)^{\frac{\rho_C - 1}{\rho_C}} \right]^{\frac{\rho_C}{\rho_C - 1}}$. The corresponding consumer price index, P_t, is: $P_t = \left[\gamma_C \left(P_t^H\right)^{1-\rho_C} + (1-\gamma_C) \left(P_t^F\right)^{1-\rho_C} \right]^{\frac{1}{1-\rho_C}}$.

Optimality Conditions Household behavior is determined by the consumption allocation: $\frac{C_t^H}{C_t^F} = \frac{\gamma_C}{1-\gamma_C} \left(\frac{P_t^H}{P_t^F} \right)^{-\rho_C}$, labor allocation: $\frac{W_t}{P_t} \varsigma_t = a_n H_t^{\gamma_n}$. Where $\varsigma_t = \varepsilon_t^b C_t^{-\gamma}$ is the marginal utility of the consumption index. The consumption and saving intertemporal allocation is: $1 = \beta E_t \left\{ \frac{\varsigma_{t+1}}{\varsigma_t} (1+i_t) \frac{P_t}{P_{t+1}} \right\}$. Finally, the optimality condition governing the choice of foreign bonds, yields the following uncovered interest parity condition: $E_t \left\{ \varsigma_{t+1} \frac{P_t}{P_{t+1}} \left[(1+i_t) - \Phi_t (1+i_t^*) \frac{S_{t+1}}{S_t} \right] \right\} = 0$.

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 captures the phenomenon of ongoing firm births and deaths, as well as discards the possibility that wholesalers will ultimately accumulate enough wealth to be fully self-financing. The probability of surviving to the next period is ζ. I assume the birth rate of wholesalers is 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 (1999) 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: $Y_t = \varepsilon_t^a (u_t K_{t-1})^{\alpha} L_t^{1-\alpha}$, 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, u_t the capital utilization rate, and ε_t^a is an exogenous technology shock. Let $P_{W,t}$, be nominal price of wholesale goods. Then, labor demand satisfies: $(1-\alpha)\Omega \frac{Y_t}{H_t} P_{W,t} = W_t$, and $(1-\alpha)(1-\Omega)\frac{Y_t}{H_t^e} P_{W,t} = W_t^e$.

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: $Q_t K_t = N_t + \frac{D_{t+1}}{P_t}$. 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, I can write the expected gross return to holding a unit of capital from t to $t+1$ as:

$$E_t(1+r_{t+1}^k) = E_t\left[\frac{\frac{P_{W,t+1}}{P_{t+1}}\frac{\alpha Y_{t+1}}{K_t} + Q_{t+1}\left(1-\delta_{t+1}\right)}{Q_t}\right]. \tag{3}$$

Where δ_{t+1} is the endogenous depreciation rate. Following Baxter and Farr (2001), the capital utilization decision assumes that depreciation is increasing in u_t: $\delta_t = \bar{\delta} + \frac{b}{1+\Gamma}(u_t)^{1+\Gamma}$, with $\delta, b, \Gamma > 0$. Its optimality condition is such that: $\frac{P_{W,t}}{P_t}\frac{\alpha Y_t}{u_t} = Q_t K_{t-1} b(u_t)^{\Gamma}$.

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 (1999) , I assume the existence of an external finance problem that makes uncollateralized external finance more expensive. I assume the existence of a costly state verification problem. In this case, the idiosyncratic shock ω_t, is private information for the entrepreneur.[8] 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: $\psi_t\left(.\right) = \varepsilon_t^{fp}\psi\left(\frac{N_t}{Q_t K_t}\right), \psi'(.) < 0$, $\psi(0) = 0$, $\psi(\infty) = \infty$.[9] Notice that $\psi_t\left(.\right)$ depends on the aggregate leverage ratio (and not on any wholesaler-specific variable) and includes a shock to the external finance premium, ε_t^{fp}. 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). The standard credit channel (also referred to as the balance-sheet channel) 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 a significant effect 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:

$$E_t\left(1+r_{t+1}^k\right) = \left(1+\Xi_{t+1}\right)\psi_t\left(.\right)E_t\left\{\left(1+i_t\right)\frac{P_t}{P_{t+1}}\right\}. \tag{4}$$

Equation (4) is the critical component of my model. The wholesalers' overall marginal ex-ante cost of funds is the product of three different terms. $E_t\left\{\left(1+i_t\right)\frac{P_t}{P_{t+1}}\right\}$ indicates the bank's gross cost of funds (i.e. the real interest rate paid to depositors), $\psi_t(.)$ is the gross 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

[8] See appendix A, for a detailed explanation of the agency problem for a monopolistic bank

[9] This expression could be defined in terms of the leverage ratio as follows: $\psi_t\left(.\right) = \varepsilon_t^{fp}\tilde{\psi}\left(\frac{\frac{D_{t+1}}{P_t}}{N_t}\right), \tilde{\psi}'(.) > 0$, $\tilde{\psi}(0) = 0$, $\tilde{\psi}(\infty) = \infty$.

safe rate that households receive for their deposits. Net interest margins proxy for Ξ_{t+1} in the data and reflect the disintermediation generated by the banking system. The external finance premium (bank spread) proxies for the combined effects of $\psi_t(.)$ and $(1+\Xi_{t+1})$. The functional form of Ξ is described later.

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:

$$V_t = (1+r_t^k)Q_{t-1}K_{t-1} - \left[(1+\Xi_t)\psi_{t-1}(.)\,(1+i_{t-1})\,\frac{P_{t-1}}{P_t}\right]\frac{D_t}{P_{t-1}}. \tag{5}$$

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: $N_t = \zeta V_t + W_t^e/P_t$. Exiting wholesalers in period t consume their remaining resources: $C_t^e = (1-\zeta)V_t$.

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: $I_t = \left[(\gamma_I)^{\frac{1}{\rho_I}}\left(I_t^H\right)^{\frac{\rho_I-1}{\rho_I}} + (1-\gamma_I)^{\frac{1}{\rho_I}}\left(I_t^F\right)^{\frac{\rho_I-1}{\rho_I}}\right]^{\frac{\rho_I}{\rho_I-1}}$. Competitive capital producers choose the optimal mix of foreign and domestic inputs according to the intra-temporal first-order-condition: $\frac{I_t^H}{I_t^F} = \frac{\gamma_I}{1-\gamma_I}\left(\frac{P_t^H}{P_t^F}\right)^{-\rho_I}$. Therefore, the investment price index, $P_{I,t}$, is given by: $P_{I,t} = \left[\gamma_I\left(P_t^H\right)^{1-\rho_I} + (1-\gamma_I)\left(P_t^F\right)^{1-\rho_I}\right]^{\frac{1}{1-\rho_I}}$. 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 $\Psi\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right)K_{t-1}$, for an aggregate investment expenditure of I_t. $\Psi(.)$ is increasing and concave. As in Smets and Wouters (2003), I introduce a shock to the investment cost function, ε_t^I. 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: $Q_t\Psi\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right)K_{t-1} - \frac{P_{I,t}}{P_t}\varepsilon_t^I I_t - r_t^l K_{t-1}$. The optimality conditions for the choices of I_t and K_{t-1} yields: $Q_t\Psi'\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right) - \frac{P_{I,t}}{P_t} = 0$, and $Q_t\left[\Psi\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right) - \Psi'\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right)\frac{\varepsilon_t^I I_t}{K_{t-1}}\right] = r_t^l$. 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. These optimality conditions imply that Q_t increases in $\frac{I_t}{K_{t-1}}$ as predicted by standard Q theory of investment.[10] The adjustment costs generate a variable price of capital, crucial for the balance-sheet channel. The resulting economy wide capital accumulation is: $K_t = \Psi\left(\frac{\varepsilon_t^I I_t}{K_{t-1}}\right)K_{t-1} + (1-\delta_t)K_{t-1}$.

[10] In the estimation, the elasticity that characterizes this relationship is defined as φ.

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: $Y_t^H = \left[\int_0^1 Y_t^H(z)^{\frac{1}{1+\xi_t}} dz\right]^{1+\xi_t}$. The price of the composite final domestic good, P_t^H, is given by: $P_t^H = \left[\int_0^1 P_t^H(z)^{-\frac{1}{\xi_t}} dz\right]^{-\xi_t}$. Domestic households, capital producers, and the foreign country buy final goods from retailers. The time-varying gross markup in the domestic goods markets is: $(1+\xi_t) = \varepsilon_t^{\xi}(1+\bar{\xi})$. As standard in the literature, shocks to $(1+\bar{\xi})$ will be interpreted as a "cost-push" shock to the inflation equation. To introduce price inertia, I assume that the retailer is free to change its price in a given period only with probability $1-\theta$ (Calvo, 1983). As in Smets and Wouters (2003), I introduce exogenous inertia in the inflation rate by assuming partial indexation to last period's inflation rate. $P_{o,t}^H$ denote the domestic production price set by retailers that are able to change prices at t, and solves:

$$\sum_{k=0}^{\infty}\theta^k E_t\left\{\Lambda_{t,k}\left[\frac{P_{o,t}^H}{P_{t+k}^H}\left(\frac{P_{t+k-1}^H}{P_{t-1}^H}\right)^{\iota_H} - (1+\xi_t)\frac{P_{W,t+k}}{P_{t+k}^H}\right]\left[\frac{P_{o,t}^H\left(\frac{P_{t+k-1}^H}{P_{t-1}^H}\right)^{\iota_H}}{P_{t+k}^H}\right]^{-\frac{\xi_t+1}{\xi_t}} Y_{t+k}^H\right\} = 0, \tag{6}$$

Where the discount rate $\Lambda_{t,k} = \beta^k \frac{\varsigma_{t+k}}{\varsigma_t}$ is the intertemporal marginal rate of substitution and ι_H is the indexation degree in price setting. The price index is: $P_t^H = \left[\theta\left[P_{t-1}^H\left(\frac{P_{t-1}^H}{P_{t-2}^H}\right)^{\iota_H}\right]^{-\frac{1}{\xi_t}} + (1-\theta)\left(P_{o,t}^H\right)^{-\frac{1}{\xi_t}}\right]^{-\xi_t}$. Combining the last two equations yields an expression for the gross domestic inflation rate (within a neighborhood of the zero inflation steady-state): $\frac{P_t^H}{P_{t-1}^H} = \left((1+\xi_t)\frac{P_{W,t}}{P_t^H}\right)^{\lambda_H}\left(\frac{P_{t-1}^H}{P_{t-2}^H}\right)^{\iota_H/(1+\beta\iota_H)} E_t\left\{\frac{P_{t+1}^H}{P_t^H}\right\}^{\beta/(1+\beta\iota_H)}$, where $\lambda_H = \frac{(1-\theta)(1-\beta\theta)}{\theta}/(1+\beta\iota_H)$.

This expression is the familiar optimization-based Phillips curve. Foreign goods traded in the domestic economy are subject to an analogous markup over the wholesale price. Let $P_{W,t}^F$ denote the wholesale price of foreign goods in domestic currency, and $P_t^{F^*}$ the foreign currency price of such goods. The law of one price holds at the wholesale level. This implies: $P_{W,t}^F = S_t(\varepsilon_t^{F^*}P_t^{F^*})$. Where, $\varepsilon_t^{F^*}$ is a terms of trade shock affecting the price of imports.

Inflation in foreign goods satisfies: $\frac{P_t^F}{P_{t-1}^F} = \left((1+\bar{\xi})\frac{P_{W,t}^F}{P_t^F}\right)^{\lambda_F}\left(\frac{P_{t-1}^F}{P_{t-2}^F}\right)^{\iota_F/(1+\beta\iota_F)} E_t\left\{\frac{P_{t+1}^F}{P_t^F}\right\}^{\beta/(1+\beta\iota_F)}$. Where ι_F is the foreign good price indexation degree and $\lambda_F = \frac{(1-\theta)(1-\beta\theta)}{\theta}/(1+\beta\iota_F)$. [11] Then, it is possible to obtain an economy-wide inflation, π_t, combining the results above in the consumer price index.

[11] Given the data available, it not possible to distinguish a terms of trade shocks from a shock to the the foreign goods retailer markup. For simplicity, in the estimation I only consider the first type of shocks.

3.3 The Banking System

The model assumes 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 in 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: $\upsilon_l \varepsilon_t^{oc} \left(\frac{D_{t+1}}{P_t}/n \right)^{1-\tau}$, where ε_t^{oc} is an aggregate shock to the banking operating costs. The constant υ_l is the cost-efficiency level, and captures any idiosyncratic operational (in)efficiency and information (dis)advantages a 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). The banking industry is characterized by its operational economies of scope and scale over operating costs. Thus, I assume that $0 < \tau < 1$.

The expected present value of ex-post real profits for carrying and monitoring the bank contract (between depositors and entrepreneurs) are: $E_t \left\{ \Lambda_{t,1} \left[\Xi_{t+1}(1+i_t) \left(\frac{D_{t+1}}{P_{t+1}}/n \right) \right] \right\} - \upsilon_l \varepsilon_t^{oc} \left(\frac{D_{t+1}}{P_t}/n \right)^{1-\tau}$. The first term is discounted entrepreneurs' payments, net of payments to depositors and bankruptcy costs. The second term is the operation costs incurred at the time the transaction occurs.

Entry and mergers I assume that entry is possible in the banking system, but that entry occurs in successive stages. Entrants in the banking system at time t only start competing in the chosen niche at time $t+1$. This introduces a one-period time-to-build lag in the model. Right after the entry decision is taken (i.e. sunk costs are incurred in t), the entrant is placed inside the banking system, but only at the "wholesale level". The aim of this is to capture the evidence of entry taking place in the wholesale market first, with the ultimate goal of spreading to the retail segment (niches).[12]

A detailed explanation of the entry stages can be found in Appendix B, which demonstrates some important results. Established incumbents cannot avoid entry (unless government regulation prohibits it). Once the entrant is inside the niche, 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 only visible outcome is the possible change of the niches's incumbent at the very beginning of $t+1$. In these circumstances, low cost-efficiency incumbents have the incentive to "signal" the idiosyncractic efficiency to new entrants by offering a low markup to influence and redirect entrants' decisions towards less efficient

[12] 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.

niches (see Milgrom and Roberts, 1982, for details). That is, entrants in the banking system know that only more efficient incumbents can offer a low markup and still make profits. In this scenario, incumbents are forced to "compete", and offer low markups to deter entry in their own niches. However, Appendix B shows that there exists a collusion level among the incumbents that enforces the secrecy of the idiosyncratic cost-efficiency levels. This arrangement consists of a markup such that:

$$E_t \left\{ \Lambda_{t,1} \left[\Xi_{t+1}(1+i_t) \left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n} \right) \right] \right\} - \lambda \varepsilon_t^{oc} \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} = 0. \tag{7}$$

Incumbents are better off when committing to this collusive level. As in Athey et al (2004), a rigid-price scheme (i.e. where firms' optimal collusive price is independent of their idiosyncratic cost) diminishes the informational costs derived. 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.

The limit pricing strategy embedded in equation (7) can be interpreted as follows: The greater the aggregate investment (and the amount of credit provided), the bigger the size of all niches, and the higher the competitive pressure of the new entrants. This forces incumbents to offer lower markups.

A larger τ implies larger economies of scale, higher probability of outsiders operating at an efficient scale in a booming economy, and therefore, stronger countercyclicality of the bank markups. As in Rotemberg and Saloner (1986), the sustainable collusive pricing level increases (decreases) during recessions (booms). These countercyclical markups, jointly with the standard balance-sheet channel, constitute the "broad" financial accelerator at work in equation (4). Relative to the standard balance-sheet channel, this "broad" accelerator magnifies the propagation and amplification of shocks to the economy.

3.4 The Foreign Sector

The small open economy takes all foreign variables as given. I use a very simple foreign demand for the domestic tradable, or exports, C_t^{H*} with an inertia component given by $\left[C_{t-1}^{H*}\right]^{1-\varpi}$. Following Gertler et al (2007), I postulate an empirically sensible reduced-form export demand curve: $C_t^{H*} = \left[\left(\frac{\varepsilon_t^{H^*} P_t^H}{S_t P_t^*} \right)^{-\chi} Y_t^* \right]^{\varpi} \left[C_{t-1}^{H*}\right]^{1-\varpi}$, $0 \leq \varpi \leq 1$. 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 $C_{H^*,ss}/Y_{ss} = M_{ss}/Y_{ss}$, where $M = C^F + I^F$. I normalize the steady-state terms of trade at unity. $\varepsilon_t^{H^*}$ is a foreign demand shock.

3.5 The Resource Constraint

The resource constraint for the domestic traded good sector is: $Y_t^H = C_t^H + C_t^e + C_t^{H*} + I_t^H$.

3.6 Monetary Policy Rule

I 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.

$$S_t = \bar{S}, \tag{8}$$

for all t. With the description of the monetary policy, the specification of the model is complete. When I restrict the net financial markup, Ξ_{t+1}, to zero in (4), I 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 channel). Similarly, this last channel may be turned off by restricting $\psi_t(.)$ to one in (4).

3.7 Shock processes

The structural shocks are assumed to follow a $AR(1)$ process with an i.i.d. normal error term: $\varepsilon_{t+1}^{\hat{\imath}} = \epsilon_0(\varepsilon_t^{\hat{\imath}})^{\rho_i} \exp(\eta_{\hat{\imath},t+1})$, $0 < \rho_{\hat{\imath}} < 0$, $\eta_{\hat{\imath}} \sim N(0, \sigma_{\hat{\imath}})$, where $\hat{\imath} = \{b, i^*, a, fp, I, \xi, F^*, oc, H^*\}$

4 Data

The number of data series cannot exceed the number of structural shocks in the model, therefore I use data for Argentina over the period 1994Q1 to 2001Q3 on nine key macroeconomic and financial variables: real GDP, real consumption, real investment, consumer price index, real exports, real imports, foreign interest rate of reference (EMBI+ index), net interest margin, and the risk premium.[13] By law, the Argentine currency board pegged the peso to the US dollar in the period under consideration.[14] The ex-ante bank interest spread is defined as the difference between lending and deposit rates.[15] Net interest margins is defined as the net interest income over total banks' assets, obtained from the system banks' balance sheets. In the model, the spread has two components: the premium aimed to cover expected bankruptcy costs (risk premium) and the bank markup (interest margin). The risk premium is thus the difference between the posted spread and the banks' net interest margins. Refer to equation (4), for further details.

[13] The original source for real variables and the CPI index is Ministerio de Economía (ME y OSP). JP Morgan is the source for the EMBI+ index. Banking data is from Banco Central de la República Argentina (BCRA).

[14] It is reasonable to believe that the probability that Argentina would abandon the currency board during this period was very low. It is less certain whether same conclusion applies in the months preceding the financial crisis that began in December 2001.

[15] In the calculations, the deposit rate is the rate paid on 30-day certificates of deposit. The loan rate is the system average rate charged on free-allocated operations.

Real variables are linearly detrended and transformed in $\Delta \ln$ to be expressed in growth rates.[16] Since financial innovation, market deregulation, and the technological improvements in monitoring activities most likely changed their average levels, the same detrending procedure is applied to the interest margin and risk premium. The vector with observed variables is defined as:

$$Z_t = \left[\Delta \ln Y_t^H \quad \Delta \ln C_t \quad \Delta \ln I_t \quad \pi_t \quad \Delta \ln C_t^{H*} \quad \Delta \ln M_t \quad R_t^* \quad \Delta \ln(1 + \Xi_{t+1}) \quad \Delta \ln \psi_t\right]$$

The thick line in Figure 1, depicts the data we match with this model.

5 The Bayesian Estimation

The Bayesian estimation technique uses a general equilibrium approach that addresses the identification problems of reduced-form models. This is of particular interest, given the interaction between the "broad" financial accelerator and the macroeconomy, and the feedback between the balance-sheet and the bank-supply channel. Essentially, the estimation procedure boils down to combining the prior information from the model (given by the specified prior distributions for the parameters), with the information that comes from the data as summarized in the likelihood function of the time series. The posterior density of the parameters is then used to draw statistical inference on the parameters. The marginal likelihood serves to compare the empirical performance of different model specifications.[17]

Calibration Some parameters are kept fixed throughout the calculations. This can be seen as a prior that is extremely precise. Table 1 reports the calibrated parameters and resulting steady-state values. The quarterly discount factor β is set at 0.99. I assign a relatively high value for the capital share, $\alpha = 0.40$ and fix the steady-state quarterly depreciation, $\delta(u_{ss})$, at 0.025. These values reflect the calibrated values used for Argentina in Kydland and Zarazaga (2002). I use this method since I do not have accurate estimates of the capital stock, but regardless, these parameters cannot be accurately estimated unless I take the absolute values of the time series in the calculations. As in Altug (1989) and Ireland (2004), I find this strategy necessary to produce good estimates of real business cycle models. Other values are calibrated to address identification issues. High estimated values of σ_ξ and a relative low inflation volatility are consistent with an underestimated value of θ. See Rabanal and Rubio-Ramírez (2005) for details. Since I do not have strong prior information about the standard deviation of innovations, I fix this parameter to a value standard in the literature. I follow Gertler et al (2007) and set the probability of the price not adjusting, θ, at 0.75 and

[16] Traditional HP-filtering may result in spurious cycles in the data which can affect the estimates (See Cogley and Nason, 1995, for details).

[17] Appendix C provides further details of this methodology.

fix the steady-state markup in the tradable goods markets at 1.2.

Some of the parameters can be linked to these steady-state values of observed variables and are calibrated so as to roughly match their sample mean. Specifically, I fix the quarterly steady-state annual value of the bank gross interest margin and risk premium to reflect historical values. The steady-state ratio of investment to output is 0.15, and the ratio of exports to domestic output is set equal to 0.24. I assume that the share of domestic goods in the consumption and investment tradable composites, γ_C and γ_I are 0.8 and 0.6 respectively. The elasticity of Φ_t with respect to $-B_t^*$ is set at 0.01. Finally, I set the entrepreneurial labor share of the total wage bill at 0.01, the steady-state ratio of C_e/Y^H at 0.005 and the entrepreneurial death rate $(1-\zeta)$ at 0.272.

Prior Distributions The remaining parameters are estimated. Figure 2 depicts the prior density (grey line) of the parameters to be estimated. The first five columns of Table 2 present the mean and standard deviation of the prior distributions, together with their respective density. As in Smets and Wouters (2007), the stochastic processes are harmonized. The variances of the shocks are assumed to possess an Inverse Gamma distribution with a degree of freedom equal to 2 and a mean of 0.01. This distribution delivers a positive variance with a rather large domain. The autoregressive parameters in the shocks are assumed to follow a Beta distribution that covers the range between 0 and 1. As standard in the Bayesian estimation literature, I select a rather strict standard error (i.e. a precise prior mean) in order to obtain a clear separation between persistent and non-persistent shocks. The distribution is centered at 0.8 with a standard error equal to 0.1.

For clarity in the argument, I report the estimate of the additive inverse of τ so that a positive value of estimated $-\tau$ reflects procyclicality of the bank markup, and a negative one countercyclicality. This key parameter is theoretically restricted to the interval $[-1, 0]$. However, I do not want to discard, *a priori,* the possibility of a procyclical bank markup (i.e. the possibility that $-\tau$ is positive). Therefore, for estimation purposes, I assume it possesses a normal distribution that comprises all real numbers. To obtain a clear identification of the two components of the external finance premium, I choose an uninformative prior centered at zero across a wide range of possible values for $-\tau$, and a precise prior with a Beta distribution for the elasticity of the risk premium with respect to the leverage ratio, $\eta = -\frac{\psi'(D/N)}{\psi(D/N)}\frac{D}{N}$. The prior for η is centered at -0.051, as in Bernanke et al (1999). The standard error for this parameter is relatively small, 0.01, but high enough to capture the range of estimates in the literature. The prior for the inverse of the Frisch intertemporal elasticity of substitution in the labor supply, γ_n, is centered at 0.35, a value typically used in the macro literature. I mimic Gertler et al (2007) and fix the intratemporal elasticity of substitution for the investment composite, ρ_I, at 0.25. Since consumption goods are thought to have a higher degree of substitution than intermediate or investment goods, I set the prior for the intratemporal elasticity of substitution, ρ_C, at 0.50. Regarding the parameters of the reduced-form export demand function , I center the prior for the elasticity, χ, equal to 0.3 and the inertia parameter, ϖ, equal to 0.25, which is the same value used in Gertler et al (2007). I assume a relatively low prior for the price indexation coefficients, ι_F and ι_H, which are fixed at 0.25. The prior for Γ, which represents the elasticity of marginal depreciation with respect to the utilization rate, $\frac{u\delta''(u)}{\delta'(u)}$, is set equal to 1, consistent with Baxter and Farr (2001).

There is no consensus in the literature about the value of φ, which is the elasticity of the price of capital with respect to the investment capital ratio. Given that this value typically lies between 0 and 2, I presuppose a loose prior that is centered at 1. I also adopt a lax prior for the elasticity of intertemporal substitution, $\frac{1}{\gamma}$, which is centered at 1 (i.e. nesting the case of log utility).[18]

Estimation results (posterior distributions) The last five columns of Table 2 report the posterior mean, mode, standard deviation (obtained from the inverse Hessian) along with the 90% probability interval of the structural parameters. Figure 2 shows the posterior density (black line) and mode (from the numerical optimization of the posterior kernel). It should be highlighted that I obtain a sizeable value for the posterior mode of $-\tau$, equal to -0.76 (despite the agnostic prior) confirming the countercyclical bank markup assumption.[19] The specified priors were fairly informative apart from a few exceptions. The posterior modes of $\gamma_n, \gamma, \varphi, \eta$ are $0.38, 0.83, 0.77, -0.05$ respectively. I also find that the posterior of $\chi = 0.54$, is significantly higher than the prior, reflecting a high sensitivity of exports to the terms of trade. The intratemporal elasticity of substitution of consumption goods is significantly higher ($\rho_C = 0.72$), probably reflecting a lower weight of nontradables in households preferences. Finally, I obtain a significantly low degree of inflation inertia, with ι_H, ι_F equal to 0.16 and 0.15, respectively. From Figure 2, it appears that the model is unable to properly identify Γ, which is likely a consequence of not having capacity utilization as an observable variable.

Regarding the stochastic processes, results indicate that the neutral technology shock is highly persistent ($\rho_a = 0.99$), which is in line with the estimates in Ireland (2004) and Smets and Wouters (2003). On the contrary, the low persistence of the autoregressive parameter for the foreign interest rate of reference ($\rho_{i^*} = 0.75$) reflects the volatile EMBI, likely the result of successive financial crisis episodes in Mexico, East Asia, Russia and Brazil.

[18] Appendix D checks the sensitivity of the results by increasing the prior standard deviation on the model's structural parameters and the persistence of the shocks.

[19] I obtain similar results if I limit the prior to the bounded interval [-1,0]. For instance, when I impose a uniform prior distribution $U(-1, 0)$, the posterior mode is -0.77.

Model Fit Figure 1 reports the data and benchmark model's Kalman filtered one-sided estimates computed at the posterior. The model fit appears to be satisfactory. To further assess the model adequacy, I conduct a posterior predictive analysis where the actual data are compared to artificial time series generated from the estimated benchmark DSGE model. As in Adolfson et al (2007), I compare vector autocovariance functions in the model and the data as well as unconditional second order moments. The vector autocovariance functions are computed by estimating an unrestricted VAR model on the Argentinean data for the period under consideration. I include the following six variables in the VAR: R_t^*, $\Delta \ln(1 + \Xi_{t+1})$, $\Delta \ln C_t$, $\Delta \ln I_t$, $\Delta \ln Y_t^H$, π_t.[20] Figure 3 displays the median vector autocovariance function from the DSGE specification (thin line) along with the 2.5 and 97.5 percentiles (dotted lines) for the mentioned subset of variables.[21]

The posterior intervals for the vector autocovariance functions are wide. This, in part, reflects sample uncertainty, which is the result of using relatively few observations in the computations. Nonetheless, in general the data covariances (thick lines) fall within the error bands, suggesting that the model is somewhat able to mimic the cross-variances in the data. In particular, the model replicates the bank markup cyclical dynamics significantly well. Consistent with the evidence in Neumeyer and Perri (2005), interest rates are also countercyclical and lead the cycle in both the model and the data. In addition, higher foreign interest rates preceed higher bank markups, thus contributing to higher borrowing costs during recessions. Although the model predicts reasonably well the contemporaneous (co)variances of real variables, it clearly fails to generate persistent sequences. Contrary to the data, the model generated sequence (thin line) rapidly falls and reach values in the neighborhood of zero in the diagonal elements. But the model does accurately predict inflation persistence.

Table 3 reports unconditional moments for the actual data, and Table 4 reports the median (along the 5th and 95th percentiles) from the simulated distribution of moments using the samples generated with parameters draws from the posterior distributions. Overall, the conclusions from the autocovariance functions are in line with those from the unconditional moments.

The model succeeds in accounting for the absolute and relative standard deviation of the bank markup (interest margins) as well as its countercyclical pattern, and accurately matches the relative standard deviation of real variables. In particular, investment and consumption are significantly more volatile than output, which constitutes a characteristic evidence of emerging economies (See Aguiar and Gopinath, 2007). The model overestimates to certain extent the unconditional variance of domestic real variables and fails to de-

[20] I draw 3000 parameter combinations from the posterior distribution and simulate 3000 artificial data sets of the same length than the Argentinean one. Then I use the 3000 data sets to estimate vector autocovariance functions using the same VAR specification applied on the actual Argentinean data.

[21] I use only one lag in the estimated VAR. Notice that unfortunately the data set includes very few observations (1994Q1 to 2001Q3) and adding an additional lag would significantly reduce the degrees of freedom in the estimation.

liver any persistence in their dynamics (the resulting autocorrelation coefficients are either not significantly different than zero, or even negative). These results are in line with García-Cicco et al (2006) who obtain similar autocorrelation coefficients when they estimate a small open economy RBC model with Argentinean data. On the contrary, the model significantly overpredicts the volatility of CPI inflation, but successfully predicts its persistence. The model also does a good job matching the volatility of imports and exports, and the persistence of the latter.[22]

6 The Role of Financial Frictions

Table 5 reports counterfactual moments which are obtained by using the posterior median of the estimated parameters, turning off one financial friction every time: Benchmark model, only the standard balance-sheet-effect added, only monopolistic banking sector added, baseline small open economy (SOE) model with no financial frictions.[23] Results of the complete model with the "broad" financial accelerator acting on the entrepreneurs capital acquisition are best at matching the relative standard deviation of investment with respect to output. While the SOE setup predicts a relative standard deviation of 1.34, the benchmark model predicts 1.72, closer to 2.47 which is the number for the actual data. The benchmark model also delivers a higher relative consumption volatility.

Table 6 reports estimated parameters for each of the counterfactual scenarios. When I turn-off the balance sheet channel I obtain an estimated value of $-\tau$ equal to -1.56. This is significantly higher (in absolute value) than the value in the benchmark model. This suggests that the data force the model to overestimate the countercyclicality of bank markups when the balance-sheet channel is supressed. Similarly, the risk premium elasticity, η, seems to be overestimated when the bank-supply channel is muted, while the estimate of the elasticity of the price of capital with respect to the investment capital ratio, φ, needs to be relatively low to fit better the data when none of the channels are included. The marginal likelihood may be interpreted as a summary statistic to assess the model's out-of-sample performance. The (log) Bayes Factor is directly related to the predicted density of each model and is computed as the difference of the log marginal likelihood of each specification. Here I consider the Laplace approximation (Gaussian) based on the numerical optimization of the posterior mode. For robustness I also report the Modified Harmonic Mean estimator (Geweke, 1999), which nonetheless provides similar outcomes. See appendix C.2 for technical details. The log marginal likelihood difference between the complete (benchmark) model and the standard

[22] The modeling of CPI inflation and real exports includes *ad-hoc* artifacts that introduce inertia in their evolution and, as a result, address better their documented persistence. Additional sources of variable persistence, like habit formation may improve the predictive performance of these type of models.

[23] Notice that unconditional moments in Table 4 and 5 are slightly different. The first table reports the median from the simulated distribution of moments using samples generated with parameter draws of the posterior distribution, while the second simulates the model using the posterior median of the estimated parameters.

SOE setup is 306.11. In addition, the data favor the richer model with the "broad" financial accelerator included. The difference between the model that takes into account only the bank-supply channel and the complete model is 133.73. Similarly, the difference between the model that includes only the balance-sheet channel and the complete model is 171.28. Even when penalizing for overparametrization, in order to choose the model that includes only the balance-sheet channel over the model with the "broad" financial accelerator included, the Bayes factor requires a prior probability over the first exp(171.28) times larger than over the complete model. A difference that can be regarded as sizable (See Rabanal and Rubio-Ramírez, 2005, for an explanation). Nonetheless, these differences can only be interpreted as weak evidence in favor of one model over the other as, by definition, the standard model cannot explain bank specific variables.[24]

7 Impulse Response Functions

Figures 4-7 report the impulse response functions to several shocks at the posterior median of the estimated parameters (one standard deviation increase).[25] I focus on three counterfactual scenarios: the baseline SOE model with nominal rigidities, the same model with only the bank-supply channel included, and the complete model which also adds the balance-sheet channel to the external finance premium. For consistency across the experiments, I assume that all shocks persist at a rate of 0.95 quarter and, with the exception of those parameters characterizing each of the channels (i.e. τ and η), all the remaining parameters maintain the same estimated values obtained for the complete model.[26]

Figure 4(a) plots the response to a foreign interest rate shock. With fixed exchange rates, the domestic nominal interest rate rises to match the increase in the foreign interest rate so that the interest parity condition holds. Due to nominal price rigidities, there is also a significant increase in the real interest rate which, in turn, induces a contraction in output. While foreign goods prices remain unaffected, the fall in the demand for domestic goods causes domestic prices to fall. The economy enters a deflationary spiral (CPI inflation is depicted), with lower capital utilization and employment, 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 and lower assets prices damages the financial position of firms. Hence, immediately after the shock, the conventional balance-sheet channel starts working. Even if the nominal exchange rate does not change in this experiment, the economy improves its international position

[24] That is, an increase in the marginal likelihood could also be the result of an improvement in the fit of financial variables.

[25] Figure 11 displays impulse response functions of the estimated model (median and 10th, 90th percentiles) for all the shocks.

[26] For instance, when I force the risk premium and bank markup to remain constant, estimation results indicate that the price elasticity of capital demand, φ, is significantly lower than the one estimated for the complete model (0.4931 rather than 0.7723). A lower φ reflects a stronger reaction of investment to a change in borrowing costs. Such a low value is needed to match the high volatility of investment in the data when the external finance premium is forced to be muted.

(with higher exports and greater import substitution) as a result of the local recession and the deflationary environment. With monopolistic competition in the banking sector, the amplification mechanism is even stronger. 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. When compared with the model that only includes the conventional financial accelerator, the banking channel further increases the external finance premium and amplifies the negative response of investment (refer to Figure 4(b)).

Figure 5 displays the response to a shock to the discount rate factor that increases consumption on impact. In the baseline SOE model, this increase in aggregate demand results in higher inflation, which lowers the real interest rate. The bank-supply channel leads to lower bank markups and amplifies the response of investment. The increase in investment is further enhanced when the balance-sheet channel is added in the complete model. As the economy expands and asset prices increase, firms' external finance premia fall to a greater extent. In turn, as the financial market expands, the decline in the bank markup is reinforced when both channels interact. Notice, however, that the inclusion of the balance-sheet channel slightly dampens the response of output to this shock. The resulting investment boom coexists with sizable increase in asset prices, which discourages the costly capital utilization that erodes firms' assets. Consequently, the relatively lower capital utilization reduces the amplitude of the output expansion.

Figure 6 depicts the impulse response to a foreign demand shock. In general, the results are similar to those characterizing the domestic demand innovation described above. In this case, the increase in the cost of capital utilization dampens the increase in investment when the bank-supply channel is included. However, when both financial channels are considered, the decrease in external finance costs surpasses the increase in the utilization costs and the increase in investment is actually more robust.

Finally, Figure 7 portrays the response to a neutral technology shock. As is standard in SOE models with fixed exchange rate regimes, a positive shock to technology results in an initial drop in output (See Dam and Linaa, 2005, for details). Namely, a better technology triggers lower prices for domestic goods. Since the domestic interest rate is tied to the foreign rate, this deflationary pressure leads to an increase in the real interest rate. Households react by postponing consumption and investment, thus negatively affecting output upon immediate impact. As the deflationary pressure recedes, the real rate returns to trend and output expands. When this happens, the financial market expands and bank markups decrease. Nonetheless, a relatively high real interest rate drives asset prices lower, negatively affecting firms' balance sheets. Overall, the external finance premium is higher despite the lower bank markups. As a consequence, both financial channels move in the opposite directions in the short run. However, as discussed in the previous section, technology innovations are only relevant to explain long run dynamics.

Flexible Exchange Rates From a normative perspective, and as a sensitivity analysis, I consider a counterfactual scenario in which the central bank is able to credibly commit to a Taylor rule. In this case, the policy instrument is the nominal interest rate. The central bank adopts a flexible inflation target 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:

$$(1+i_t) = (1+r)\left(\frac{P_t}{P_{t-1}}\right)^{\gamma_\pi}\left(\frac{Y_t^H}{Y^0}\right)^{\gamma_y}, \tag{9}$$

with $\gamma_\pi > 1$ and $\gamma_y > 0$, and where $(1+r)$ is the steady-state gross real interest rate. Notice that the monetary policy rule in equation (9) replaces the original formulation in equation (8). 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. For the policy experiment, 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.

In Figure 8, I consider both the standard SOE model (dotted line), the same model with the conventional balance-sheet channel included (thin-solid line) and the complete model (thick-solid). 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 (9). The rise in the foreign interest rate produces an immediate depreciation in the domestic currency (i.e. S_t increases) which in turn prompts an increase in the foreign demand for domestic 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 moderate change in the real interest rate. Moderate 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 small and the external finance premium wholesalers face is not sizable. 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.[27]

[27] The eslasticity of substitution for the investment good is relatively low. Therefore it becomes significantly more expensive

Therefore, the standard financial accelerator fails to deliver any amplification and propagation mechanism in this context. Existent models are forced to include liabilities mostly denominated in foreign currency to improve upon their empirical performance. The results are different, however, if we also recognize the presence of monopoly power in the banking system. 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. To ameliorate the negative impact these events have on domestic output, the central bank responds less aggressively when increasing the interest rates.

8 Historical and Variance Decompositions

Table 7 displays the forecast error variance decomposition of real variables (consumption, investment, output, exports, imports), as well as CPI inflation at various horizons based on the mode of the benchmark model's posterior distribution. In the very short run, movements in domestic output are primarily driven by foreign interest rate shocks, which account for almost 30 percent of the forecast error variance. Productivity accounts for most of the output variation in the medium to long-run horizon (in line with documented evidence in Smets and Wouters, 2003, 2007). Consumption and investment register a similar pattern.

In addition, foreign demand and terms of trade shocks explain a significant variation on most variables, highlighting the importance of foreign determined variables driving the dynamics of the Argentinean business cycle. Across all horizons, inflation is determined for the most part, by three shocks: terms of trade, productivity and cost-push. Cost-push shocks also play a decisive role in explaining the fluctuation of real variables in the medium run. Notably, specific banking system exogenous innovations (i.e. risk premium and bank operation costs) play a limited role in explaining the cyclical dynamics of these variables, may be emphasizing the role of financial frictions acting as an internal propagation mechanism (as proposed in this paper).

Figure 9 shows the historical contribution of five types of shocks (productivity, borrowing, demand, cost push and trade) to growth over the sample period.[28]It is useful to put this analysis in context. The evidence suggests that the Mexican crisis, known as the Tequila effect was, to a certain extent, inherited by Argentina.

after the depreciation of the local currency.

[28]Productivity shocks include neutral technology and investment specific, borrowing costs include (foreign interest rate, idiosyncratic risk premium, bank operating), the demand shock is the discount factor shock, and trade include both the terms of trade and the foreign demand shocks.

Massive capital flight along with a sharp increase in the EMBI followed this episode and served as a prelude of a deterioration of economic activity during 1995. By early 1996, a rapid decline of the EMBI signaled the end of the financial panic episode, and the economy witnessed a robust economic recovery until 1998. This benign scenario changed dramatically after the successive financial crisis in East Asia, Russia and Brazil. Followed by this were capital outflows and the EMBI increased to remain at a relative high level. These events triggered a long lasting recession beginning in 1998, which deepened in 2001.

Recent papers have emphasized that frequent sharp declines in measured productivity are a robust characteristic of emerging economies, raising the possibility that productivity (technology) shocks may be the true underlying cause (see, for instance, Aguiar and Gopinath, 2007). However, the evidence shows that capacity utilization falls sharply during economic downturns (Gertler et al, 2007). Therefore, the drop in productivity may reflect mismeasurement of capital input utilization and not necessarily a true shift in productivity. The historical decomposition is consistent with this evidence. Namely, sizable shocks affecting the interest rate (borrowing costs) seem to lead the economic downturn of 1995, 1998 and 2001. This supports the hypothesis stating that business cycles are driven by "sudden stops" in capital inflows, being the financial disturbances propagated by the financial frictions, discussed in this paper. It can also be observed that shocks affecting the international position of trade also help to explain this downturn. In general, these shocks explain most of the variability of exports, but are not crucial to explain the historical decomposition of imports. Finally, inflation is relatively low and its evolution can be explained by the shocks described above.

9 Conclusions

The modeling of the banking system captures several features of the empirical evidence observed in emerging economies. Entry occurs at the wholesale level with the intention to later spread into a highly segmented retail market, where banks have a cost-efficiency advantage given their proximity to costumers. Entry threats force the incumbents to set lower markups to deter 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 banking system behavior generates a bank-supply channel which interacts with the evolution of the firms' balance sheets to reinforce the credit channel: credit is more expensive during recessions, so 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 and amplifies the business cycle.

There are several extensions of the analysis that can be pursued in future work. The model could be easily modified to study the impact of currency depreciation when liabilities are heavily denominated in foreign currency. It could serve to measure the impact of financial development in the magnitude of the business cycle. It may also be extended to a two-country setup to study the role of foreign bank penetration in the transmission of the international business cycle.[29]

A Appendix-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 (1999).

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 monopolistic return on lending for the bank equals the cost of funds (deposit rate), $R = 1 + i$, 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 monopolistic return $(1 + \Xi)R$, implying:

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

The optimal contract maximizes the payoff to the entrepreneur subject to the bank earning the monopolistic rate of return. Given constant returns to scale, the cutoff $\bar{\omega}$ determines the division of expected gross profits $R^k QK$ between the bank and borrower. The expected gross share of profits going to the bank, $\Gamma(\bar{\omega})$, is: $\Gamma(\bar{\omega}) \equiv \int_0^{\bar{\omega}} \omega f(\omega)d\omega + \bar{\omega}\int_{\bar{\omega}}^{\infty} \omega f(\omega)d\omega$. Similarly, I define the expected monitoring costs , $\mu G(\bar{\omega})$ as: $\mu G(\bar{\omega}) \equiv \mu\int_0^{\bar{\omega}} \omega f(\omega)d\omega$. 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 $0 \leq \Gamma(\bar{\omega}) \leq 1$.

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. The first order conditions for an interior solution to the contracting problem imply

[29] For an interesting discussion, see Goldberg (2006).

that: $s(\bar{\omega}) \equiv \frac{\iota(\bar{\omega})}{\Upsilon(\bar{\omega})}, k(\bar{\omega}) \equiv \frac{\Upsilon(\bar{\omega})}{1-\Gamma(\bar{\omega})}$, and $\iota(\bar{\omega}) \equiv \frac{\Gamma'(\bar{\omega})}{\Gamma'(\bar{\omega})-\mu G'(\bar{\omega})}$. Where: $\Upsilon(\bar{\omega}) = 1 - \Gamma(\bar{\omega}) + \iota(\bar{\omega})\left[\Gamma(\bar{\omega}) - \mu G(\bar{\omega})\right].$ Defining ι as the Lagrange multiplier on the constraint that the banks earn their monopolistic rate of return in expectation.

These equations provide an implicit relationship between capital expenditures per unit of net worth $k(\bar{\omega})$ and the risk premium on external funds: $k(\bar{\omega}) = \kappa(s(\bar{\omega}));\ \kappa'(s) > 0$. Notice, finally, that the set up of this contracting problem allows us to express V_t in equation (5) as:

$$V_t = R_t^k Q_{t-1} K_{t-1} - \left[R_t(1+\Xi_t)\frac{D_t}{P_{t-1}} + \mu \int_0^{\bar{\omega}} \omega R_t^k Q_{t-1} K_{t-1} f(\omega) d\omega \right]. \tag{A.2}$$

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.

B Appendix-Entry Stages and Limit Pricing

B.1. Entry Stages The entry stages (shown in Figure 10) 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 in the 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.[30] 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 each is finally established in only one of them. The cost of serving other niches at the wholesale level is: $\lambda \varepsilon_t^{oc} \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau}$, where $\lambda \geq \upsilon_l$ for every l, given the common uniform distribution $U(\upsilon)$ with support on $[0, \lambda]$. As previously explained, ε_t^{oc} is an aggregate operating cost shock. I assume that retail banks that are physically closer to their customers have lower costs of transacting with both firms

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

and depositors. As discussed in Petersen and Rajan (1994), banks with local presence are considered to have "soft information" with an operating advantage of assessing the creditworthiness of small or informatively opaque firms.

(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 described later 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. Therefore entrants are indifferent about which 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 $t+1$.*[31]

Proof. See B.4.

(G) If successful, the new incumbent keeps the niche until it is hit by an exit-inducing shock that occurs right before the transaction with costumers takes place, 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.

B.2. Implicit Collusion Agreement and Limit Pricing By assumption, entrants are unable to learn about the cost-efficiency of the incumbents when serving at a distance.[32] In these circumstances, the incumbents' pricing strategy, Ξ_{t+1}, must ensure that none of the new competitors at the wholesale level can obtain any expected positive profits in the case that they decide to offer a net markup below Ξ_{t+1} and serve the niche.[33] That is:

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

[32] This assumption is supported by the evidence in the "commercial-lending-distance" literature. See for instance, Agarwal and Hauswald (2007).

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

$$E_t\left\{\Lambda_{t,1}\left[\Xi_{t+1}(1+i_t)\left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n}\right)\right]\right\}-\lambda\varepsilon_t^{oc}\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right)^{1-\tau}\leq 0. \tag{B.1}$$

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 (B.1) hold as an equality (hereafter, the binding limit). Entrants in the banking system know that only more efficient incumbents can offer a markup, Ξ_{t+1}, well below $\lambda\varepsilon_t^{oc}\left(\frac{D_{t+1}}{P_t}/n\right)^{-\tau}$ and still make profits. Therefore, these incumbents have incentives to offer markups levels somewhat below the binding limit in (B.1) to influence and redirect entrants' decisions toward less-efficient niches. The higher 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. As in Athey et al (2004), I assume instead that there exists an implicit collusion agreement among the incumbents that enforces the secrecy of the idiosyncratic cost-efficiency levels. I also assume that any implicit collusion agreement must necessarily satisfy all incumbents in order to be possible.[34] Consequently, a cartel markup below the binding limit in (B.1) does not work. The uniform distribution with support on $[0,\lambda]$ and the assumption that n is very large imply 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 the defectors. Therefore, the arrangement must consist of a markup equal to the binding limit in (B.1):

$$E_t\left\{\Lambda_{t,1}\left[\Xi_{t+1}(1+i_t)\left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n}\right)\right]\right\}-\lambda\varepsilon_t^{oc}\left(\frac{\frac{D_{t+1}}{P_t}}{n}\right)^{1-\tau}=0. \tag{B.2}$$

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 one chosen by the defector, $\Xi_{t+1}^{def}-\varepsilon$ (ε is negligible in size). The resulting expected negative profits for serving the niche under this condition are equally distributed among the members of the cartel.[35] That is,

$$\frac{E_t\left\{\Lambda_{t,1}\left[\left(\Xi_{t+1}^{def}-\varepsilon\right)(1+i_t)\left(\frac{D_{t+1}}{P_{t+1}}/n\right)\right]\right\}-\lambda\varepsilon_t^{oc}\left(\frac{D_{t+1}}{P_t}/n\right)^{1-\tau}}{n-1}<0. \tag{B.3}$$

I assume that, in principle, such punishment would take place only if there is a single monopolistic bank

[34] I assume that a single defector can transform the tacit agreement into an explicit one.

[35] Support for this assumption can be found in Ahaldeff (1980) survey on branch-system predatory practices. In addition, in a study on the German Banking Industry, Krahnen (2005) considers that independent regional savings banks engage in "regional associations" which in practice end up acting as single entities. Some of these savings banks had negative margins, and competitors claim that such losses were the result of predatory pricing tolerated by the associations' auditors.

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 (B.2).

Hence, expected profits, π_t, for each incumbent, l, for transactions taking place in t are:

$$\pi_{l,t} = E_t \left\{ \Lambda_{t,1} \left[\Xi_{t+1}(1+i_t) \left(\frac{\frac{D_{t+1}}{P_{t+1}}}{n} \right) \right] \right\} - \upsilon_l \varepsilon_t^{oc} \left(\frac{\frac{D_{t+1}}{P_t}}{n} \right)^{1-\tau} > 0. \tag{B.4}$$

B.3. 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, $V_{j,t}$, is positive:

$$V_{j,t} = E_t \left\{ \sum_{s=t+2}^{\infty} \Lambda_{s,e} \left[\Xi_s(1+i_{s-1}) \left(\frac{\frac{D_s}{P_s}}{n} \right) \right] - \sum_{s=t+2}^{\infty} \Lambda_{s-1,e} \left[\upsilon_l \left(\frac{\frac{D_s}{P_{s-1}}}{n} \right)^{1-\tau} \right] \right\} \left(1 - \frac{\upsilon_j}{\lambda} \right) - m_t > 0. \tag{B.5}$$

Where $\Lambda_{s,e} = [\beta (1-\delta_D)]^{s-t} \frac{\varsigma_s}{\varsigma_t}$. 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 (B.5) and (B.4) imply that entry is procyclical (i.e. entry increases when the amount of credit, purchase of new capital, and 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.[36] Equation (B.5) implies that the higher 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 m_t, the more likely entries are to be 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.

B.4. Proof of Proposition 1. Define the break-even level of markups θ_l and θ_j for the incumbent and the entrant as the value of the net markup that provides zero expected profits when serving the niche.

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

That is, $\pi_{l,t} = 0$, and $\pi_{j,t} = 0$, respectively. 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 it 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 $\upsilon_j < \upsilon_l$.■

C Appendix-Bayesian Estimation Methodology

C.1. Estimation Methodology In this section I briefly explain the estimation approach used in this paper. A more informative description of these methods can be found in Lubik and Schorfheide (2005), Justiniano and Preston (2006), Schorfheide (2000) among others. Let's define Θ as the parameter space of the DSGE model, and $Z^T = \{z_t\}_{t=1}^T$ as the data observed. From their joint probability distribution $P(Z^T, \Theta)$ we can derive a relationship between their marginal $P(\Theta)$ and conditional distribution $P(Z^T|\Theta)$ known as the Bayes theorem: $P(\Theta|Z^T) \propto P(Z^T|\Theta)P(\Theta)$. The method updates the *a priori* distribution using the likelihood contained in the data to obtain the conditional posterior distribution of the structural parameters. The posterior density $P(\Theta|Z^T)$ is used to draw statistical inference on the parameter space Θ. Combining the state-form representation implied by the solution of the linear rational expectation model and the Kalman filter, we can compute the likelihood function. The likelihood and the prior permit a computation of the posterior that can be used as the starting value of the random walk version of the Metropolis algorithm, which is a Monte Carlo method used to generate draws from the posterior distribution of the parameters. In this case, the results reported are based on 500,000 draws of such algorithm. The jump distribution is chosen to be a normal one with covariance matrix equal to the Hessian of the posterior density evaluated at the maximum. The scale factor is chosen in order to deliver an acceptance rate between 20 and 30 percent depending on the run of the algorithm. Measures of uncertainty follow from the percentiles of the draws.

C.2. Empirical Performance Define the marginal likelihood of a model A as follows: $M_A = \int_\Theta P(\Theta|A)P(Z^T|\Theta, A)d\Theta$. Where $P(\Theta|A)$ is the prior density for model A, and $P(Z^T|\Theta, A)$ is the likelihood function of the observable data, conditional on the parameter space Θ and the model A. The Bayes factor between two models A and B is the defined as: $\mathcal{F}_{AB} = M_A/M_B$.[37] The marginal likelihood of a model (or the Bayes factor) is directly related to the predicted density of the model given by: $\hat{p}_{T+1}^{T+m} = \int_{\Theta} P(\Theta|Z^T, A) \prod_{t=T+1}^{T+m} P(z_t|Z^T, \Theta, A) d\Theta$. Where $\hat{p}_0^T = M_T$. Therefore the marginal likelihood of a model also reflects its prediction performance.

D Appendix- Sensitivity Analysis and Additional Results

In Table 8 I report report results when increasing the prior standard deviation of the structural parameters of the model and the persistance of the shocks by 50 percent. By comparing these set of results with the benchmark results in Table 2, we see that the posterior distributions are similar in most cases indicating that the choice of priors is satisfactory. It can be observed that the estimate for $-\tau$ is -0.8329. This value is larger in absolute value than the benchmark model parameter estimation (i.e. stronger countercyclicality) and provides additional support to the hypothesis of countercyclical markups.

E Appendix- Convergence Diagnostics

I monitor the convergence of iterative simulations with the methods described in Brooks and Gelman (1998).

General Univariate Diagnostics The empirical 80 percent interval for some parameter, ϱ, is taken from each individual chain first. That is, the 10 and 90 percent of the n simulated draws. Then, m within-sequence interval length estimates are constructed. Next, a set of mn observations, generated from all chains, is also used to calculate the 80% interval, and a total-sequence interval length estimate is obtained, so that $\hat{R}_{interval} = \frac{\text{length of total-sequence interval}}{\text{mean length of the within-sequence interval}}$ can be evaluated. Convergence is approached when the numerator and denominator coincide (i.e. $\hat{R} \to 1$).

Non interval-based alternatives are also possible to calculate and are reported for robustness. The numerator and denominator in the expression above is replaced by an empirical estimate of the central s^{th} order moments calculated from all sequences together, and the mean s^{th} order moment calculated from each individual sequence, so as to define for every s: $\hat{R}_s = \frac{\frac{1}{mn-1}\sum_{j=1}^{m}\sum_{t=1}^{n}|\varrho_{jt}-\bar{\varrho}_{..}|^s}{\frac{1}{m(n-1)}\sum_{j=1}^{m}\sum_{t=1}^{n}|\varrho_{jt}-\bar{\varrho}_{j.}|^s}$. In Figure 12, I plot the numerator and denominator from measures of $\hat{R}_{interval}, \hat{R}_2, \hat{R}_3$ for each of the parameters estimated. The scale used for drawing the initial value of the MH chain is twice that of the jumping distribution in the MH

[37] Notice that $\ln(\mathcal{F}_{AB}) = \log(M_A/M_B) = \log(M_A) - \log(M_B)$.That is the Bayes Factor may be interpreted as the difference of the log marginal likelihood of each specification.

algorithm. As it is observed, convergence is achieved before 100,000 iterations (the number of parallel chains used is 5).

Multivariate extensions In this case, I redefine ϱ as a a vector parameter based upon observations $\varrho_{jt}^{(i)}$ denoting the i_{th} element of the parameter vector in chain j at time t. The direct analogue of univariate approach in higher dimensions is to estimate the posterior variance-covariance matrix as: $\hat{V} = \frac{n-1}{n}W + (1 + \frac{1}{m})B/n$, where $W = \frac{1}{m(n-1)}\sum_{j=1}^{m}\sum_{t=1}^{n}(\varrho_{jt} - \bar{\varrho}_{j}.)(\varrho_{jt} - \bar{\varrho}_{j}.)'$ and $B/n = \frac{1}{m-1}\sum_{j=1}^{m}(\bar{\varrho}_{j.} - \bar{\varrho}_{..})(\bar{\varrho}_{j.} - \bar{\varrho}_{..})'$. It is possible to summarize the distance between $\hat{V}$ and W with a scalar measure that should approach 1 (from above) as convergence is achieved, given suitably overdispersed starting points. We can monitor both $\hat{V}$ and W, determining convergence when any rotationally invariant distance measure between the two matrices indicates that they are sufficiently close. In Figure 13, I report measures of this aggregate.[38] Convergence is achieved before 100,000 iterations.

Finally, as a sensitivity analysis, Figure 14 shows same measure when increasing the scale used in drawing the initial value by 25 and 100 percent respectively (so as to draw values from a sufficiently stretched out distribution). Convergence is again achieved before 100,000 iterations.

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Table 1: Parameters and steady state relationships

Parameter/St.State	Description	Value	Parameter/St. State	Description	Value
β	Discount Factor	0.99	$\psi(.)$	Gross Risk Premium (quarterly)	1.0060
α	Capital Share in Production	0.40	$(1+\Xi)$	Gross Bank Markup (quarterly)	1.0147
$\delta(u_{ss})$	Depreciation Rate	0.025	$(1-\zeta)$	Entrepreneur Death Rate	0.272
$(1+\bar{\xi})$	Gross Markup Goods Market	1.20	H_{ss}	Hours Labor Supply	1/3
θ	Prob. prices not adjusting	0.75	C_{ss}/Y_{ss}	C/Y ratio	0.86
$\epsilon_{\Phi_t;-B_t}$	Elasticity to Foreign Debt	0.001	I_{ss}/Y_{ss}	I/Y ratio	0.15
γ_C	Share Domestic in Consumption	0.8	$C_{H^*,ss}/Y_{ss} \simeq M_{ss}/Y_{ss}$	Exports-Imports/Y ratio	0.24
γ_I	Share Domestic in Investment	0.6	$C_{e,ss}/Y_{ss}$	Entrepreneur C/Y ratio	0.005
$(1-\Omega)$	Entrepreneur Labor Share	0.01	P_{ss}	CPI Price level	1

Table 2: Summary statistics for the prior and posterior distribution of the parameters.

Prior Distribution					Posterior Distribution				
Description	Name	Density	Mean	Std Dev	Sd (Hess)	Mode	Mean	5%	95%
Inv Elast Labor	γ_n	Beta	0.35	0.1	0.1015	0.3775	0.3888	0.2208	0.5545
Intertemp Elast	γ	Gamma	1	1	0.1884	0.8280	0.9160	0.6074	1.2017
Price Capital Elast	φ	Gamma	1	1	0.1068	0.7723	0.7987	0.6185	0.9611
Inv Bank Markup Elast	$-\tau$	Normal	0	3	0.4913	-0.7552	-0.7241	-1.5160	0.0739
Risk Premium Elast	η	Normal	-0.051	0.01	0.0094	-0.0546	-0.0545	-0.0700	-0.0391
Export Elast	χ	Gamma	0.3	0.2	0.1345	0.5428	0.5372	0.3175	0.7563
Export Inertia	ϖ	Beta	0.25	0.05	0.0400	0.2225	0.2172	0.1495	0.2815
Elast Subs Invest	ρ_I	Beta	0.25	0.05	0.0510	0.2597	0.2648	0.1820	0.3492
Elast Subs Consump	ρ_C	Beta	0.50	0.1	0.0671	0.7196	0.6999	0.5896	0.8093
Domestic G Infl Inertia	ι_H	Beta	0.25	0.1	0.0866	0.1580	0.2125	0.0733	0.3483
Foreign G Infl Inertia	ι_F	Beta	0.25	0.1	0.0794	0.1480	0.1869	0.0568	0.3054
Depreciation Elast	Γ	Gamma	1	0.25	0.2583	0.9687	1.0218	0.6154	1.4516
Int Rate Shock	ρ_{i^*}	Beta	0.8	0.1	0.0574	0.7480	0.7417	0.6527	0.8371
Tech Shock	ρ_a	Beta	0.8	0.1	0.0101	0.9899	0.9827	0.9680	0.9973
Bank Operat Shock	ρ_{oc}	Beta	0.8	0.1	0.0686	0.7517	0.7515	0.6400	0.8649
Risk Premium Shock	ρ_{fp}	Beta	0.8	0.1	0.0775	0.5893	0.5920	0.4641	0.7194
Disc Factor Shock	ρ_b	Beta	0.8	0.1	0.1030	0.7528	0.7745	0.6199	0.9442
Cost Push Shock	ρ_ξ	Beta	0.8	0.1	0.0510	0.8384	0.8070	0.7253	0.8870
Investment Shock	ρ_I	Beta	0.8	0.1	0.0768	0.7996	0.7813	0.6626	0.9064
Exp Demand Shock	ρ_{H^*}	Beta	0.8	0.1	0.0400	0.9020	0.8787	0.8198	0.9387
Terms of Trade Shock	ρ_{F^*}	Beta	0.8	0.1	0.0693	0.7690	0.7172	0.6097	0.8297
Int Rate Shock	σ_{i^*}	Inv gamma	0.01	2*	0.0008	0.0054	0.0056	0.0044	0.0068
Tech Shock	σ_a	Inv gamma	0.01	2*	0.0049	0.0133	0.0167	0.0091	0.0243
Bank Operat Shock	σ_{oc}	Inv gamma	0.01	2*	0.0118	0.0854	0.0907	0.0713	0.1088
Risk Premium Shock	σ_{fp}	Inv gamma	0.01	2*	0.0008	0.0056	0.0060	0.0047	0.0072
Disc Factor Shock	σ_b	Inv gamma	0.01	2*	0.0039	0.0111	0.0143	0.0082	0.0202
Cost Push Shock	σ_ξ	Inv gamma	0.01	2*	0.0147	0.0657	0.0786	0.0552	0.1012
Investment Shock	σ_I	Inv gamma	0.01	2*	0.0086	0.063	0.0658	0.0520	0.0793
Exp Demand Shock	σ_{H^*}	Inv gamma	0.01	2*	0.0346	0.0871	0.1038	0.0546	0.1529
Terms of Trade Shock	σ_{F^*}	Inv gamma	0.01	2*	0.0436	0.1863	0.2211	0.1514	0.2871

Notes: For the Inverted gamma function the degrees of freedom are indicated.

Table 3: Unconditional moments for Argentina. Data: 1994Q1–2001Q3

Variable (Growth Rate)	St. Dev	Relative St. Dev	Autocorr	Corr with $\Delta \ln Y_t$	Corr with $\Delta \ln P_t$
Output	1.87	1.00	0.54	1.00	0.34
CPI	0.61	0.33	0.50	0.34	1.00
Investment	4.62	2.47	0.51	0.89	0.27
Consumption	2.03	1.08	0.39	0.90	0.25
Exports	1.92	1.02	0.85	0.39	0.79
Imports	4.75	2.54	0.86	0.86	0.23
Bank Markup	0.13	0.07	0.17	-0.20	0.21

Note: Variables were transformed in $\Delta \ln$ (expressing everything in growth rates).

Table 4: Unconditional moments for the estimated benchmark (complete) model

Variable (Growth Rate)	St. Dev	Relative St. Dev	Autocorr	Corr with $\Delta \ln Y_t$	Corr with $\Delta \ln P_t$
Output	3.14 2.41/3.59	1.00	−0.04 −0.12/0.01	1.00 −−	−0.01 −0.12/0.16
CPI	2.27 1.90/2.60	0.72	0.68 0.65/0.73	0.00 −0.12/0.16	1.00 −−
Investment	5.28 4.39/6.36	1.68	−0.04 −0.09/0.03	0.84 0.78/0.91	−0.04 −0.22/0.10
Consumption	3.74 2.71/4.33	1.19	−0.10 −0.15/−0.06	0.96 0.94/0.98	0.01 −0.11/0.14
Exports	1.58 1.27/1.96	0.50	0.70 0.65−0.74	0.37 0.31/0.44	0.03 −0.18/0.27
Imports	4.71 3.91/5.46	1.50	0.04 −0.05/0.14	0.79 0.71/0.88	0.05 −0.05/0.20
Bank Markup	0.15 0.12/0.18	0.05	−0.12 −0.16/−0.06	−0.29 −0.52/−0.12	0.01 −0.05/0.07

Note: I report the median from the simulated distribution of moments using the samples generated with parameters draws of the posterior distribution. The 5th and 95th percentiles are included.

Table 5: Counterfactual moments (standard deviation)

Variable (Growth Rate)	Complete	B.Sheets	Monop.Bank	SOE
Output	2.92(1.00)	2.73(1.00)	2.97(1.00)	2.72(1.00)
CPI	2.19(0.75)	2.14(0.78)	2.20(0.74)	2.15(0.79)
Investment	5.01(1.72)	4.45(1.63)	4.39(1.48)	3.65(1.34)
Consumption	3.46(1.18)	3.16(1.16)	3.55(1.20)	3.18(1.17)
Exports	1.59(0.54)	1.59(0.58)	1.60(0.54)	1.60(0.59)
Imports	4.50(1.54)	4.39(1.61)	4.53(1.53)	4.37(1.61)
Bank Markup	0.15(0.05)	0.00(0.00)	0.15(0.05)	0.00(0.00)

Note: I simulate the model using the posterior median of the estimated parameters, turning off one financial friction every time. In parenthesis, relative standard deviation with respect to output. See additional details in Table 6.

Table 6: Summary statistics for the prior and posterior mode of the parameters for different model specifications.

Prior Distribution					Posterior Mode			
Description	Name	Density	Mean	StdDev	Complete	B. Sheets	Monop. Bank	SOE
Inv Elast Labor	γ_n	Beta	0.35	0.1	0.3775	0.3744	0.3585	0.3589
Intertemp Elast	γ	Gamma	1	1	0.8280	0.7453	0.8726	0.7410
Price Capital Elast	φ	Gamma	1	1	0.7723	0.6905	0.6064	0.4931
Inv Bank Markup Elast	$-\tau$	Normal	0	3	-0.7552	–	-1.5644	–
Risk Premium Elast	η	Normal	-0.051	0.01	-0.0546	-0.0552	–	–
Export Elast	χ	Gamma	0.3	0.2	0.5428	0.5319	0.3483	0.4816
Export Inertia	ϖ	Beta	0.25	0.05	0.2225	0.2249	0.2288	0.2283
Elast Subs Invest	ρ_I	Beta	0.25	0.05	0.2597	0.2603	0.2622	0.2629
Elast Subs Consump	ρ_C	Beta	0.50	0.1	0.7196	0.7248	0.7401	0.7451
Domestic G Infl Inertia	ι_H	Beta	0.25	0.1	0.1580	0.1565	0.1411	0.1668
Foreign G Infl Inertia	ι_F	Beta	0.25	0.1	0.1480	0.1458	0.1467	0.1400
Depreciation Elast	Γ	Gamma	1	0.25	0.9687	0.9794	0.9865	0.9899
Int Rate Shock	ρ_{i^*}	Beta	0.8	0.1	0.7480	0.7318	0.7096	0.7250
Tech Shock	ρ_a	Beta	0.8	0.1	0.9899	0.9901	0.9870	0.9916
Bank Operat Shock	ρ_{oc}	Beta	0.8	0.1	0.7517	–	0.7164	–
Risk Premium Shock	ρ_{fp}	Beta	0.8	0.1	0.5893	0.5809	–	–
Disc Factor Shock	ρ_b	Beta	0.8	0.1	0.7528	0.7463	0.7008	0.7215
Cost Push Shock	ρ_ξ	Beta	0.8	0.1	0.8384	0.8223	0.8518	0.8138
Investment Shock	ρ_I	Beta	0.8	0.1	0.7996	0.8077	0.8085	0.8150
Exp Demand Shock	ρ_{H^*}	Beta	0.8	0.1	0.9020	0.8955	0.9266	0.8913
Terms of Trade Shock	ρ_{F^*}	Beta	0.8	0.1	0.7690	0.7617	0.7575	0.7448
Int Rate Shock	σ_{i^*}	Inv gamma	0.01	2*	0.0054	0.0055	0.0051	0.0055
Tech Shock	σ_a	Inv gamma	0.01	2*	0.0133	0.0119	0.0100	0.0098
Bank Operat Shock	σ_{oc}	Inv gamma	0.01	2*	0.0854	–	0.0885	–
Risk Premium Shock	σ_{fp}	Inv gamma	0.01	2*	0.0056	0.0055	–	–
Disc Factor Shock	σ_b	Inv gamma	0.01	2*	0.0111	0.0099	0.0088	0.0081
Cost Push Shock	σ_ξ	Inv gamma	0.01	2*	0.0657	0.0649	0.0603	0.0641
Investment Shock	σ_I	Inv gamma	0.01	2*	0.0630	0.0630	0.0630	0.0630
Exp Demand Shock	σ_{H^*}	Inv gamma	0.01	2*	0.0871	0.0883	0.1295	0.0958
Terms of Trade Shock	σ_{F^*}	Inv gamma	0.01	2*	0.1863	0.1871	0.1853	0.1869
$\Delta_{\log(\hat{L})}$ (Laplace)					–	-171.28	-133.73	-306.11
$\Delta_{\log(\hat{L})}$ (Mod.Harmonic)					–	-172.15	-133.55	-306.51

Notes: SOE is the baseline small open economy model with nominal rigidities (assuming constant banking specific variables). B.Sheets adds the standard balance-sheet channel to the previous specification. Monop.Bank adds the Monopolistic Banking System setup. Finally, the complete specification adds the broad financial accelerator (i.e. the combined effect of both). For the Inverted Gamma function the degrees of freedom are indicated.

Table 7: Forecast Error Variance Decomposition

	Techn	Fogn rate	Bank Op	Risk Prem	Demand	Cost	Invest	Fogn Demand	TOT
t=1									
Consumption	23.67	34.34	0.02	0.08	16.32	0.12	0.91	19.03	5.52
Investment	34.14	20.58	0.82	8.51	0.28	10.73	0.01	24.72	0.21
Output	19.49	29.52	0.00	0.05	11.56	1.92	2.37	25.94	9.15
Inflation	27.75	1.83	0.00	0.01	0.10	31.82	0.00	6.90	31.60
Exports	1.33	0.09	0.00	0.00	0.00	1.52	0.00	96.87	0.18
Imports	32.09	24.69	0.04	0.49	6.42	0.02	13.76	20.50	1.99
t=4									
Consumption	14.91	24.47	0.03	0.10	15.02	20.96	1.47	17.54	5.50
Investment	21.03	9.86	0.49	3.73	0.14	31.07	0.03	21.85	11.81
Output	10.38	15.69	0.00	0.02	8.04	33.76	1.84	26.02	4.25
Inflation	32.66	1.31	0.00	0.02	0.07	28.4	0.02	8.45	29.07
Exports	7.51	0.17	0.00	0.00	0.01	6.05	0.00	85.23	1.03
Imports	25.86	23.5	0.03	0.55	5.64	0.79	11.64	15.97	16.01
t=8									
Consumption	16.01	17.08	0.02	0.07	10.83	33.71	1.50	13.01	7.77
Investment	14.36	6.52	0.33	2.43	0.09	38.93	0.06	19.74	17.54
Output	18.94	8.70	0.00	0.01	4.56	44.94	1.09	18.68	3.09
Inflation	32.80	1.91	0.00	0.03	0.09	28.22	0.04	8.50	28.40
Exports	11.58	0.25	0.00	0.01	0.01	6.77	0.02	79.68	1.69
Imports	25.08	23.14	0.03	0.53	5.56	0.87	11.54	15.45	17.80
t=Asympt.									
Consumption	27.36	7.58	0.01	0.04	2.97	14.71	1.23	27.60	18.51
Investment	21.29	5.03	0.15	1.05	0.13	23.01	0.51	28.42	20.41
Output	67.20	2.65	0.01	0.03	1.18	15.76	0.41	9.63	3.13
Inflation	32.14	2.07	0.00	0.03	0.09	28.81	0.05	8.47	28.35
Exports	11.12	0.48	0.00	0.01	0.02	6.50	0.03	80.06	1.79
Imports	24.27	22.41	0.03	0.51	5.39	1.04	11.22	14.96	20.17

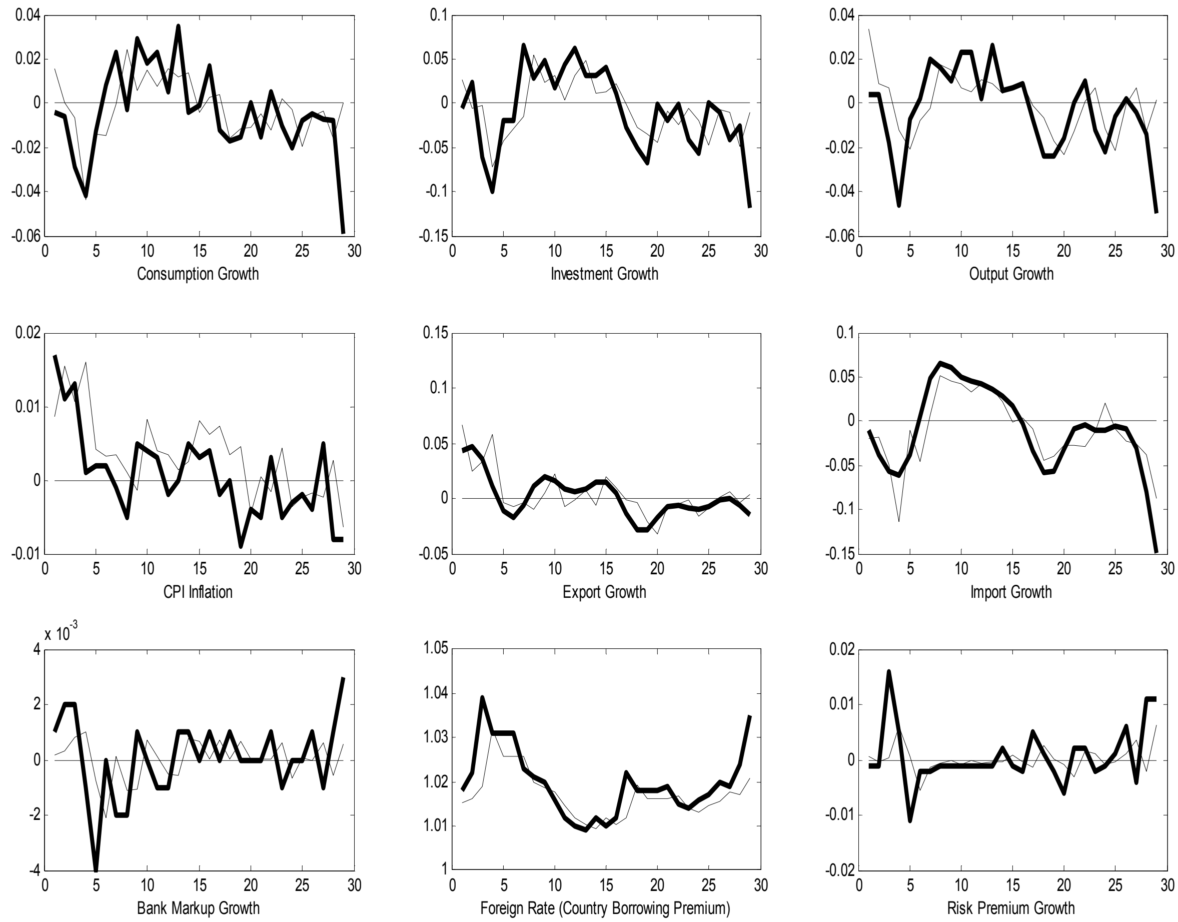
Note: Forecast error variance decomposition at the posterior mode. Forecast horizon: Q1, Q4, Q8, asymptotic. Shocks: neutral technology, foreign interest rate, bank operating, idiosyncratic risk premium, discount factor shock (demand), cost push, investment specific, foreign demand, terms of trade.

Table 8: Summary statistics for the distribution of the parameters (Sensitivity Analysis).

Prior Distribution					Posterior Distribution				
Description	Name	Density	Mean	Std Dev	Sd (Hess)	Mode	Mean	5%	95%
Inv Elast Labor	γ_n	Beta	0.35	0.15	0.1733	0.4199	0.4089	0.1612	0.6468
Intertemp Elast	γ	Gamma	1	1.5	0.1291	0.7233	0.8345	0.6104	1.0745
Price Capital Elast	φ	Gamma	1	1.5	0.0839	0.7011	0.7345	0.5766	0.8783
Inv Bank Markup Elast	$-\tau$	Normal	0	3	0.5079	-0.9052	-0.8329	-1.6951	0.2335
Risk Premium Elast	η	Normal	-0.051	0.015	0.0133	-0.0579	-0.0590	-0.0792	-0.0370
Export Elast	χ	Gamma	0.3	0.3	0.1562	0.5468	0.5524	0.1474	0.8011
Export Inertia	ϖ	Beta	0.25	0.075	0.0528	0.2183	0.1937	0.1122	0.2774
Elast Subs Invest	ρ_I	Beta	0.25	0.075	0.0827	0.2652	0.2795	0.1567	0.3956
Elast Subs Consump	ρ_C	Beta	0.50	0.15	0.0716	0.8299	0.7914	0.6821	0.9023
Domestic G Infl Inertia	ι_H	Beta	0.25	0.15	0.0633	0.0610	0.1345	0.0048	0.2624
Foreign G Infl Inertia	ι_F	Beta	0.25	0.15	0.0699	0.0675	0.1525	0.0080	0.2835
Depreciation Elast	Γ	Gamma	1	0.375	0.3676	0.9599	1.0588	0.4602	1.6915
Int Rate Shock	ρ_{i^*}	Beta	0.8	0.15	0.0584	0.7228	0.7128	0.6133	0.8296
Tech Shock	ρ_a	Beta	0.8	0.15	0.0032	0.9992	0.9949	0.9895	1.0000
Bank Operat Shock	ρ_{oc}	Beta	0.8	0.15	0.0794	0.7260	0.7246	0.6006	0.8543
Risk Premium Shock	ρ_{fp}	Beta	0.8	0.15	0.0981	0.5087	0.5214	0.3711	0.6993
Disc Factor Shock	ρ_b	Beta	0.8	0.15	0.2035	0.5309	0.6632	0.4133	0.9419
Cost Push Shock	ρ_ξ	Beta	0.8	0.15	0.0403	0.8448	0.8146	0.7239	0.8963
Invest Shock	ρ_I	Beta	0.8	0.15	0.1000	0.7961	0.7558	0.6116	0.9178
Exp Demand Shock	ρ_{H^*}	Beta	0.8	0.15	0.0323	0.9129	0.8674	0.7783	0.9503
Terms Trade Shock	ρ_{F^*}	Beta	0.8	0.15	0.0673	0.7781	0.6976	0.5447	0.8414
Int Rate Shock	σ_{i^*}	Inv gamma	0.01	2*	0.0007	0.0055	0.0057	0.0045	0.0069
Tech Shock	σ_a	Inv gamma	0.01	2*	0.0027	0.0093	0.0125	0.0053	0.0194
Bank Operat Shock	σ_{oc}	Inv gamma	0.01	2*	0.0107	0.0859	0.0914	0.0696	0.1091
Risk Premium Shock	σ_{fp}	Inv gamma	0.01	2*	0.0007	0.0056	0.0060	0.0048	0.0073
Disc Factor Shock	σ_b	Inv gamma	0.01	2*	0.0020	0.0082	0.0116	0.0070	0.0166
Cost Push Shock	σ_ξ	Inv gamma	0.01	2*	0.0093	0.0560	0.0664	0.0476	0.0846
Invest Shock	σ_I	Inv gamma	0.01	2*	0.0078	0.0630	0.0662	0.0538	0.0802
Exp Demand Shock	σ_{H^*}	Inv gamma	0.01	2*	0.0291	0.0872	0.1287	0.0420	0.2487
Terms of Trade Shock	σ_{F^*}	Inv gamma	0.01	2*	0.0290	0.1557	0.1963	0.1350	0.2610

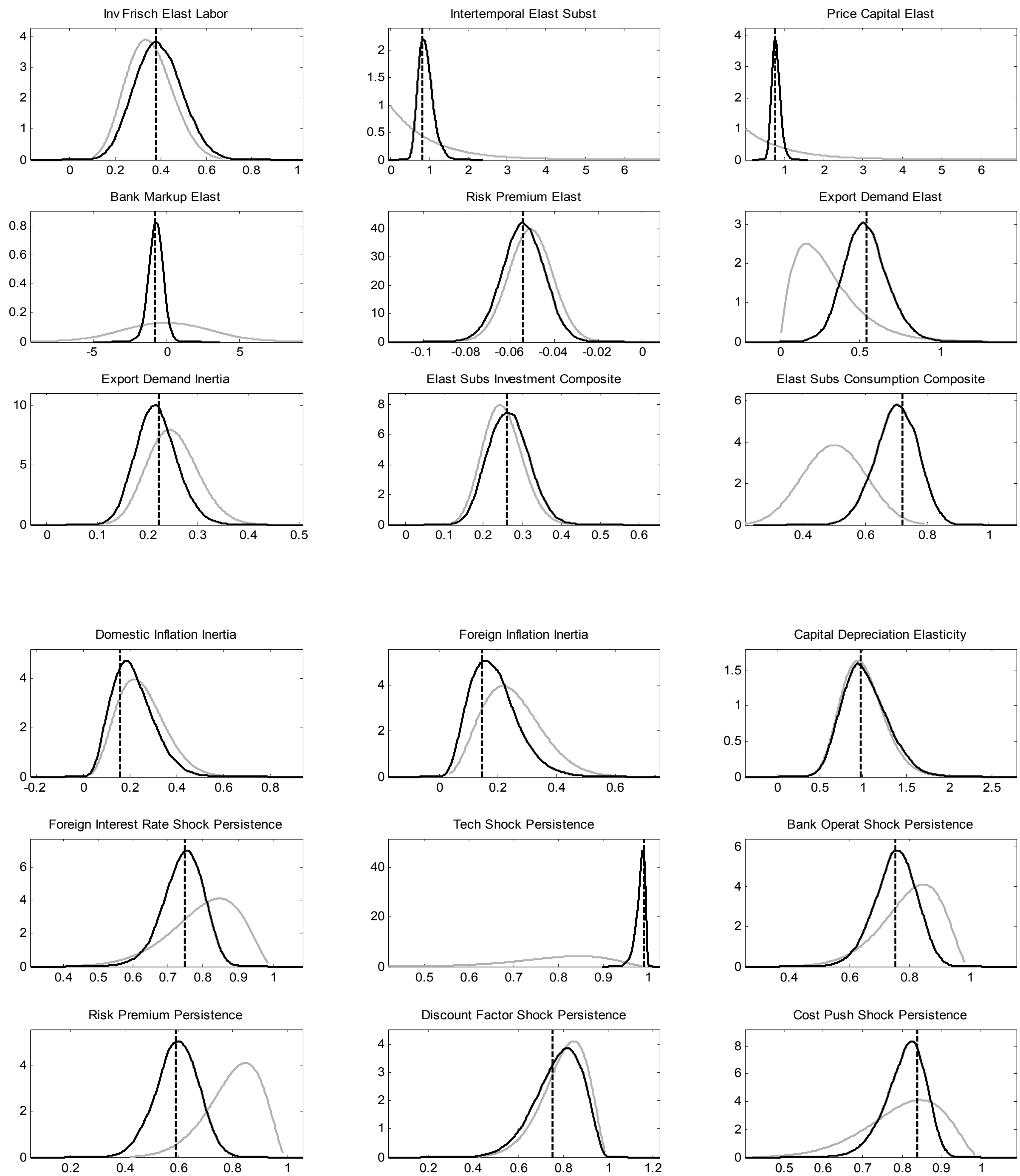
Notes: For the Inverted Gamma function the degrees of freedom are indicated.

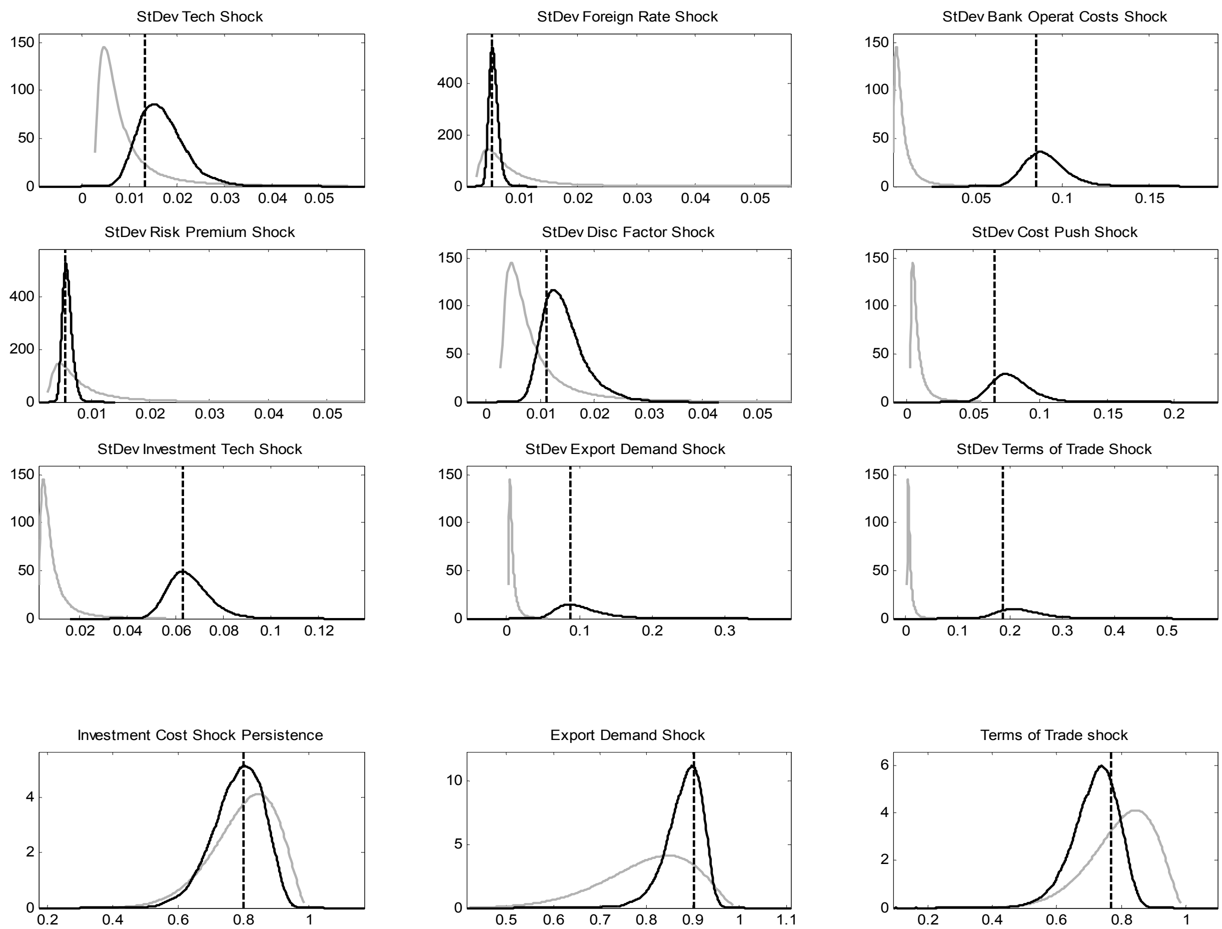
Figure 1. Data and predicted values from the model



Note: Data (thick) and benchmark model's Kalman filtered one-sided predicted values (thin). The variables depicted are: household consumption, investment, domestic output, consumer price index inflation, exports, imports, gross bank markup (interest margin), gross foreign interest rate of reference and gross risk premium. Real and banking specific variables were transformed in Δln (expressing everything in growth rates).

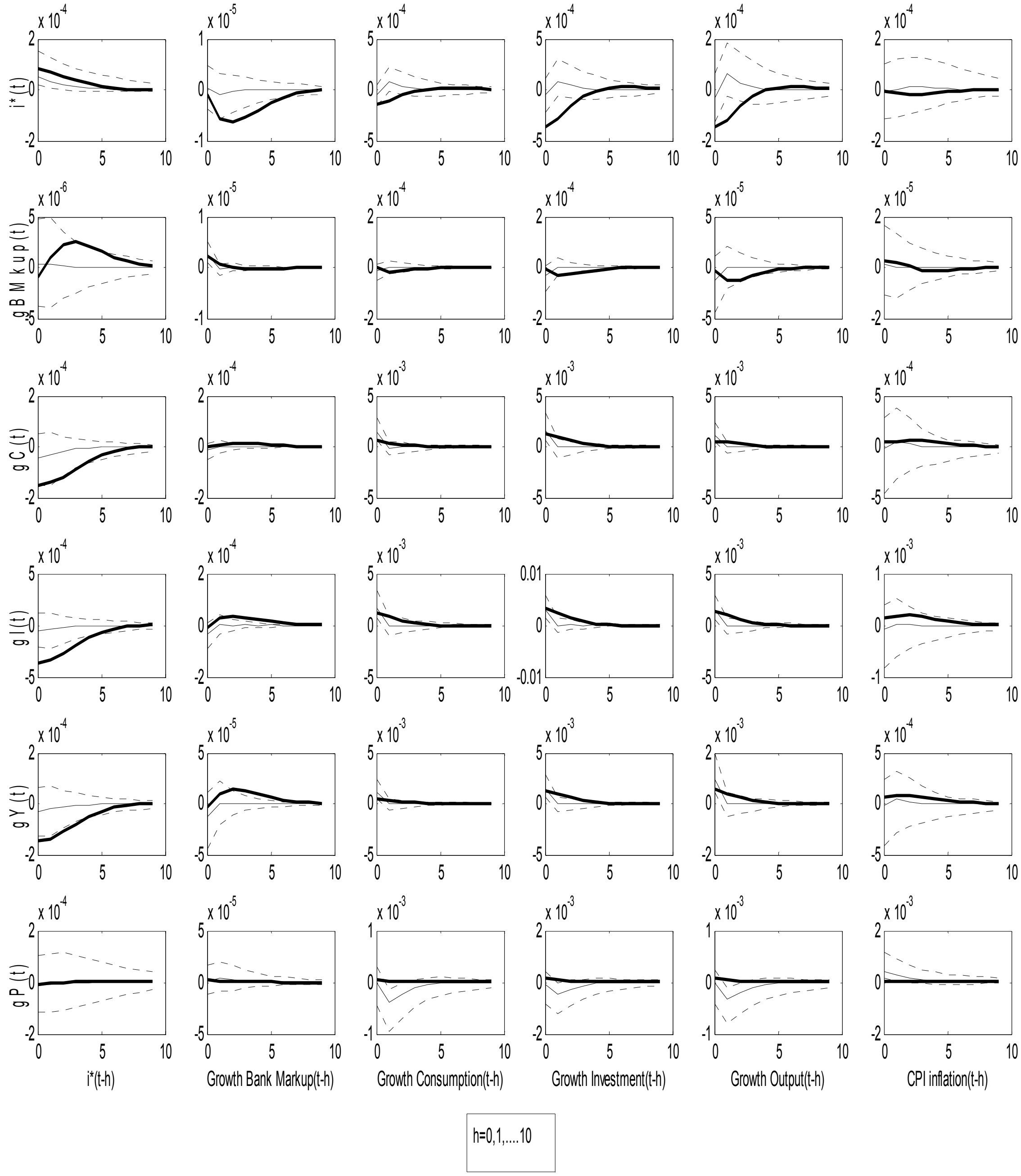
Figure 2. Prior and Posterior Distributions





Note: Benchmark Model. Results based on 500,000 draws of the Metropolis algorithm. Gray line: prior. Black line: posterior. Vertical dashed line: mode (from the numerical optimization of the posterior kernel)

Figure 3. Autocovariance functions



Note: The vector auto-covariance function is computed by estimating an unrestricted VAR (1) model with an uninformative prior for the variables plotted. The thin (solid) line refers to the median vector auto-covariance function along with the 2.5 and 97.5 percentiles (dotted lines) .The thick line refers to the actual data.

Figure 4(a). Impulse responses to a foreign interest rate shock

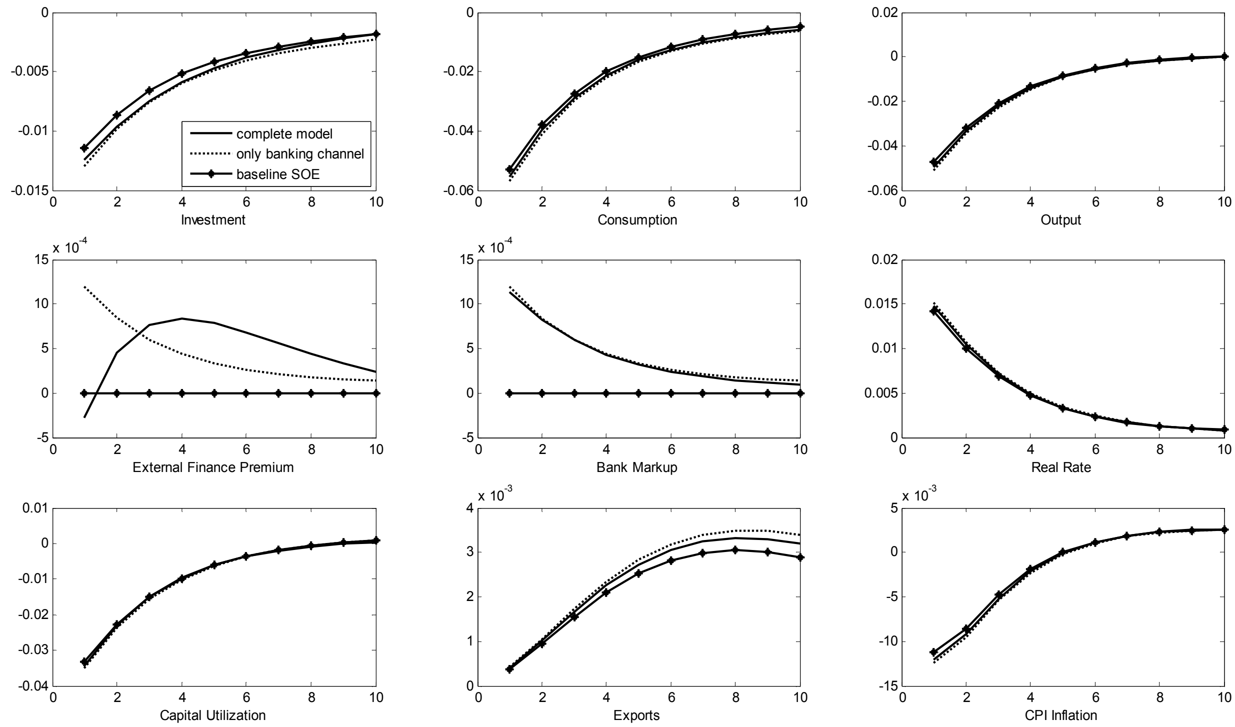
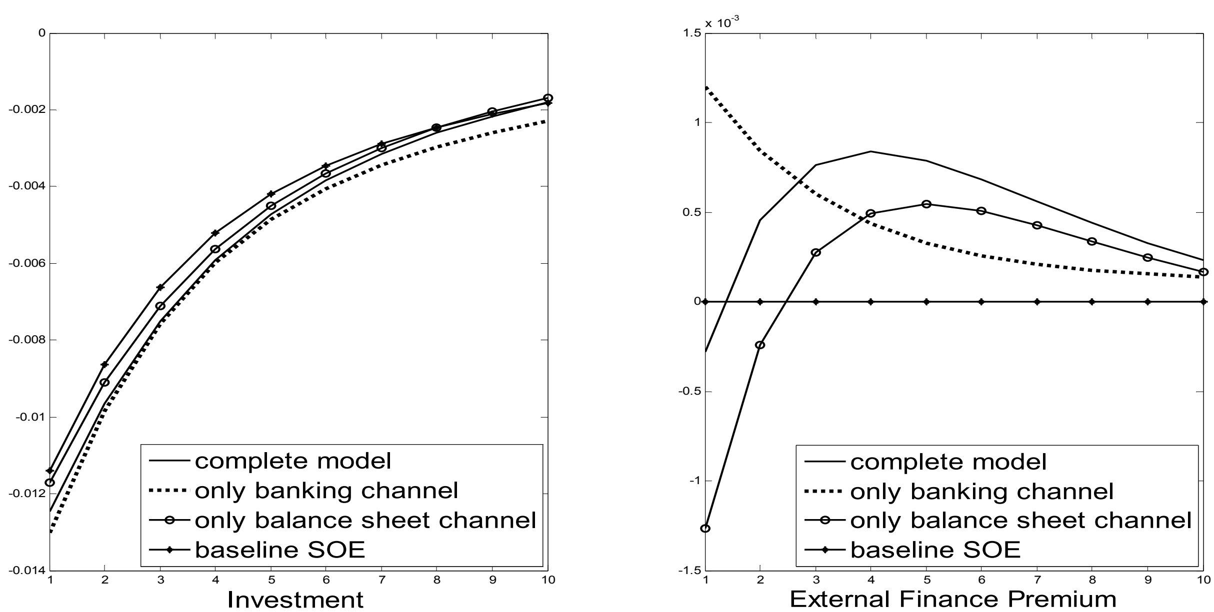
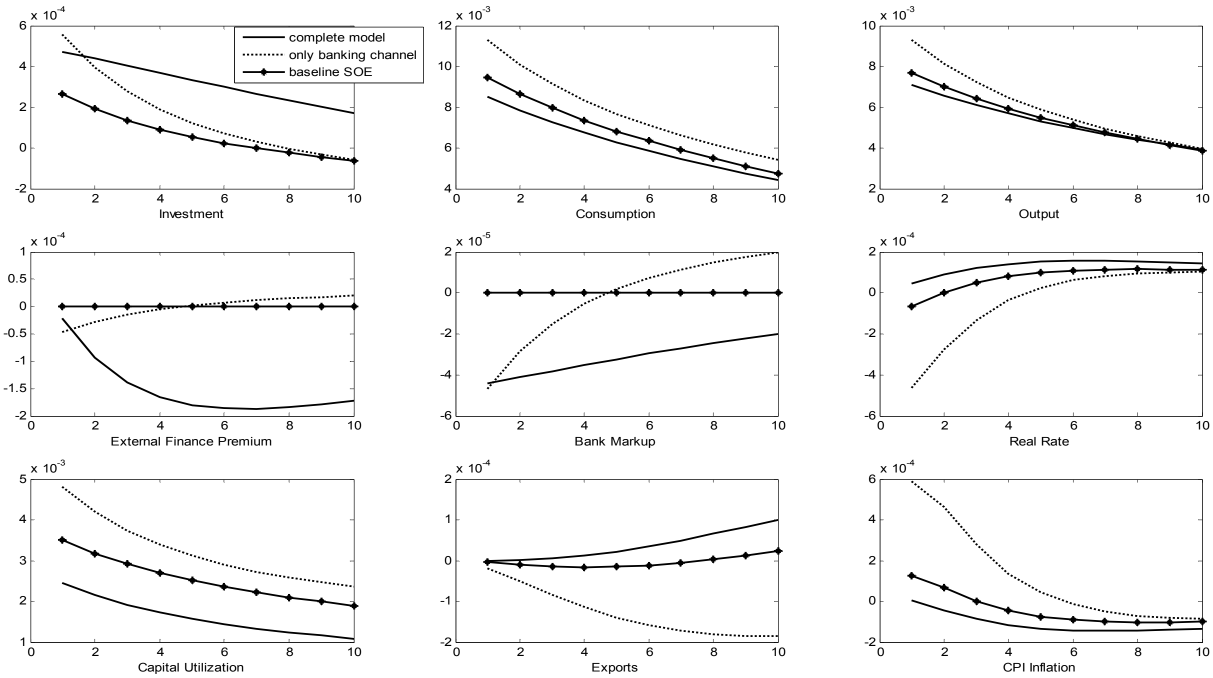


Figure 4(b). Impulse responses to a foreign interest rate shock



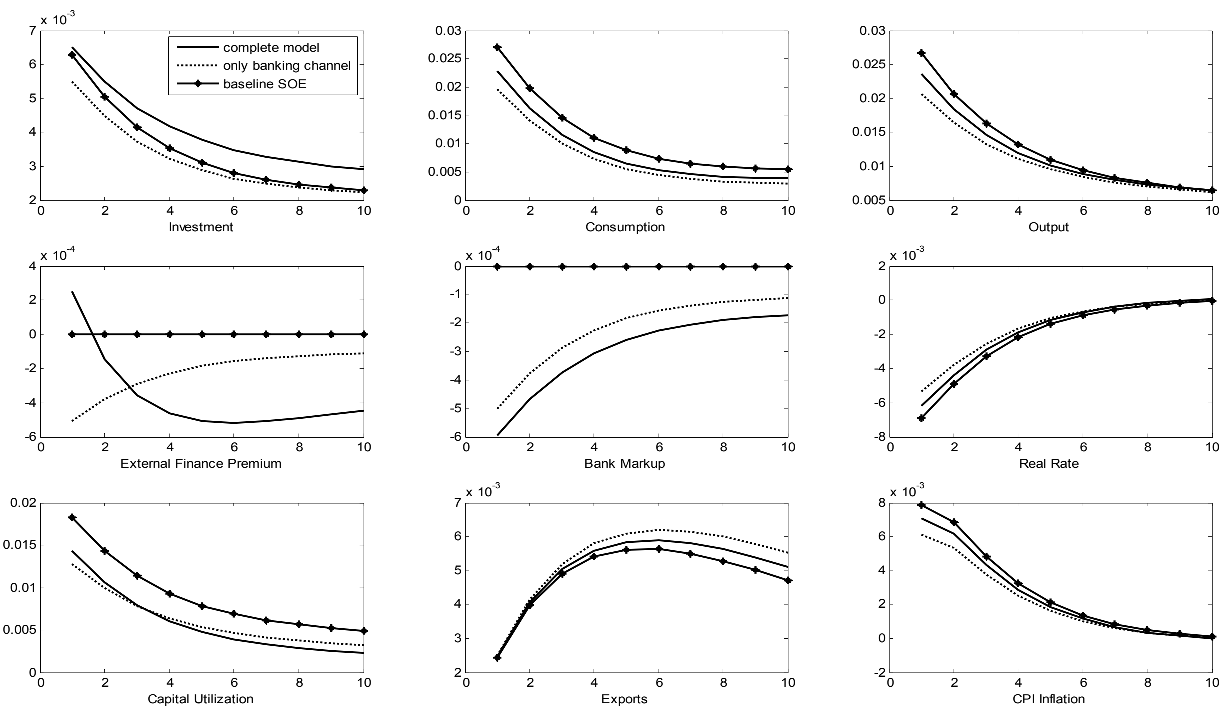
Note: Impulse response to a foreign interest rate shock (one standard deviation) at the median of the estimated parameters.

Figure 5. Impulse responses to a preference shock (discount rate factor)



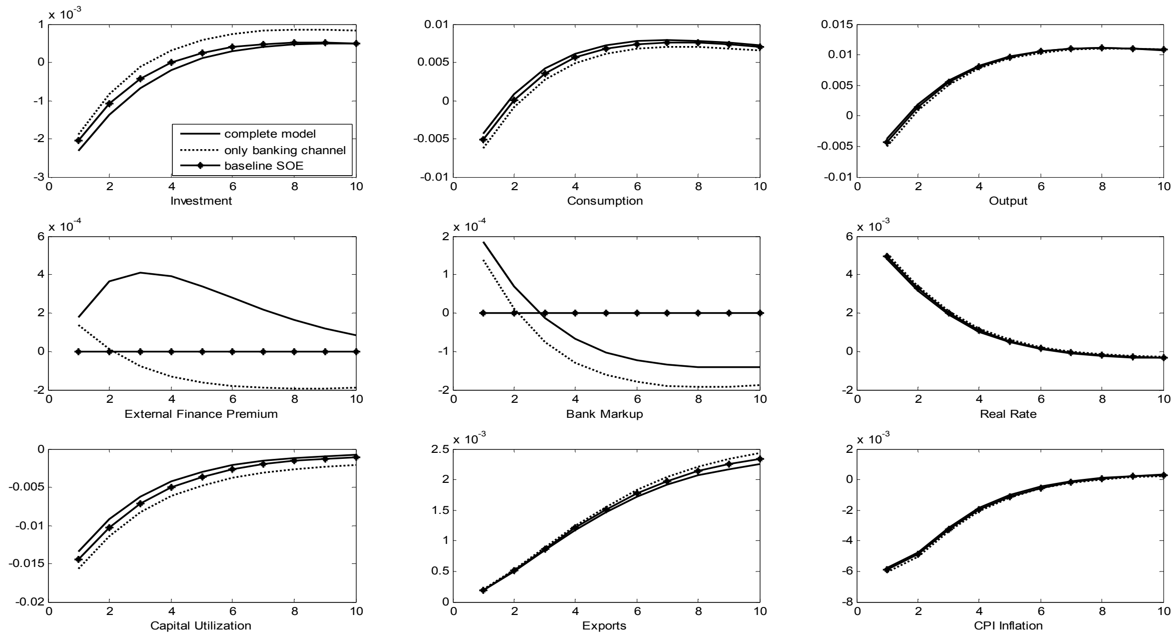
Note: Impulse response to a shock to the discount rate (one standard deviation) at the median of the estimated parameters.

Figure 6. Impulse responses to a foreign demand shock



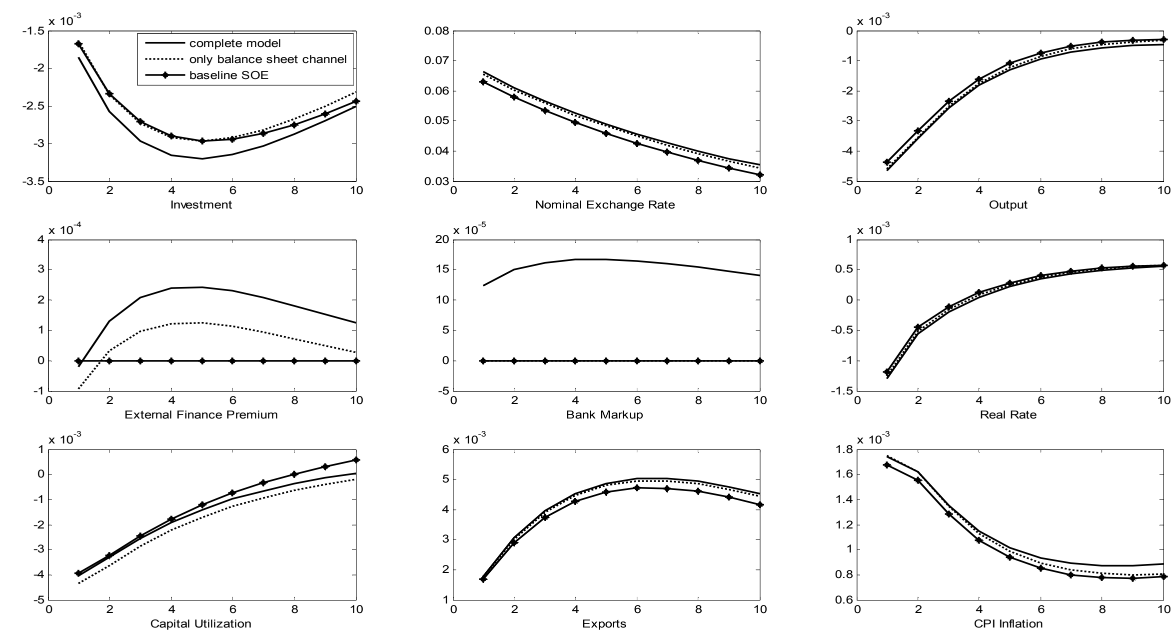
Note: Impulse response to a foreign demand shock (one standard deviation) at the median of the estimated parameters.

Figure 7. Impulse responses to a technology shock



Note: Impulse response to a neutral technology shock (one standard deviation) at the median of the estimated parameters.

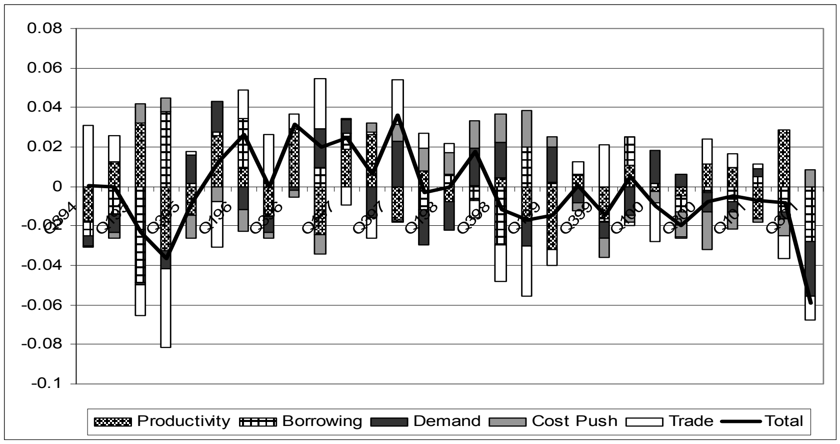
Figure 8. Impulse response to a foreign interest rate shock (Flexible Exchange Rates).



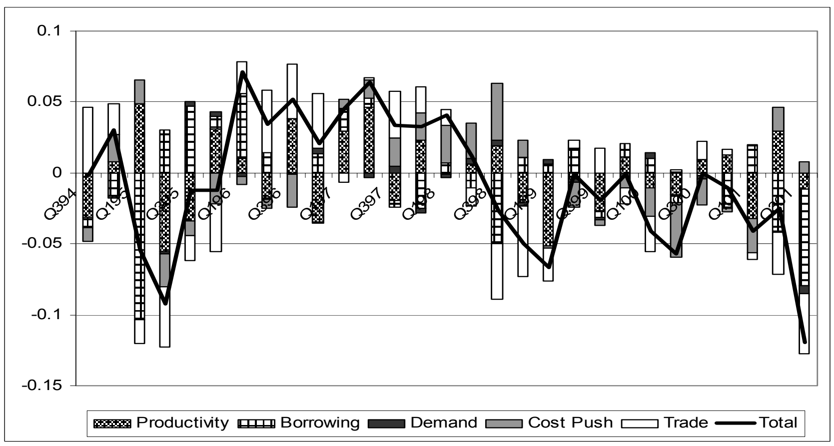
Note: Impulse response to a foreign interest rate shock (one standard deviation) at the median of the estimated parameters.

Figure 9. Historical Decomposition

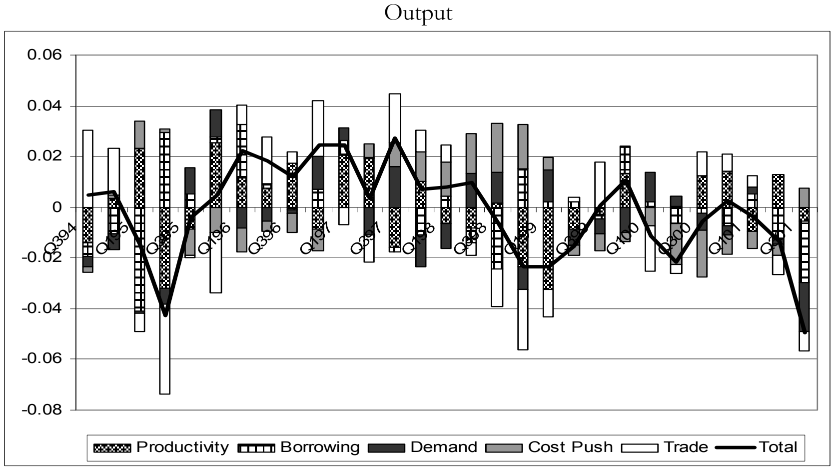
Consumption



Investment



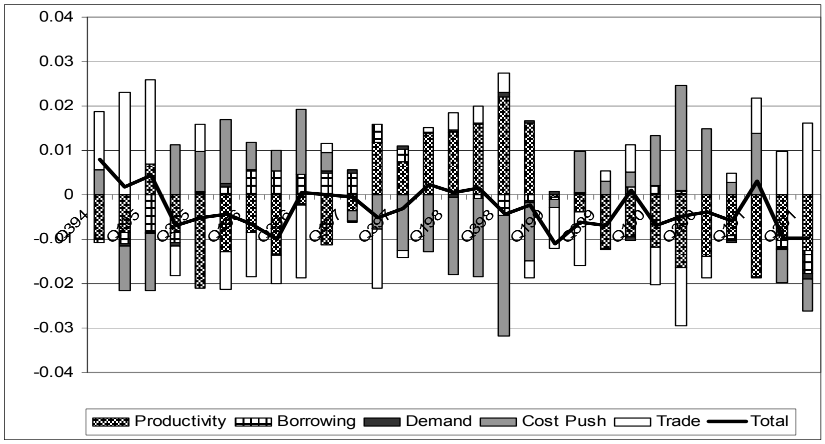
Output



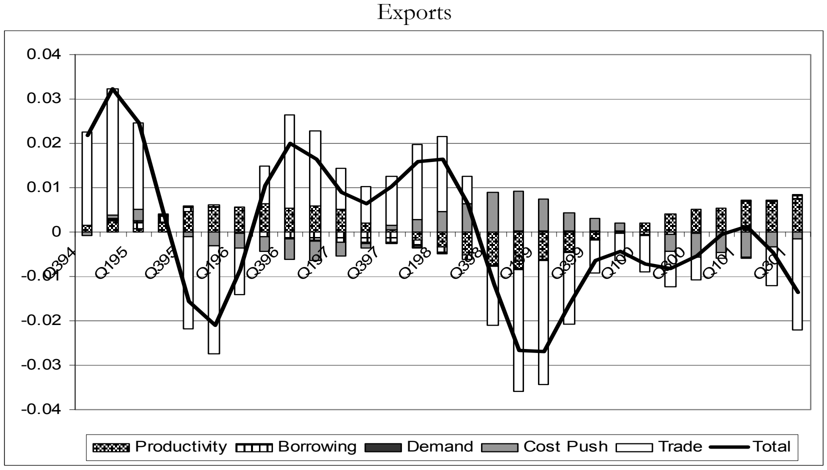
Note: Quarterly growth (deviation from trend). Productivity shocks include neutral technology and investment specific. Borrowing cost shocks include foreign interest rate, idiosyncratic risk premium, and bank operating. The demand shock is the discount factor shock, and trade include both terms of trade and foreign demand shocks.

Figure 9. Historical Decomposition (continuation)

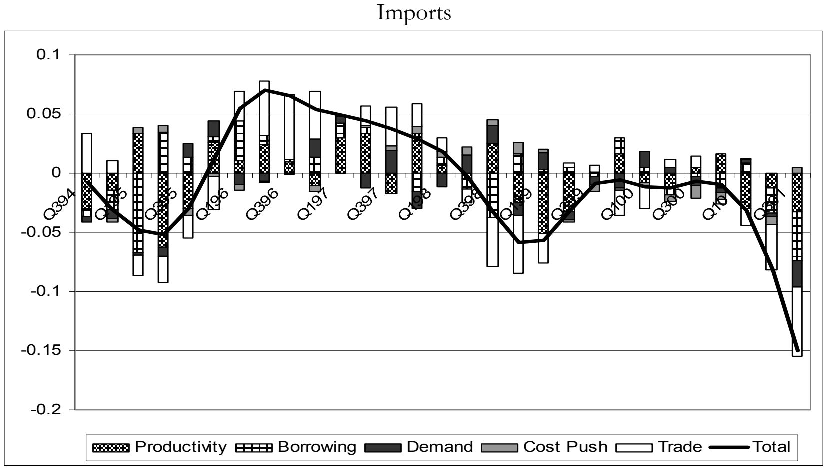
CPI inflation



Exports



Imports



Note: Quarterly growth (deviation from trend). Productivity shocks include neutral technology and investment specific. Borrowing cost shocks include foreign interest rate, idiosyncratic risk premium, and bank operating. The demand shock is the discount factor shock, and trade include both terms of trade and foreign demand shocks.

Figure 10. Bank Entry Stages

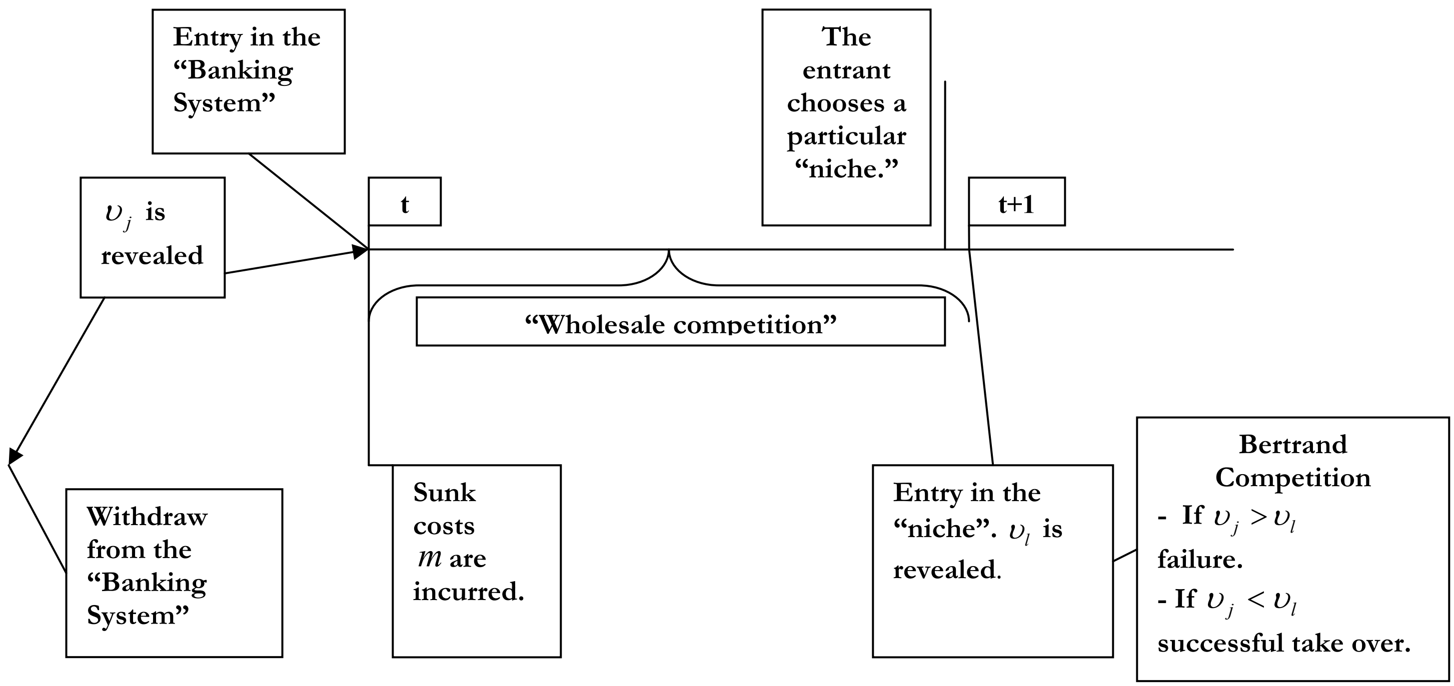
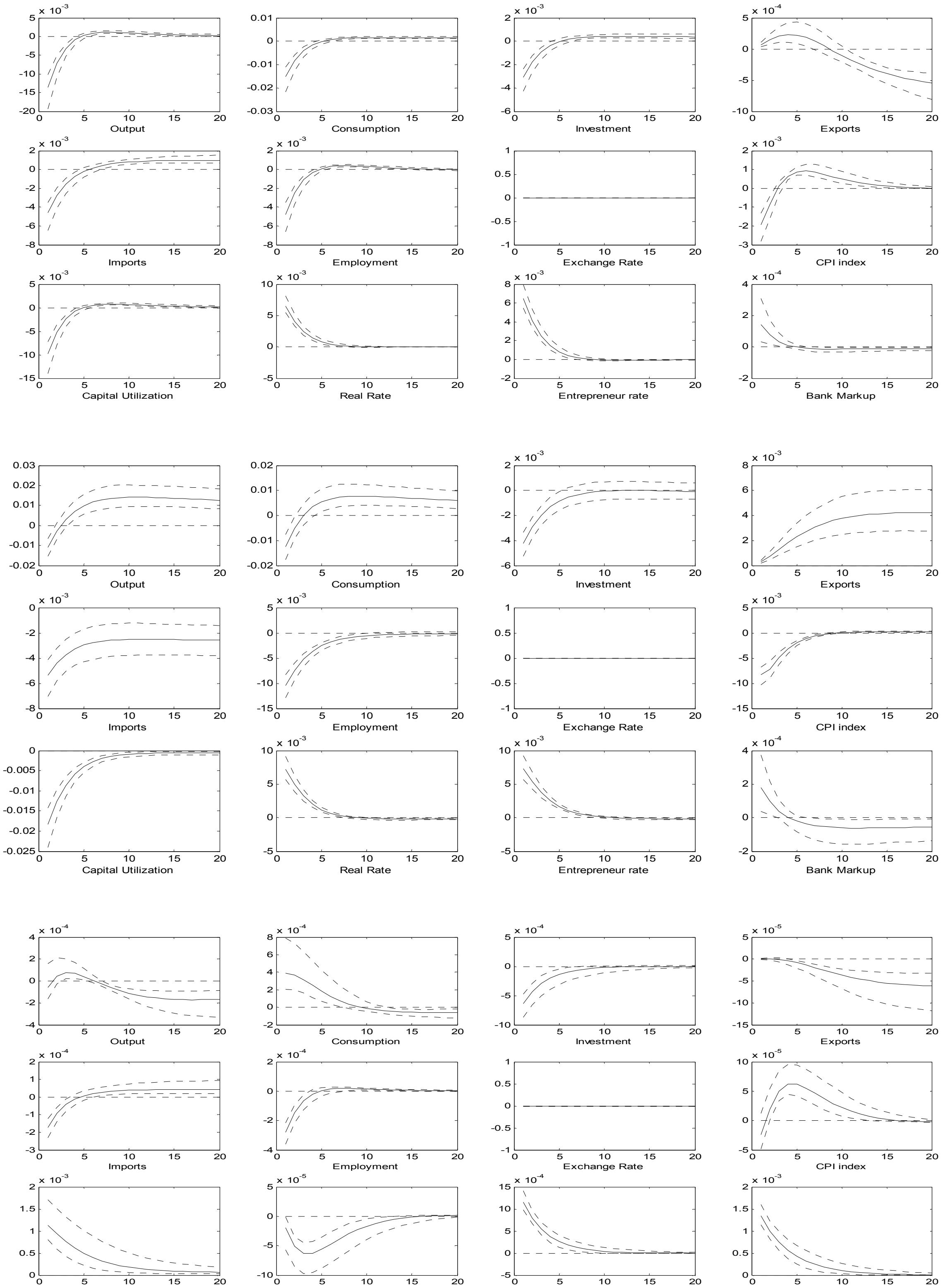
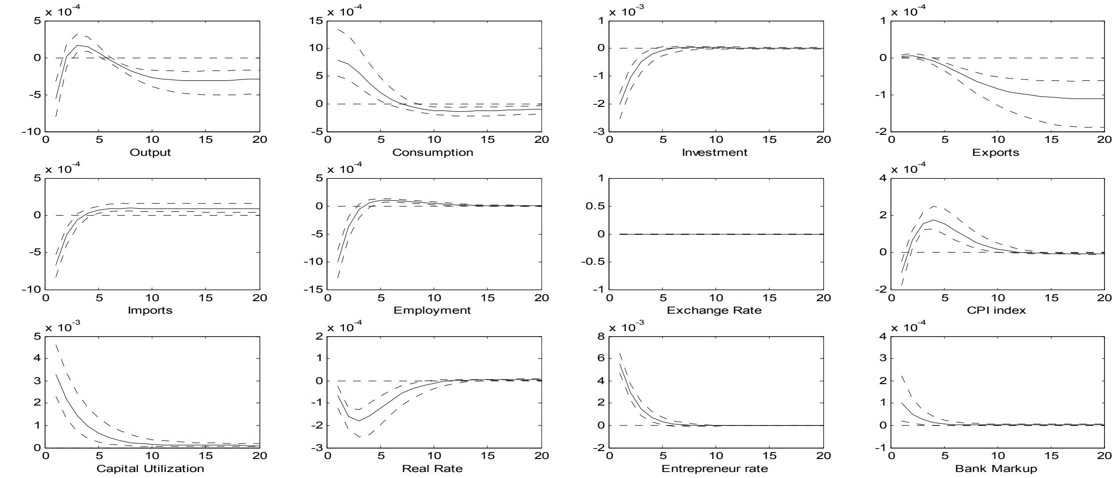
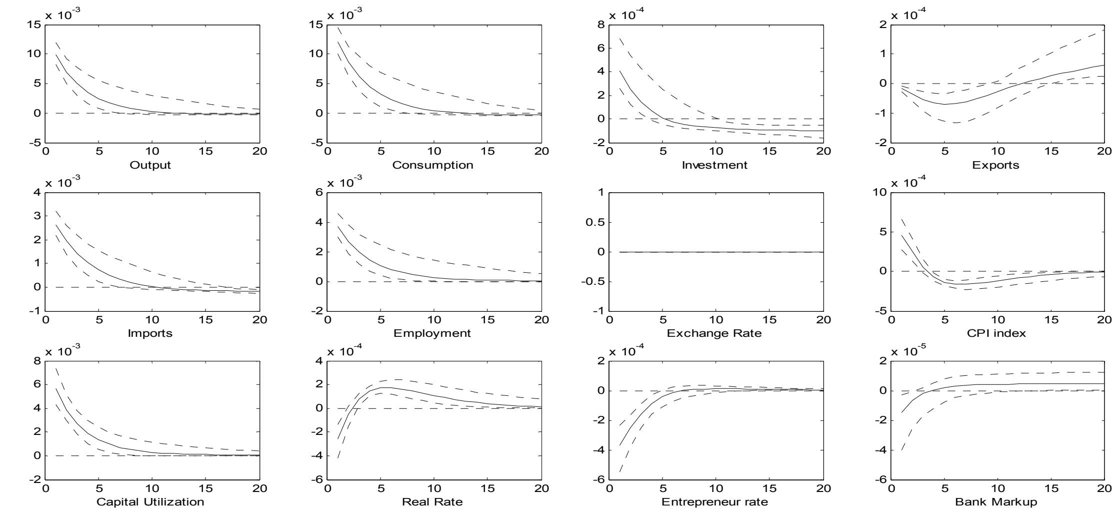
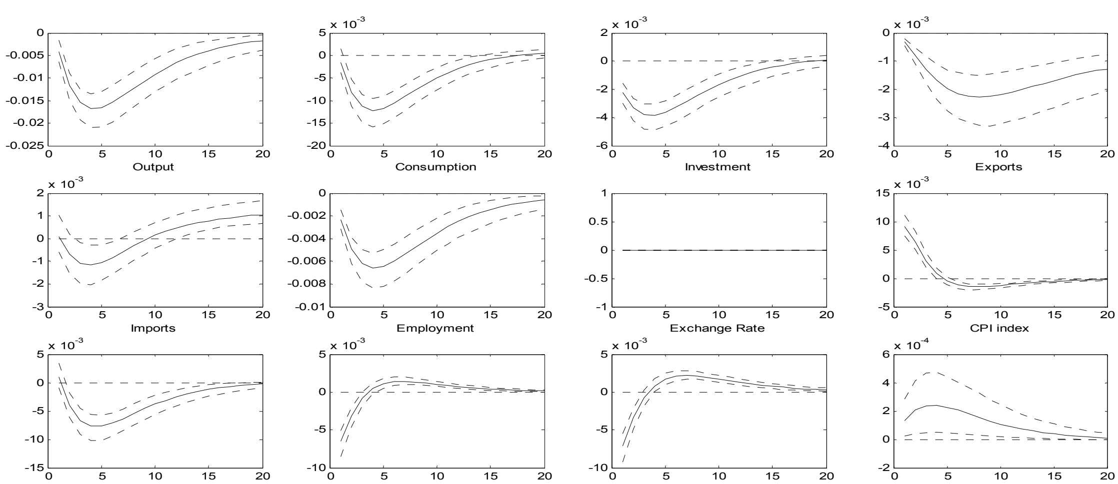


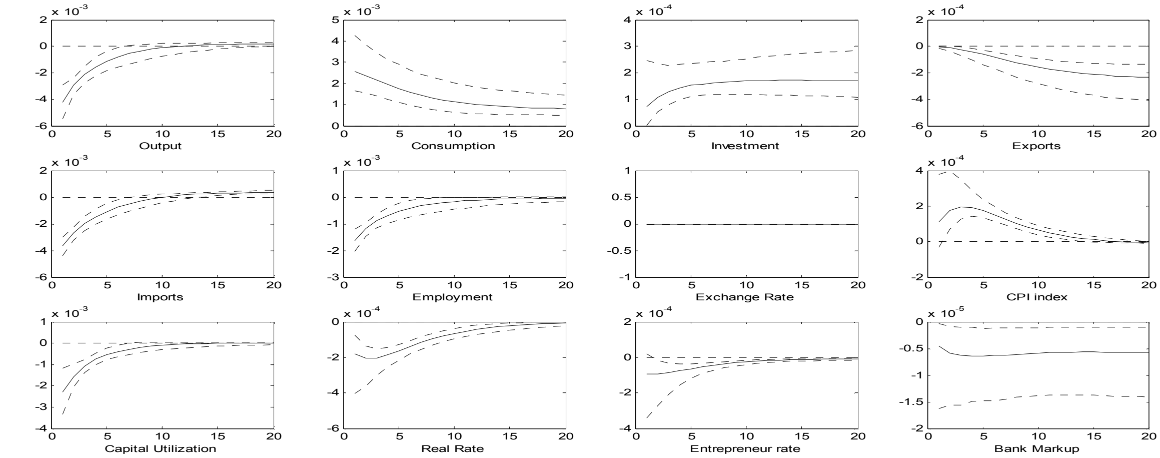
Figure 11. Impulse Response Functions to Model's shocks.

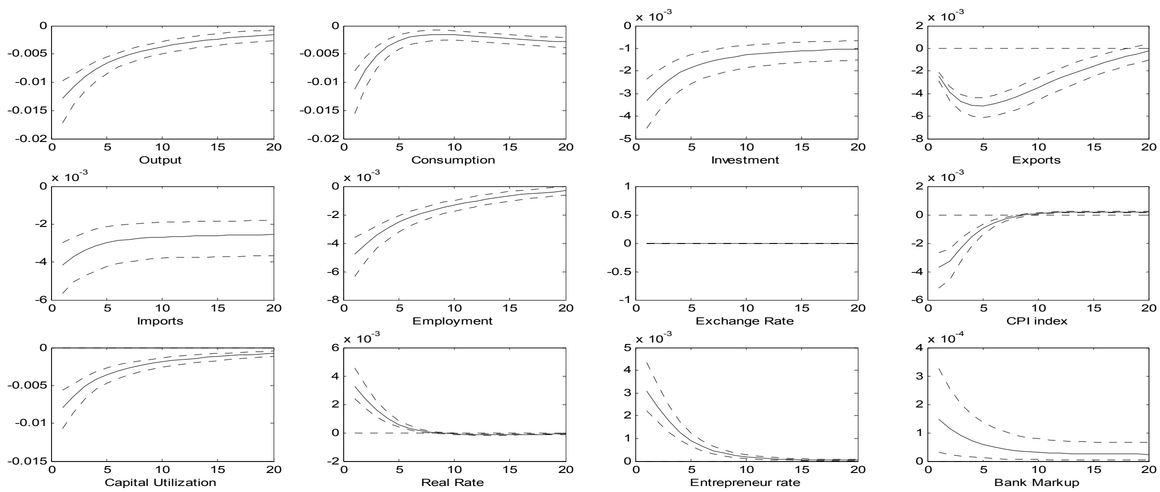


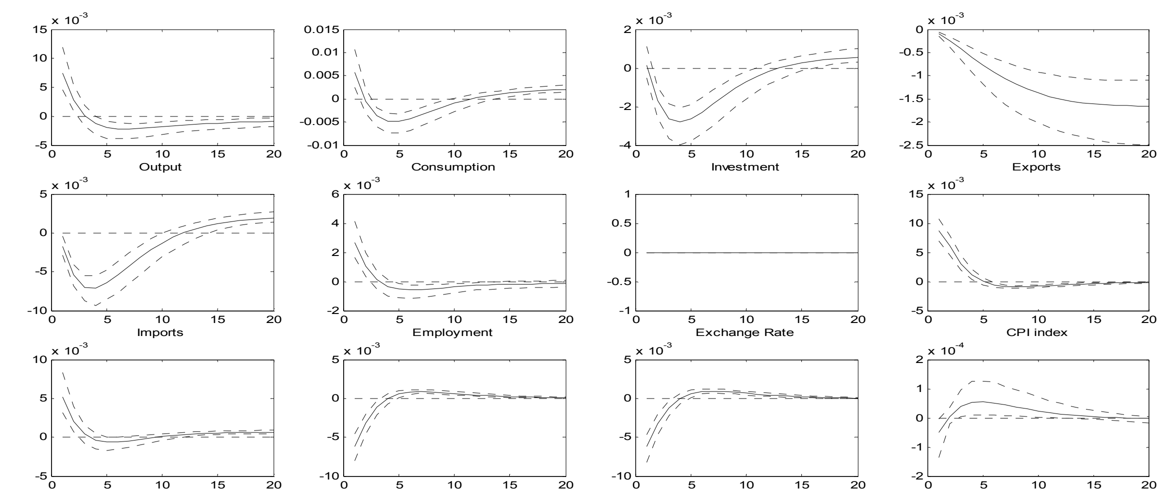

Output
Consumption
Investment
Exports
Imports
Employment
Exchange Rate
CPI index
Capital Utilization
Real Rate
Entrepreneur rate
Bank Markup


Output
Consumption
Investment
Exports
Imports
Employment
Exchange Rate
CPI index
Capital Utilization
Real Rate
Entrepreneur rate
Bank Markup


Output
Consumption
Investment
Exports
Imports
Employment
Exchange Rate
CPI index
Capital Utilization
Real Rate
Entrepreneur rate
Bank Markup







Note: The solid line is the median impulse response to one standard deviation of the shocks; the dotted lines are the 10 and 90 percent posterior intervals. Shocks are ordered as follows: foreign interest rate, neutral technology, bank operation costs, risk premium, discount factor, cost push, investment, export demand, terms of trade.

Figure 12. MCMC Univariate Convergence Diagnostics

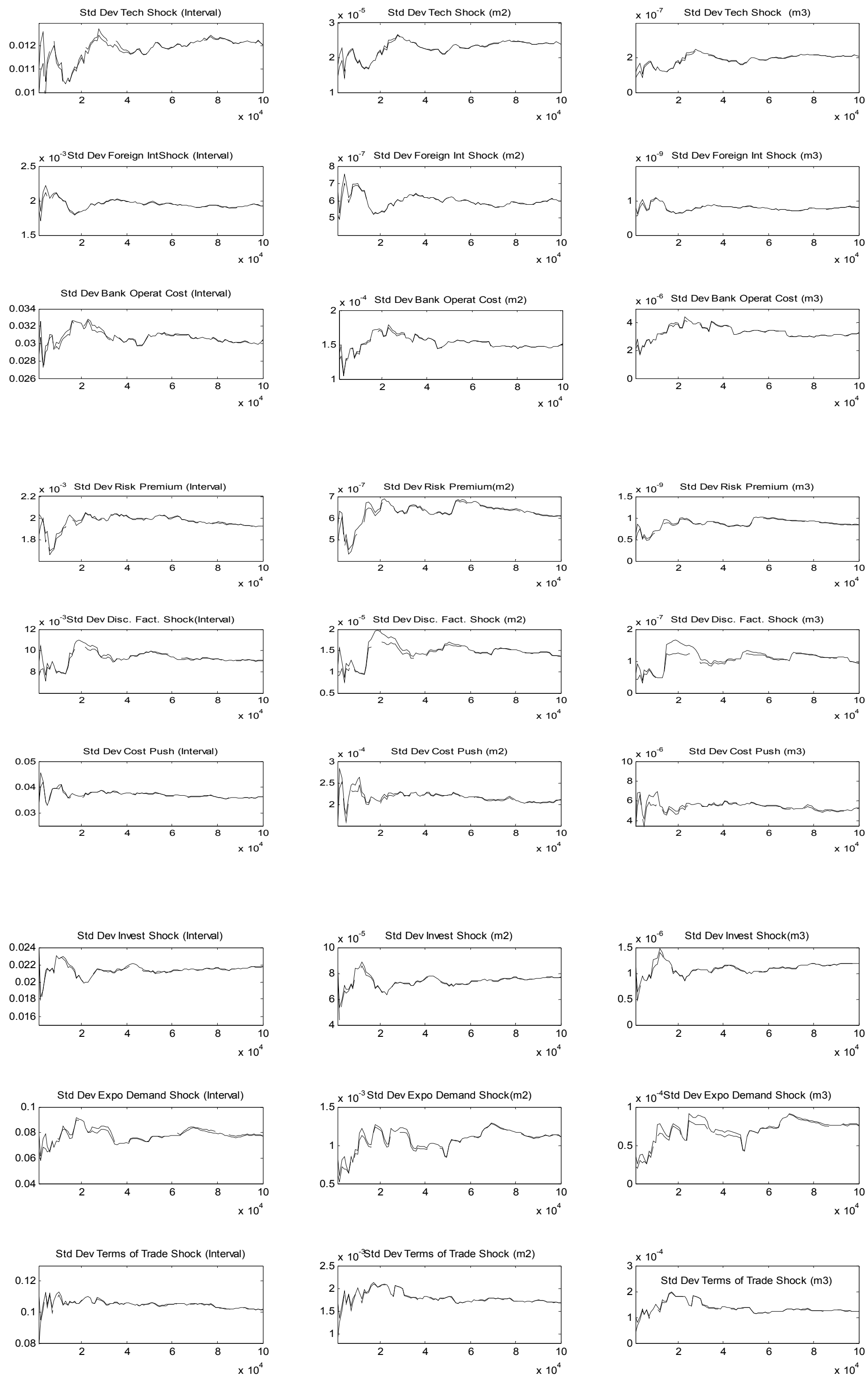


Figure 12. MCMC Univariate Convergence Diagnostics (Continuation)

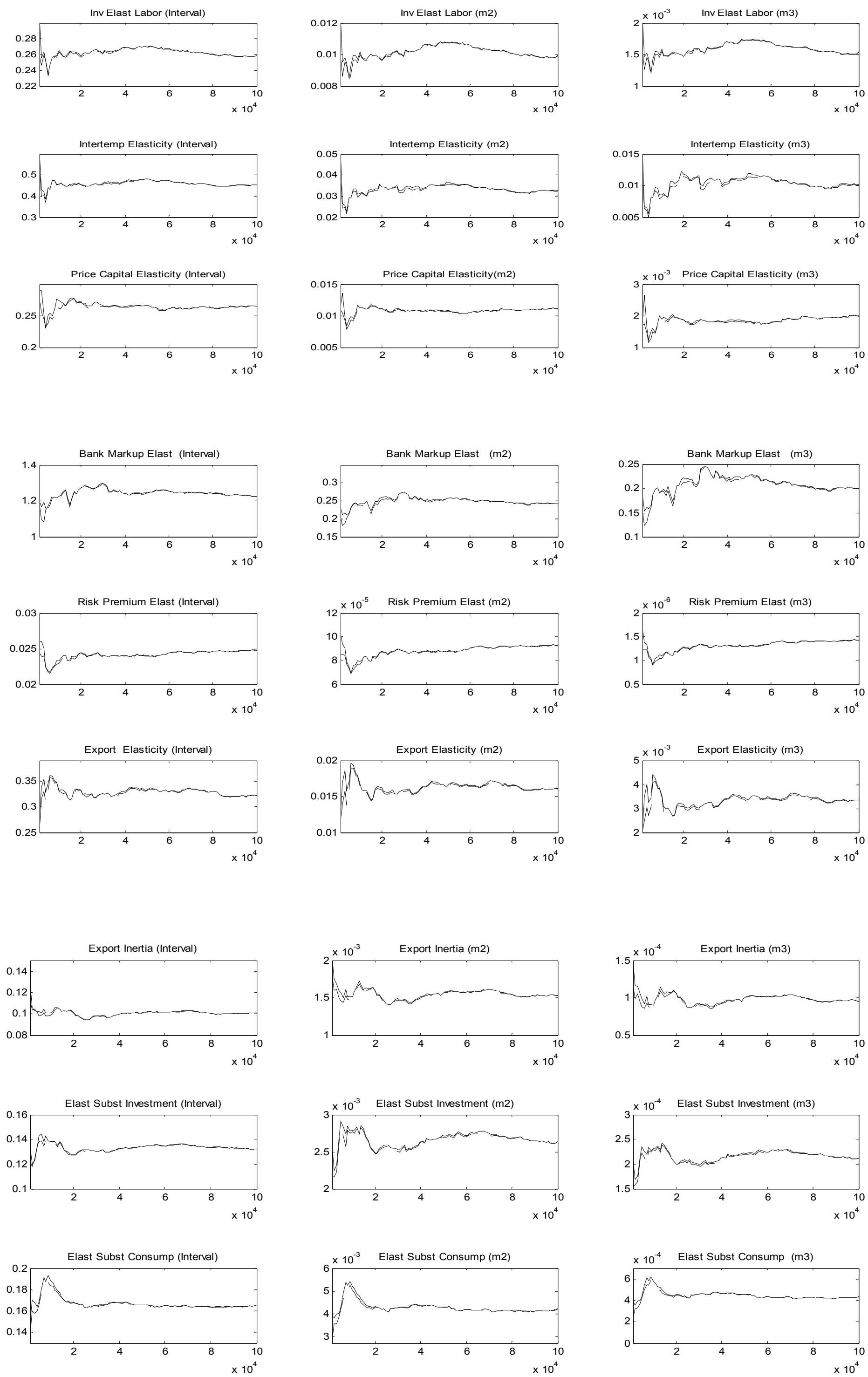


Figure 12. MCMC Univariate Convergence Diagnostics (Continuation)

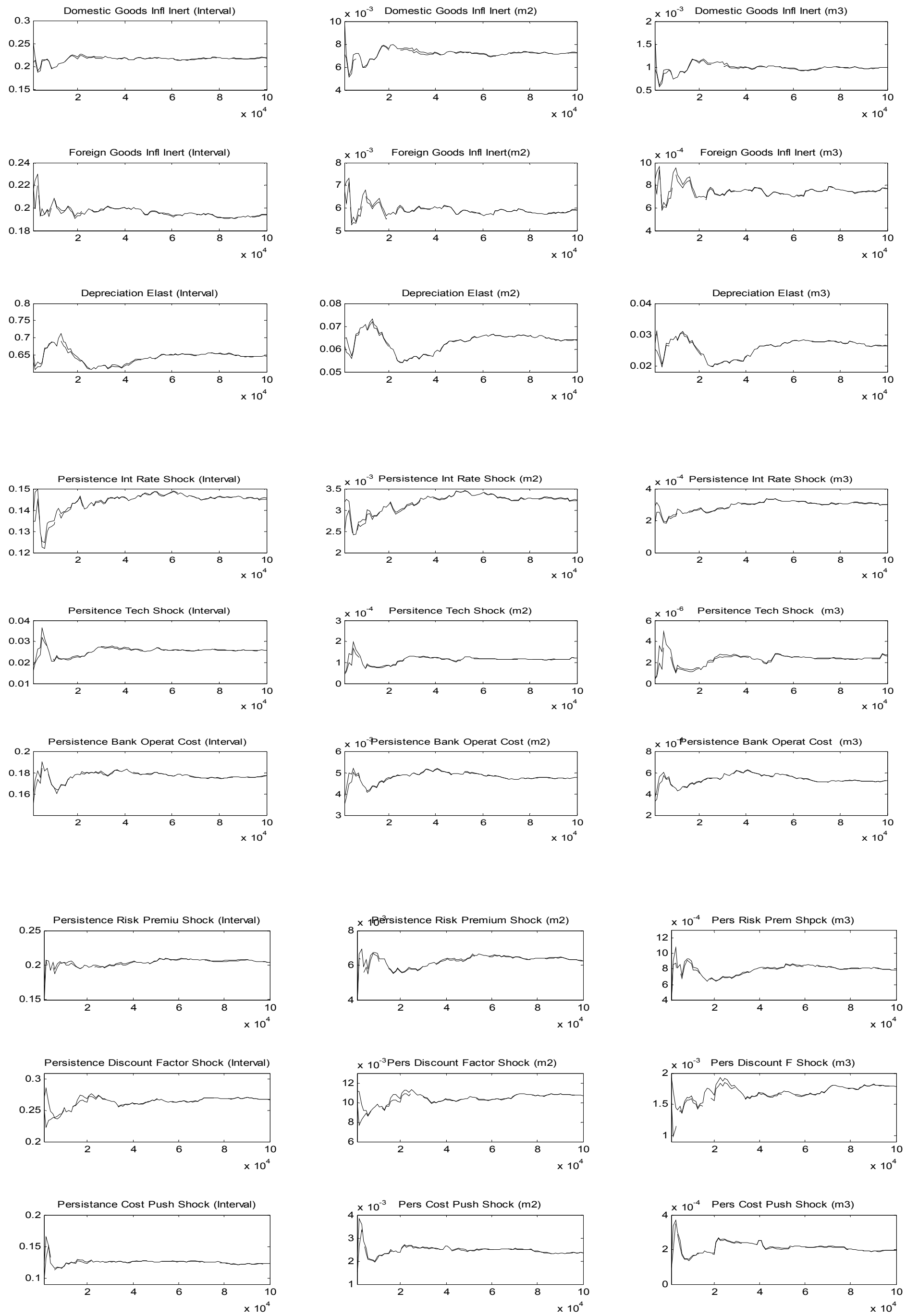
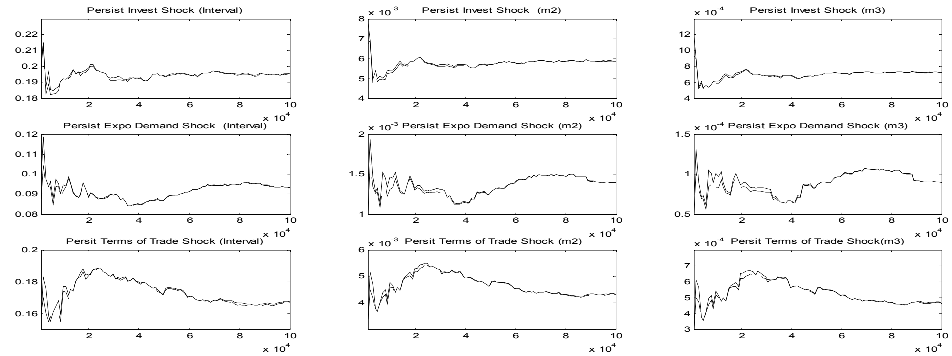
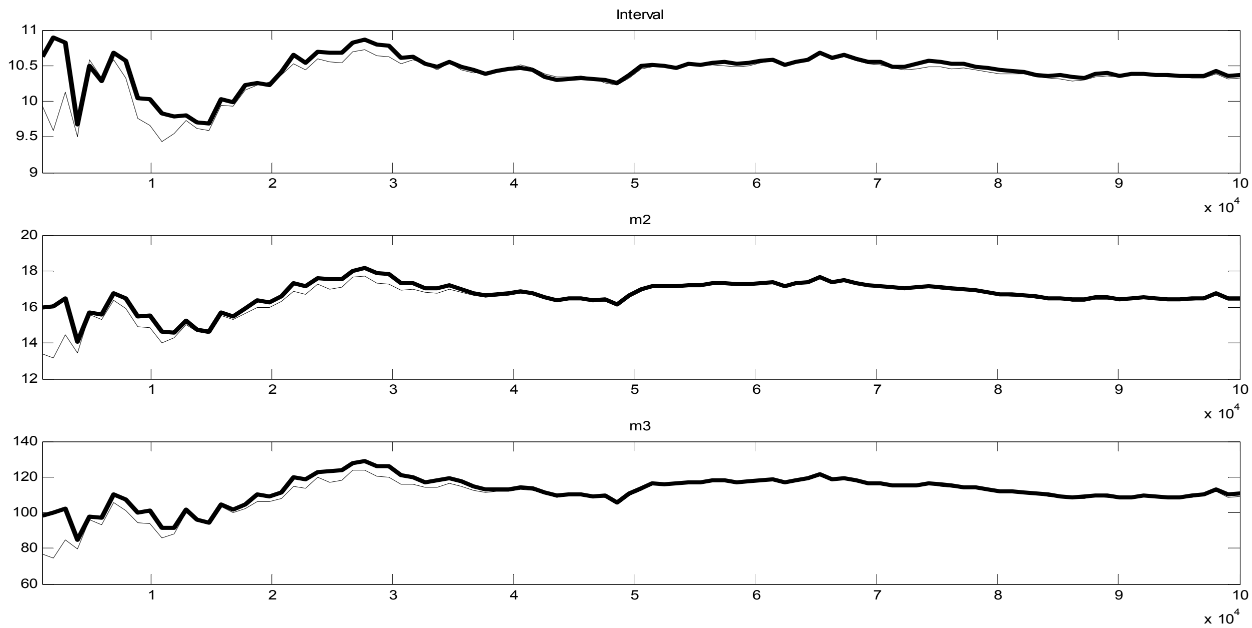


Figure 12. MCMC Univariate Convergence Diagnostics (Continuation)



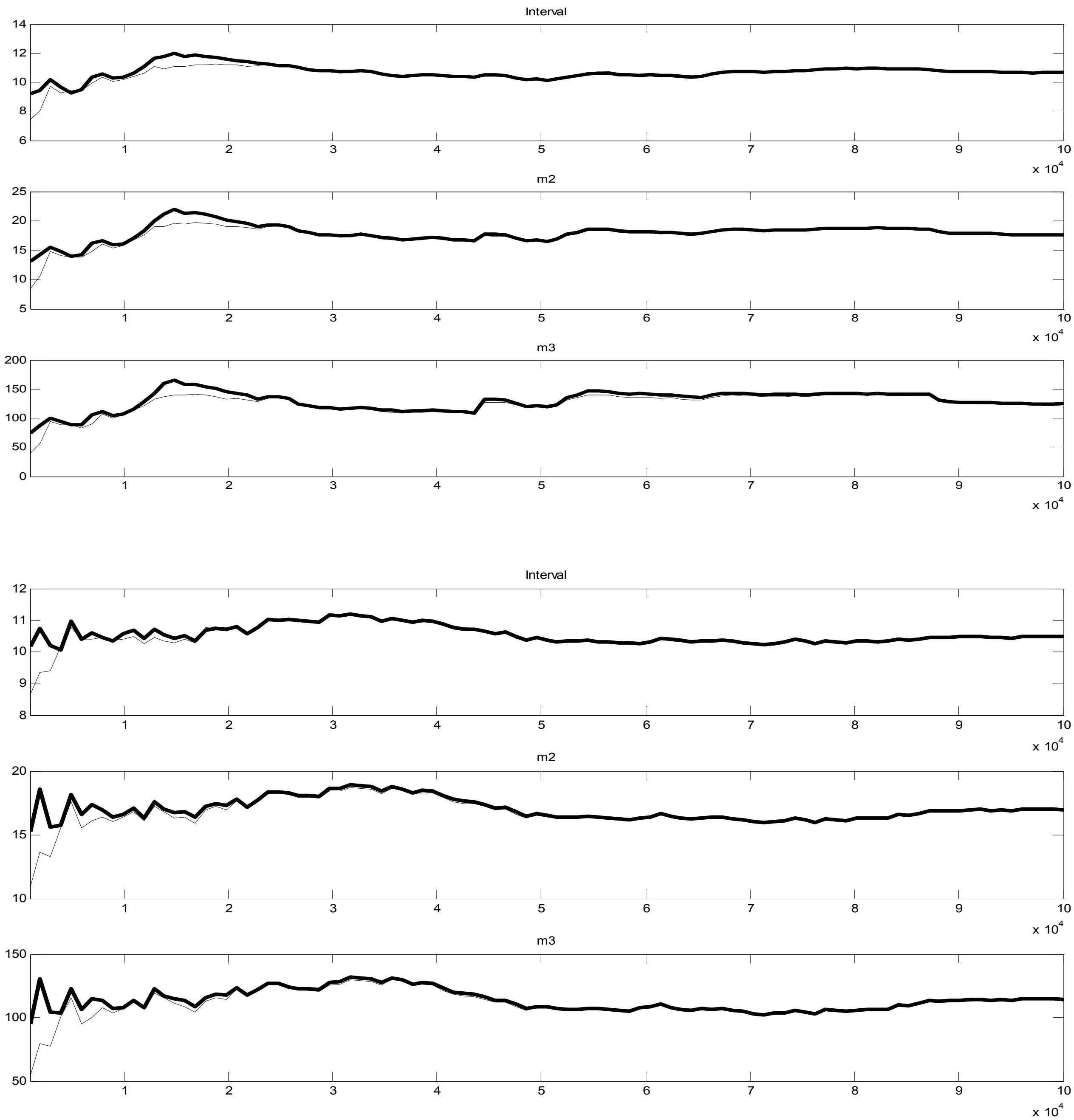
Note: Univariate convergence diagnostics- Brooks and Gelman (1998)-. The first, second and third columns are respectively the criteria based on the eighty percent interval, the second and third moments.

Figure 13. MCMC Multivariate Convergence Diagnostics



Note: Multivariate Convergence Diagnostics- Brooks and Gelman (1998)-. The first, second and third graphs are respectively the criteria based on the eighty percent interval, the second and third moments.

Figure 14. MCMC Multivariate Convergence Diagnostics (Sensitivity Analysis)



Note: Multivariate Convergence Diagnostics- Brooks and Gelman (1998)-. The first, second and third graphs are respectively the criteria based on the eighty percent interval, the second and third moments. The scale factor to draw the initial value of the multiple chains is increased by 25 and 100 percent respectively.