Financial considerations in a small open economy model for Mexico*

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Abstract

This paper develops a quantitative SOE model with financial frictions and an imperfectly competitive banking sector for the Mexican economy. The model is used to evaluate the role of both financial and banking frictions on the transmission and propagation of aggregate shocks into the economy, to assess the importance of financial shocks in business cycle fluctuations and try to examine considerations about the transmission mechanism of monetary policy.

1 Introduction

This paper develops a quantitative SOE model with financial frictions and a banking sector for the Mexican economy. The model Is designed to account for some of the most representative stylized facts of credit markets in Mexico and it is used to evaluate the role of both financial and banking frictions on the transmission of aggregate shocks into the economy.

As shown in the top panel of Figure 1 and in Table 1, new loans to households and firms (approximated by the quarter to quarter difference in credit volumes per sector as a percentage of GDP) are positively correlated with the business cycle, indicating that, as in many other countries, credit flows in Mexico are pro-cyclical. Moreover, the counter-cyclicality of the credit spreads that agents face (see bottom panel of Figure 1 and Table 1) suggests the presence of financial frictions in the domestic credit markets, as Quadrini (2011) points out. Another important feature of the Mexican banking system is given by the fact, although competition has gradually increased in the past years, the empirical evidence suggests that the market operates in an environment of monopolistic competition, which has potential implications for the transmission of monetary policy to other interest rates in the economy (see Negrín et. al. (2006) and Mier y Terán (2012)).

In particular, the framework we consider to characterize the main macro-financial linkages of the Mexican economy embeds collateral constraints, into a New Keynesian setup, in the vein of Iacovello (2005). The small open economy characterization of the model resembles the one proposed by Adolfson et. al. (2007) which features an incomplete exchange rate pass-through. In the model, patient agents provide resources to impatient agents who are constrained by credit limits which are, in turn, determined by the value of their collateral. On one hand, impatient households use their housing stock as collateral to finance their credit needs and, on the other hand, entrepreneurs use their capital holdings as source of collateral to finance part of their production. The inclusion of these financial frictions allows introducing an amplification mechanism of shocks into the model.

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Following Gerali et al. (2010) the behavior of a banking sector is explicitly introduced into our setup in order to capture the role of interest rate spreads in the transmission of monetary policy and in the propagation of business cycle dynamics. We assume that the banking sector intermediating resources among agents operates under monopolistic competition which prevent deposit and lending rates from being equal to the monetary policy rate. As an additional element the adjustment of interest rates in the economy is subject to certain degree of stickiness so as to capture the sluggish reaction of lending and saving rates to changes in the monetary policy rate.

The mix of a standard new Keynesian small open economy model with financial frictions and a banking sector allows capturing a comprehensive approach to model credit conditions that could affect the propagation of macroeconomic shocks. While aspects of the demand side for credit are considered in the introduction for financial frictions of impatient agents, credit supply features are introduced by the explicit modeling of a banking sector of the type just described. An additional benefit of our setup is that it is flexible enough to permit the introduction of additional financial frictions, such as working capital, and credit shocks (e.g. shocks to loan to value ratios) that could play an important role in determining the dynamics of the business cycle.

In this draft we present preliminary results about the dynamics of an estimated model for the Mexican economy as the one described. The model is estimated using Bayesian techniques. We pay particular attention to model's responses to productivity and monetary policy shocks.

This work is closely related to Brzoza-Brzezina and Makarski (2011) and Ajevskis and Vitola (2011) who introduce small open economy model versions into Gerali et al. (2010). Our contribution is to combine the previous framework with introduction of a working capital channel which seems to be one of the main uses of banking credit by firms in Mexico as suggested in Castellanos et al. (2012), CNBV (2012) and Banxico (2013). As mentioned in Quadrini (2011) a working capital channel associated to the borrowing constraint gives an extra kick to the amplification effects of financial frictions.

The draft is organized as follow. Section II describes the model. Section III presents the estimation results. In section IV we analyze the impulse response functions. In section V we present the concluding remarks and mention the next steps to pursue.

2 Model Economy

A said before, the model we present is one which incorporates heterogeneous agents into a small open economy model with financial frictions. The economy is populated by three different types of agents: patient households, impatient households and entrepreneurs. Both types of households consume, accumulate housing goods and supply work to labor packers. They differ in the fact that patient households save in deposit accounts whereas impatient households borrow subject to a collateral constraint. Entrepreneurs derive utility from consumption and in order to finance it, they produce a homogeneous intermediate good using capital, purchased from capital producers, and homogeneous labor, hired from labor packers; they also demand loans subject to a collateral constraint. Labor packers collect different varieties of work from each household and transform them into an homogeneous labor type to sell it to the entrepreneurs.

Production has three stages. First, entrepreneurs produce an homogeneous good which they sell to retailers (home firms or exporting firms). In the second stage home and exporting firms buy the homogeneous good from the entrepreneurs, brand them and sell them to home and export aggregators. In the third stage, home aggregators buy differentiated home and imported goods and aggregate them into a final homogeneous good.

There are capital and housing goods producers. These producers buy the respective undepreciated good from households and entrepreneurs, as well as a part of the final good (investment), to transform it into new capital or new housing goods. Both producers face investment adjustment cost.

This economy also features a banking system which intermediates resources between patient agents and impatient agents. The structure of this system can be represented by the diagram shown at the bottom of appendix C. As can be seen in the diagram, credit resources flow through several stages in which different entities are involved. Financial intermediaries receive resources from impatient households; these funds are captured by saving banks which in turn supply these resources in an interbank market. In addition to saving banks, net foreign lenders can provide of credit funds in the interbank market, thus consolidating the supply of funds to the economy. On the demand side for credit in the interbank market, there are borrowing banks which take loans and allocate them to borrowing intermediaries, which are the entities in charge to carrying out loans to firms and households. In our model, we assume that saving and borrowing banks interact in a monopolistic competition environment which generates spreads between the rates faced by the public and the rates negotiated in the interbank market. A detailed description of the market structure in each stage as well as the role of entities is provided below.

The model integrates financial frictions in two sides of the economy: i) real sector and ii) banking sector. On one hand we incorporate credit limits to agents in the real side of economy; on the other, we introduce frictions in the flow of funds in the banking system. The first group of frictions is collateral constraints in the ability to obtain credit. In the case of impatient households this constraint limits the amount of intertemporal debt that can be hired. For the case of entrepeneurs, this constraint limits the ability to obtain loans for either intertemporal debt or intra-temporal debt to finance working capital. In particular, the introduction of working capital associated with a collateral constraint creates a labor wedge which can generate non trivial effects on the real side of economy. We highlight the role of this ingredient since, as mentioned above, it is an important feature of the credit Mexican economy. The banking sector faces frictions in the flow of funds in the interbank market, in particular we introduce we introduce exogenous shocks that affect the amount of resources leaving (going in to) the interbank market. The purpose of introducing these types of shocks is that they can account for financial distresses that could be happening in the interbank market and which tighten (relax) the flow in the amount of credit of this economy. Introducing this type of ingredients allows us to analyze the effects that exogenous financial distress cause into the real side of the economy.

2.1 Households and entrepreneurs

The economy is populated by households and entrepreneurs, each one with unit mass. Households consume final goods, work and accumulate housing goods, while entrepreneurs produce intermediate homogeneous goods by buying capital from capital-goods producers, and hiring labor from labor packers. A key difference among the agents is their degree of impatience; in particular, households are divided into patient and impatient. Patient households have a discount factor β_P that is higher than that of impatient households, β_I, and entrepreneurs, β_E. This allows that in the neighborhood of the deterministic steady state, patient households become lenders and impatient households and entrepreneurs become borrowers.[1]

2.1.1 Patient households

A representative patient household i chooses consumption $c_t^P(i)$, housing goods $\chi_t^P(i)$, real wages $w_t^P(i)$ and deposits $D_t(i)$ in order to maximize its utility function subject to its budget constraint and the demand for its labor type.[2]

The utility function of a patient household i is:

$$E_0 \sum \beta_P^t \left[\varepsilon_t^u \frac{(c_t^P(i) - hc_{t-1}^P(i))^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_t^x \frac{\chi_t^P(i)^{1-\sigma_\chi}}{1-\sigma_\chi} - \varepsilon_t^n \frac{n_t^P(i)^{1+\sigma_n}}{1+\sigma_n} \right]$$

where ξ denotes the degree of habit persistence in consumption and ε_t^u, ε_t^χ and ε_t^n are preference exogenous shock processes for consumption, housing and labor, respectively. The intertemporal elasticity of substitution of consumption and housing goods are, respectively, σ_c and σ_χ, while the inverse of the Frisch elasticity of labor supply is σ_n.

Patient households own all the firms in this economy and therefore use its dividends $\Pi_t^P(i)$, labor income $\left(1 - \Phi_P\left(\pi_{w,t}^P\right)\right) P_t w_t^P(i) n_t^P(i)$, and deposits from the previous period multiplied by the interest rate on deposits $R_{D,t-1}^H$ to pay for consumption, housing accumulation, new deposits and lump sum taxes $T_t(i)$. This flow of funds is represented by the following budget constraint:

$$\begin{aligned} P_t c_t^P(i) + P_t^\chi \left(\chi_t^P(i) - (1-\delta_\chi)\chi_{t-1}^P(i)\right) + D_t(i) \quad \leq \quad & \left(1 - \Phi_P\left(\pi_{w,t}^P\right)\right) P_t w_t^P(i) n_t^P(i) \\ & + R_{D,t-1}^H D_{t-1}(i) - T_t(i) + \Pi_t^P(i) \end{aligned}$$

[1] Our assumption on discount factors is such that households' and entrepreneurs' borrowing constraints would bind in a neighbourhood of the steady state. We take the size of the shocks to be small enough so that these constraints always bind in that neighbourhood.

[2] The notation closely follows that of Brzoza-Brzezina and Makarski (2011).

where P_t and P_t^χ are, respectively, the price of consumption and housing goods, and δ_χ denotes the depreciation rate fo the housing stock. Patient households also face a cost for adjusting their nominal wages, represented by the cost function $\Phi_P\left(\pi_{w,t}^P\right)$, where $\pi_{w,t}^P \equiv \frac{P_t w_t^P(i)}{P_{t-1} w_{t-1}^P(i)}$ denotes the wage inflation for patient household i. The cost function have all the usual properties: in the deterministic steady state, and up to a first differentiation is equal to zero ($\Phi_P(1) = \Phi_P'(1) = 0$) and the function is concave in the neighborhood of the deterministic steady state $\left(\Phi_P''(1) = \kappa_w^P > 0\right)$.

Finally, the measure of all patient households is $\gamma^P < 1$.

2.1.2 Impatient households

Impatient households face a similar problem than their counterpart in the patient side of the economy. However, one key difference is important to recall: the discount factor of impatient households β_I is lower than the discount factor of patient households β_P.

A representative impatient household i chooses consumption $c_t^I(i)$, housing goods $\chi_t^I(i)$, real wages $w_t^I(i)$ and loans $L_t^H(i)$ in order to maximize its utility function subject to its budget constraint, the demand for its labor type and a borrowing constraint.

The utility function of an impatient household i is:

$$E_0 \sum \beta_I^t \left[\varepsilon_t^u \frac{(c_t^I(i) - hc_{t-1}^I(i))^{1-\sigma_c}}{1-\sigma_c} + \varepsilon_t^x \frac{\chi_t^I(i)^{1-\sigma_\chi}}{1-\sigma_\chi} - \varepsilon_t^n \frac{n_t^I(i)^{1+\sigma_n}}{1+\sigma_n}\right]$$

The impatient household i spends on consumption, housing goods and debt repayment $R_{L,t-1}^H L_{t-1}^H(i)$. To finance this spending, it uses its labor income $\left(1 - \Phi_I\left(\pi_{w,t}^I\right)\right) P_t w_t^I(i) n_t^I(i)$ and new borrowings. The budget constraint of this agent is given by:

$$\begin{aligned} P_t c_t^I(i) + P_t^\chi\left(\chi_t^I(i) - (1-\delta_\chi)\chi_{t-1}^I(i)\right) + R_{L,t-1}^H L_{t-1}^H(i) \quad &\leq \quad \left(1 - \Phi_I\left(\pi_{w,t}^I\right)\right) P_t w_t^I(i) n_t^I(i) \\ &\quad +L_t^H - T(i) \end{aligned}$$

As in the case of patient households, impatient households face a cost for changing nominal wages which is represented by the function $\Phi_I\left(\pi_{w,t}^I\right)$ which is analogous to the patient households cost function and where $\pi_{w,t}^I \equiv \frac{P_t w_t^I(i)}{P_{t-1} w_{t-1}^I(i)}$ denotes the wage inflation for impatient household i. Its properties are $\Phi_I(1) = \Phi_I'(1) = 0$ and $\Phi_I''(1) = \kappa_w^I > 0$.

This household faces a borrowing constraint which is represented by the following expression:

$$R_{L,t}^H L_t^H(i) \leq m_t^H E_t\left[P_{t+1}^\chi (1-\delta_\chi)\chi_t^I(i)\right]$$

where m_t^H is the households loan-to-value ratio which follows an exogenous process.

The measure of impatient households is $1 - \gamma^P$.

2.1.3 Entrepreneurs

Entrepreneurs receive utility only from their consumption. Also, as impatient households, the discount factor of entrepreneurs, β_E, is lower than the discount factor of patient households, β_P, so in the neighborhood of the deterministic steady state they are borrowers. In order to finance their expenditures, they sell an homogeneous intermediate good y_t^w in a competitive market, buying capital k_t from capital-good producers and hiring labor n_t from labor-packers. Also, entrepreneurs can demand loans as an additional income source. Entrepreneurs choose the level of capital utilization $u_t \in [0, \infty)$ but only at a cost $\psi(u_t)k_{t-1}$ which satisfies $\psi(1) = \psi'(1) = 0$ and $\psi''(1) > 0$. We assume that in the deterministic steady state $u_t = u = 1$.

A representative entrepreneur i chooses consumption $c_t^E(i)$, capital $k_t(i)$, labor $n_t(i)$, capital utilization $u_t(i)$ and new loans $L_t^F(i)$ in order to maximize its utility function subject to its budget constraint, its production function and a borrowing constraint.

The utility function of an entrepreneur i is:

$$E_0 \sum \beta_E^t \left[\varepsilon_t^u \frac{(c_t^E(i) - hc_{t-1}^E(i))^{1-\sigma_c}}{1-\sigma_c}\right]$$

The production function of the entrepreneur i that allows him to transform capital and labor services into an homogeneous good is the following:

$$y_t^w(i) = A_t \left[u_t(i)k_{t-1}(i)\right]^{\alpha} n_t(i)^{1-\alpha}$$

where A_t is an exogenous process for the total factor productivity. So, in order to finance consumption, capital accumulation, labor services, adjustment cost on the capital utilization rate and repayment of debt $R_{L,t-1}^F L_{t-1}^F(i)$, entrepreneur i uses the revenue from their output sales and new loans

$$P_t c_t^E(i) + P_t w_t n_t(i) + P_t^k \left(k_t(i) - (1-\delta_k)k_{t-1}(i)\right) + P_t \psi(u_t(i))k_{t-1}(i) + R_{L,t-1}^F L_{t-1}^F(i) \leq P_t^w y_t^w(i) + L_t^F(i)$$

The borrowing constraint that the entrepreneur faces is

$$R_{L,t}^F L_t^F(i) + w_t n_t(i) \leq m_t^F E_t \left[P_{t+1}^k (1-\delta_k) k_t(i)\right]$$

where m_t^F is the entrepreneurs loan-to-value ratio which follows an exogenous process. Notice that the entrepreneur obtains funds to finance two types of services: loans and working capital. Unlike usual loans $L_t^F(i)$ which pay an interest rate $R_{L,t}^F$ for the service of the resources, the working capital loans do not pay an interest rate, this occurs because we assume that this type of loans are intra-period.

2.1.4 Labor packer

In the labor market, we assume that there exists a labor packer that collects differentiated types of labor (offered by both patient and impatient households), aggregates them and sells a homogeneous labor input to entrepreneurs. The problem of the labor packers is to choose $n_t(i)$ $\forall$ i in order to maximize the following expression:

$$P_t w_t n_t - \int_0^1 P_t w_t(i) n_t(i) di$$

where labor aggregation is done through a standard Dixit-Stiglitz aggreagation function

$$n_t = \left(\int_0^1 n_t(i)^{\frac{1}{1+\mu_w}} di \right)^{1+\mu_w}$$

The solution of the labor packer problem yields the following demand function for each specific type of labor i :

$$n_t(i) = \left(\frac{w_t(i)}{w_t} \right)^{-\frac{1+\mu_w}{\mu_w}} n_t$$

where

$$w_t = \left(\int_0^1 w_t(i)^{-\frac{1}{\mu_w}} di \right)^{-\mu_w}$$

is a wage index that represents the cost of labor for entrepreneurs.

2.2 Producers

The economy consists is populated by producers of three types of goods: capital goods, housing goods and consumption goods. Producers of capital and housing goods operate in a competitive environment. The production of the consumptions goods comprises several steps. First, entrepreneurs produce undifferentiated goods and sell them at a competitive price to retailers. Then, retailers brand these goods and sell the differentiated good that come out from this branding process to aggregators at home and abroad. While domestic aggregators operate as final good producers combining differentiated domestic and foreign goods (imports) to transform them into a single final good, aggregators abroad combine these differentiated domestic goods and sell them to a foreign aggregator which, in turn, uses them as inputs to produce a single final good abroad.

2.2.1 Capital good producers

As said before, capital goods are produced by firms operating in a competitive market which it is sell capital at price $p_t^k = \frac{P_t^k}{P_t}$. Each period capital goods producers use old undepreciated capital, $(1-\delta_k)k_{t-1}$, from entrepreneurs and an amount i_t^k of the final consumption good as inputs for the production of capital. Their production technology transforms each unit of undepreciated capital into one unit of current capital; and transforms i_t^k into capital by incurring in an adjustment cost $S_k\left(\frac{i_t^k}{i_{t-1}^k}\right)$. Thus the production function for new capital can be represented by:

$$k_t = (1-\delta_k)k_{t-1} + \left(1 - S_k\left(\frac{i_t^k}{i_{t-1}^k}\right)\right) i_t^k$$

The characterization of the adjustment cost satisfies $S_k(1) = S_k^{'}(1) = 0$ and $S_k^{''}(1) = \frac{1}{\kappa_k} > 0$.

2.2.2 Housing good producers

The production of housing goods is similar to that of capital goods. Housing good producers sell their product at price $p_t^\chi = \frac{P_t^\chi}{P_t}$. Each period they use old undepreciated housing, $(1-\delta_\chi)\chi_{t-1}$, from households and an amount i_t^χ of the final consumption good. In the following production function:

$$\chi_t = (1-\delta_\chi)\chi_{t-1} + \left(1 - S_\chi\left(\frac{i_t^\chi}{i_{t-1}^\chi}\right)\right) i_t^\chi$$

where the adjustment cost function, $S_x\left(\frac{i_t^\chi}{i_{t-1}^\chi}\right)$, satisfies $S_x(1) = S_x^{'}(1) = 0$ and $S_x^{''}(1) = \frac{1}{\kappa_\chi} > 0$.

2.2.3 Final good producers

Domestic final good producers buy differentiated domestic goods $y_{H,t}(j_H)$ and import varieties $y_{F,t}(j_F)$ and aggregate them into a single final good. Then, they sell it in a perfectly competitive market. Their technology to produce is given by:

$$y_t = \left[\eta^{\frac{\mu}{1+\mu}} y_{H,t}^{\frac{\mu}{1+\mu}} + \eta^{\frac{\mu}{1+\mu}} y_{F,t}^{\frac{\mu}{1+\mu}}\right]^{\frac{\mu}{1+\mu}} \tag{1}$$

where

$$y_{H,t} = \left(\int_0^1 y_{H,t}(j_H)^{\frac{1}{1+\mu_H}} dj_H\right)^{1+\mu_H} \tag{2}$$

$$y_{F,t} = \left(\int_0^1 y_{F,t}(j_F)^{\frac{1}{1+\mu_F}} dj_F\right)^{1+\mu_F} \tag{3}$$

and η represents the degree of home bias. The demands for differentiated goods are obtained from solving

the maximization problem of the aggregator:

$$y_{H,t}(j_H) = \left(\frac{P_{H,t(j_H)}}{P_{H,t}}\right)^{-\frac{1+\mu_H}{\mu_H}} y_{H,t} \tag{4}$$

$$y_{F,t}(j_F) = \left(\frac{P_{F,t(j_F)}}{P_{F,t}}\right)^{-\frac{1+\mu_F}{\mu_F}} y_{F,t} \tag{5}$$

where

$$y_{H,t} = \eta\left(\frac{P_{H,t}}{P_t}\right)^{-\frac{1+\mu}{\mu}} y_t \tag{6}$$

$$y_{F,t} = (1-\eta)\left(\frac{P_{F,t}}{P_t}\right)^{-\frac{1+\mu}{\mu}} y_t \tag{7}$$

and the price aggregates are

$$P_{H,t} = \left[\int P_{H,t}(j_H)^{-\frac{1}{\mu_H}} dj_H \right]^{-\mu_H} \tag{8}$$

$$P_{F,t} = \left[\int P_{F,t}(j_F)^{-\frac{1}{\mu_F}} dj_F \right]^{-\mu_F} \tag{9}$$

2.3 Domestic retailers

Domestic retailers consist of firms that buy an homogenous intermediate good from entrepreneurs, differentiate it by brand naming it (j_H) and then sell these differentiated goods producers. Thus, the nominal

marginal cost that domestic retailers face is given by P_t^w, the price of the domestic intermediate good produced by the entrepreneur. We assume that domestic retailers face sticky prices à la Calvo. Accordingly, each domestic retailer has a probability $1-\theta_H$ to reset its price optimally, $P_{H,t+1}^{new}$, in any period. With probability θ_H the retailer is not allowed to reoptimize, and set its price according to the following updating rule $\widetilde{P}_{H,t+1}(j_H) = P_{H,t}(j_H)\left[(1-\zeta_H)\overline{\pi} + \zeta_H \pi_{t-1}\right]$,where $\zeta_H \ \epsilon \ [0,1]$. Those retailers setting their optimal price face the following problem:

$$\max_{P_{H,t+1}^{new}} \ E_t \sum_{s=0}^{\infty} (\beta^p \theta_H) \Lambda_{t,t+s+1}^p \left[\prod_{s=1}^{t+s-1} \left[(1-\zeta_H)\overline{\pi} + \zeta_h \pi_{t+s-1}\right] P_{H,t+1}^{new} - P_{w,t} \right] y_{H,t+s}(j_H) \tag{10}$$

subject to the demand for the differentiated good $y_{H,t}(j_H)$ represented by (4).

Aggregating the price charged by optimizing and non-optimizing domestic retailers yields the price index for domestic goods in the economy:

$$P_{H,t} = \left[\theta_H^{-\frac{1}{\mu_H}} \widetilde{P}_{H,t} dj_H + (1-\theta_H) \int P_{H,t}^{new}(j_H)^{-\frac{1}{\mu_H}} dj_H \right]^{-\mu_H} \tag{11}$$

2.4 Importing retailers

Importing retailers consist of firms purchasing an homogenous good in the world, differentiating it brand naming it (j_F) and selling these differentiated goods to final goods aggregators. Thus, the nominal marginal

cost that they face is given by $e_t P_t^*$, where e_t is the nominal exchange rate and P_t^* is the price of the homogeneous good expressed in terms of the foreign currency. In order to allow for incomplete exchange rate pass-through in the price of imported goods, we follow and assume that import prices are sticky in the local currency; notice that this feature can be attained by assuming a Calvo rule setup. According to this rule, each foreign retailer face a probability $1-\theta_F$ to reset its price optimally in every period, represented by $P_{F,t+1}^{new}$. With probability θ_F the retailer is not allowed to reoptimize and sets its price accordingly to the following updating rule $\widetilde{P}_{F,t+1}(j_F) = P_{F,t}(j_F)\left[(1-\zeta_F)\overline{\pi} + \zeta_F \pi_{t-1}\right]$,where $\zeta_F \ \epsilon \ [0,1]$. Those retailers setting their optimal prices face the following problem:

$$\max_{P_{F,t+1}^{new}} \ E_t \sum_{s=0}^{\infty} (\beta^p \theta_F) \Lambda_{t,t+s+1}^p \left[\prod_{s=1}^{t+s-1} \left[(1-\zeta_F)\overline{\pi} + \zeta_F \pi_{t+s-1}\right] P_{F,t+1}^{new} - e_t P_t^* \right] y_{F,t+s}(j_F) \tag{12}$$

subject to the demand for the differentiated good $y_{F,t}(j_F)$ represented by(5).

Aggregating the price charged by optimizing and non-optimizing foreign retailers yields the price index of the foreign goods:

$$P_{F,t} = \left[\theta_F^{-\frac{1}{\mu_F}} \widetilde{P}_{F,t} dj_F + (1-\theta_F) \int P_{F,t}^{new}(j_F)^{-\frac{1}{\mu_H}} dj_F \right]^{-\mu_F} \tag{13}$$

2.4.1 Exporting retailers

The exporting retailers purchase the intermediate domestic good from entrepreneurs and differentiate it by brand naming it (j_H^*). Thus, the nominal marginal cost of is given by $\frac{P_t^w}{e_t}$, where e_t is the nominal exchange rate. Notice that this expression corresponds to price of the domestically produced good expressed in terms of the foreign currency. Each exporting retailer (j_H^*) faces the following demand $y_{H,t}^*(j_H^*)$ for its product:

$$y_{H,t}^*(j_H^*) = \left(\frac{P_{H,t}^*(j_H^*)}{P_{H,t}^*} \right)^{-\frac{1+\mu_H^*}{\mu_H^*}} y_{H,t}^* \tag{14}$$

where we assume that the export price $P_{H,t}^*(j_H^*)$ is expressed in terms of the foreign currency. The aggregate output for $y_{H,t}^*$ is defined by

$$y_{H,t}^* = \left(\int_0^1 y_{H,t}^*(j_H^*)^{\frac{1}{1+\mu_H^*}} dj_H^* \right)^{1+\mu_H^*} \tag{15}$$

and $P_{H,t}^*$ is

$$P_{H,t}^* = \left[\int_0^1 y_{H,t}^*(j_H^*)^{-\frac{1+\mu_H^*}{\mu_H^*}} dj_H^* \right]^{-\mu_H^*} \tag{16}$$

Assuming that foreign demand can be represented by a CES function, the external demand for $y_{H,t}^*$ is given by:

$$y_{H,t}^* = (1-\eta^*) \left(\frac{P_{H,t}^*}{P_t^*} \right)^{-\frac{1+\mu_H^*}{\mu_H^*}} y_t^* \tag{17}$$

In order to allow for incomplete exchange rate pass-through in the price of exported goods, we follow and assume that export prices are sticky in the foreign currency; notice that this feature can be attained by assuming a Calvo rule setup. According to this rule, each foreign retailer face a probability $1-\theta_H^*$ to reset its price optimally every period, represented by $P_{H,t+1}^{*,new}$. With probability θ_H^* the retailer is not allowed to reoptimize and set its price accordingly tp the following updating rule $\widetilde{P}_{H,t+1}^*(j_H^*) = P_{H,t}^*(j_H^*) \left[(1-\zeta_H^*)\overline{\pi}^* + \zeta_H^* \pi_{t-1}^* \right]$, where $\zeta_H^* \; \epsilon \; [0,1]$. Those retailers setting their optimal prices face the following problem:

$$\max_{P_{H,t+1}^{*,new}} E_t \sum_{s=0}^{\infty} (\beta^p \theta_H^*) \Lambda_{t,t+s+1}^p \left[\prod_{s=1}^{t+s-1} \left[(1-\zeta_H^*)\overline{\pi}^* + \zeta_H^* \pi_{t+s-1}^* \right] P_{H,t+1}^{*,new} - \frac{P_{w,t+s}}{e_{t+s}} \right] y_{H,t+s}^*(j_H^*) \tag{18}$$

subject to the foreign demand for the good variety (j_H^*), represented by (14).

2.5 Financial block

The model considers a banking sector where banks interact in a monopolistically competitive environment which allows to generate interest rate spreads between the monetary policy rate and the interest rates that households and entrepreneurs face. Furthermore, in order to capture an incomplete short-run pass-through from movements in the monetary policy interest rate to the other interest rates in the economy we assume sluggish interest rates.

The structure of the banking sector includes two blocks (i.e. the savings and lending blocks) with several partitions in the flow of credit. At the bottom of the structure, competitive financial intermediaries interact with households and entrepreneurs in order to receive or allocate credit. At the middle of the structure, monopolistically competitive banks interact with financial intermediaries in order to receive or allocate credit. At the top, these banks deposit or obtain funds in the interbank market. It is important to notice that in this setup resources from the interbank market are not available for financial intermediaries that interact with households and entrepreneurs.

In the savings block, saving intermediaries have two roles. On one hand, they capture savings from households offering a competitive interest rate; on the other hand, they receive "offers" for those savings from different banks and allocate them among those banks. The allocation of those resources among banks occurs at a noncompetitive interest rate since saving intermediaries possess market power. In turn, those banks use these resources to open saving accounts in the interbank market. The way the market is partitioned allows to generate a spread between interbank interest rate and the saving rate perceived by households.

The lending block operates in a similar manner to the savings block but with an additional consideration: there exists specialization to lending to households and entrepreneurs. Some banks are specialized in lending to entrepreneurs and others in lending to households. Thus, the lending flow from the interbank market to households and to entrepreneur operates in two parallel structures. Monopolistically competitive lending banks obtain resources from the interbank market at a common interest rate. Each bank uses its market power to allocate those resources to lending intermediaries at a differentiated interest rate, above the interbank interest rate. Financial intermediaries then allocate those loans between households and firms at a competitive interest rate. As in the saving block, the partition generates a spread among the interbank rate and the lending rates.

In order to introduce the sluggish adjustment of interest rates, the model considers that banks face nominal rigidities à la Calvo. At every period a subset of banks are able adjust their interest rates while another subset has to set interest rates anchoring them to previous rates.

In addition, we introduce exogenously driven shocks in the flow of funds from monopolistically competitive banks to the interbank market. These shocks are meant to represent exogenous factors that can produce interference, or fluency, in the flow of funds in the banking system. In particular, these shocks could represent a complex production function of funds when they are transiting between the interbank market and banking sector. This production function could comprise several factors which operate in the efficiency of the allocations of loans. Under our current setup, these shocks are materialized as exogenous changes in the spreads on the interest rates.

In the next part we describe the structure of the banking system by characterizing each stage of the flow of funds model.

2.5.1 Financial intermediaries

As described above at the bottom (but in opposite sides) of the banking structure we have saving and lending intermediaries. While the main are the main recipients of resources from the domestic economy, the latter provide credit to the economy.

Saving intermediaries draw resources from the domestic economy and channel them to the banking system. Saving intermediaries receive offers from different banks to receive a differentiated interest rate, $R^H_{D,t}(i^H_D)$, in exchange of saving resources, $D_t(i^H_D)$. These intermediaries capture the required resources from patient households, D_t, in exchange of a competitive interest rate, R^D_t. Then, saving intermediaries transform the required resources from different banks, $D_t(i^H_D)$, in an aggregate amount of deposits, D_t, through the following technology:

$$D_t = \left[\int_0^1 D_t(i^H_D)^{\frac{1}{1+\mu_D}} di^H_D \right]^{1+\mu_D} \tag{19}$$

Once the aggregate amount of deposits is produced, this intermediary interacts in a competitive market in which it receives D_t in exchange of R^D_t and allocate these resources among saving banks $D_t(i^H_D)$ in exchange of $R^H_{D,t}(i^H_D)$. Its problem is hence given by:

$$\max_{D_t(i_D^H)} \frac{1}{R_{D,t}^H} D_t - \int_0^1 \frac{1}{R_{D,t}^H(i_D^H)} D_t(i_D^H) di_D^H \tag{20}$$

Lending intermediaries obtain differentiated loans from lending banks (i_L^j) at interest rate $R_{L,t}^j(i_L^j)$. Then, they aggregate those loans to produce an undifferentiated loan by using the following technology:

$$L_t^j = \left[\int_0^1 L_t^j(i_L^j)^{\frac{1}{1+\mu_L^j}} di_L^j\right]^{1+\mu_L^j} \tag{21}$$

Once L_t^j is produced, this intermediary make loans to agents of type j at the interest rate R_L^j in a competitive environment. Its problem hence consists of choosing $L_t^j(i_L^j)$ in order to maximize

$$R_{L,}^j L_t^j - \int_0^1 R_{L,t}^j(i_L^j) L_t^j(i_L^j) di_L^j \tag{22}$$

subject to 21. The individual demand for lending products $L_t^j(i_L^j)$ can be obtained from the optimality conditions of these problems

$$L_t^j(i_L^j) = \left(\frac{R_{L,t}^j(i_L^j)}{R_{L,t}^j}\right)^{\frac{1+\mu_L^j}{\mu_L^j}} L_t^j \tag{23}$$

and given the zero profit condition we can find the aggregate interest rate $R_{L,t}^j$:

$$R_{L,t}^j = \left(\int_0^1 R_{L,t}^j(i_L^j)^{\frac{1}{\mu_L^j}} di_L^j\right)^{-\mu_L^j} \tag{24}$$

$$L_t^H = \left[\int_0^1 L_t^H(i_L^H)^{\frac{1}{1+\mu_L^H}} di_L^H\right]^{1+\mu_l^H} \tag{25}$$

$$D_t^H(i_D^H) = \left(\frac{R_{D,t}^H(i_D^H)}{R_{D,t}^H}\right)^{\frac{1+\mu_D^H}{\mu_D^H}} D_t^H \tag{26}$$

$$L_t^H(i_D^H) = \left(\frac{R_{L,t}^H(i_L^H)}{R_{L,t}^H}\right)^{\frac{1+\mu_L^H}{\mu_L^H}} L_t^H \tag{27}$$

$$L_t^F(i_D^F) = \left(\frac{R_{L,t}^F(i_L^F)}{R_{L,t}^F}\right)^{\frac{1+\mu_L^F}{\mu_L^F}} L_t^F \tag{28}$$

$$R_t^D = \left(\int_0^1 R_t^D(i_D^H)^{\frac{1}{\mu_D^H}} di_D^H\right)^{\mu_D^H} \tag{29}$$

$$R_{L,t}^H = \left(\int_0^1 R_{L,t}^H(i_L^H)^{\frac{1}{\mu_L^H}} di_L^H\right)^{-\mu_L^H} \tag{30}$$

$$R_{L,t}^F = \left(\int_0^1 R_{L,t}^F(i_L^F)^{\frac{1}{\mu_L^F}} di_L^F\right)^{-\mu_L^F} \tag{31}$$

2.5.2 Saving banks

The role of saving banks (i_D^H) is to capture resources from saving intermediate banks and deposit them in the interbank market. Each saving bank (i_D^H) obtains deposits $D_t(i_D^H)$ from saving intermediaries and repays a return of $R_{D,t}^H(i_D^H)$ for these resources. In turn, saving banks deposit these funds in the interbank market at the monetary policy rate R_t. In order to introduce shocks that disturb the spreads in the banking sector, it is assumed that deposits channeled from saving intermediaries to the interbank market are exogenously affected by a shock $z_{D,t}^H$, thus for each unit of $D_t(i_D^H)$ a quantity $z_{D,t}^H$ is canalized to the interbank market resulting in deposits $D_{IB,t}(i_D^H)$.

$$D_{IB,t}(i_D^H) = z_{D,t}^H D_t(i_D^H) \tag{32}$$

In addition, saving banks operate in a monopolistically competitive market, in which they set the interest rate $R_{D,t}^H(i_D^H)$ that maximizes their profits. In order to introduce sticky interest rates, it is assumed that banks set their interest rates with a Calvo rule; according to this rule, every period, each bank receives a signal to optimally set its optimal interest rate, $R_t^{D,new}$, with probability $1-\theta_D$. With probability θ_D it sets their interest rates to R_{t-1}^D. Thus a bank which is able to optimize its interest rate today has to incorporate the possibility of not being able to set optimal rates in the future. This results in the following optimization problem:

$$\max_{R_t^{D,new}} E_t \sum_{s=0}^{\infty} \theta_D^s \beta_p^{S+1} \Lambda_{t,t+s+1}^p \left[R_{t+s} D_{IB,t+s}^H(i_D^H) - R_t^{D,new}(i_D^H) D_{t+s}^H(i_D^H) \right] \tag{33}$$

subject to 26 and 32. Notice that $\Lambda_{t,t+s+1}^p = \frac{u_{c,t+s+1}^p}{u_{c,t}^P}$ and $\beta_p^{S+1}\Lambda_{t,t+s+1}^p$ is the discount factor of the patient household which own the banks in this economy.

2.5.3 Lending banks

In this structure there exists two types of lending banks, one lends to households (i_L^H) and the other lends to firms (i_L^F). The role of lending banks is to borrow resources from the interbank market, $L_{IB,t}^j$, at the monetary policy rate R_t, in order to lend L_t^j at rate $R_t^j(i_L^j)$ to lending intermediaries, where $j \epsilon \{H, F\}$. As in the case of saving banks, in order to introduce shocks that disturb the spreads in the banking sector, it is assumed that resources flowing from interbank market to lending intermediaries are exogenously affected by shocks $z_{L,t}^j$. This is:

$$L_t^j(i_L^j) = z_{L,t}^j L_{IB,t}^j(i_L^j) \tag{34}$$

As in the case of saving banks, lending banks operate in a monopolistically competitive market, in which they set the interest rate $R_t(i_L^j)$ that maximizes their profits. In order to introduce sticky interest rates, it is assumed that banks set their interest rates with a Calvo rule; according to this rule, every period, each bank receives a signal to optimally set its optimal interest rate,$R_t^{new}(i_L^j)$, with probability $1-\theta_L$. With probability θ_L it sets their interest rates to $R_{L,t-1}^j$. Thus a bank which is able to optimize its interest rate today has to incorporate the possibility of not being able to set optimal rates in the future. Thus a bank which is able to optimize its interest rate today has to incorporate the possibility of not being able to set optimal rates in the future. This results in the following problem:

$$\max_{R_{L,t}^{j,new}} E_t \sum_{s=0}^{\infty} \theta_D^s \beta_I^{S+1} \Lambda_{t,t+s+1}^p \left[R_{L,t}^{j,new}(i_L^j) L_{t+s}^j(i_L^j) - R_{t+s} L_{IB,t+s}^j(i_L^j) \right] \tag{35}$$

subject to deposits demand and channel formula. Notice that $\Lambda_{t,t+s+1}^p = \frac{u_{c,t+s+1}^p}{u_{c,t}^P}$ and $\beta_p^{S+1}\Lambda_{t,t+s+1}^p$ is the discount factor of the patient household which own the banks in this economy.

In addition, banks can obtain resources from the foreign interbank market subject to a risk premium, ρ_t, which, in turn, is a function of the level foreign debt position to GDP, as follows:

$$\rho_t = \exp\left(\varrho \frac{e_t L_t^*}{P_t \widetilde{y}_t} \right) \varepsilon_t^\rho \tag{36}$$

where L_t^* is the level of foreign debt, $\widetilde{y}_t$ is the real GDP and ε_t^ρ are i.i.d. normal innovations. This term is used to represent the uncovered interest rate parity condition:

$$R_t = e_t R_t^* \rho_t \tag{37}$$

2.6 Government

We assume that the government budget is balanced and given by:

$$G_t = T_t \tag{38}$$

where G_t represents the government expenditure and T_t represents lump sum taxes on households. Additionally, G_t is exogenously driven by the following process:

$$G_t = \rho_G \mu_G + (1 - \rho_G) G_{t-1} + \varepsilon_{G,t} \tag{39}$$

with $\rho_G \in (0, 1)$ and $\varepsilon_{G,t}$ i.i.d.

2.7 Central bank

Monetary policy is performed according to a Taylor rule of the form:

$$\frac{R_t}{\overline{\overline{R}}} = \left(\frac{R_{t-1}}{\overline{\overline{R}}}\right)^{\gamma_R} \left(\left(\frac{\pi_t}{\overline{\pi}}\right)^{\gamma_\pi} \left(\frac{\widetilde{y}_t}{\overline{\overline{\widetilde{y}}}}\right)^{\gamma_y}\right)^{1-\gamma_R} \varepsilon_{R,t} \tag{40}$$

where $\overline{\pi}$ is the inflation target, $\overline{\overline{\widetilde{y}}}$ is the steady state level of GDP and $\varepsilon_{R,t}$ represents i.i.d. shocks that capture deviations from the rule.

2.8 Foreign economy

We assume a simple way for modeling the foreign economy in three independent autoregressive process of order one, each one with i.i.d innovations.

2.9 Market Clearing conditions, balance of payments and GDP

The final goods market clearing condition is given by:

$$c_t + i_{k,t} + i_{\chi,t} + g_t + \psi(u_t) k_{t-1} = y_t \tag{41}$$

where

$$c_t = \left(1 - \gamma^P\right) c_t^I + \gamma^P c_t^P + c_t^E \tag{42}$$

With respect to intermediate goods, its market clearing condition is given by:

$$\int_0^1 y_{H,t}(j) dj + \int_0^1 y_{H,t}^*(j) dj = y_{W,t}$$

The market clearing condition for the housing market is given by:

$$\gamma^P \chi_t^P + \left(1-\gamma^P\right)\chi_t^I = \chi_{t-1} \quad (43)$$

The balance of payments is represented as follows:

$$\int_0^1 P_{F,t}(j_F)y_{F,t}(j_F)dj_F + e_t R_{t-1}^* \rho_{t-1} L_{t-1}^* = \int_0^1 e_t P_{H,t}^*(j_H^*)y_{H,t}^*(j_H^*)dj_H^* + e_t L_t^* \quad (44)$$

Finally, GDP is defined by the following relationship:

$$P_t\widetilde{y_t} = P_t y_t + \int_0^1 e_t P_{H,t}^*(j_H^*)y_{H,t}^*(j_H^*)dj_H^* - \int_0^1 P_{F,t}(j_F)y_{F,t}(j_F)dj_F \quad (45)$$

3 Estimation

3.1 Data

We use 11 observable variables to estimate the model. These variables can be divided into three subsets: domestic macroeconomic variables, domestic banking variables and foreign macroeconomic variables. The first group encompasses real consumption, real investment, real exports, real imports, inflation and the money market interest rate. The second group includes spreads between the monetary policy interest rate and the credit rates faced by the public; specifically we use spread on: deposits, loans to households and loans to firms. The third group of variables only includes US output.

We use quarterly data from 2000.Q2 to 2013.Q1,. Variables were transformed as follows: most macroeconomic real variables, either domestic or foreign, were detrended using the average growth rate of GDP of its corresponding country and then transformed to deviations from their sample means.[3]

3.2 Calibrated parameters and estimation results

Table 1 reports the calibrated parameters of the model. Specifically, these are two sets of parameters. One that accounts for those parameters whose values are taken from related previous studies and on another that accounts for those parameters that were calibrated to match the empirical moments of the Mexican data along the sample period. The additional calibrated parameters used in the loglinearized version of the model were taken from the steady state relationships, as shown in Appendix E.

The discount factor for patient households β_P is set to 0.999. In order to make sure that the borrowing constraint is binding in the neighborhood of the steady state, we set $\beta_I = \beta_E = 0.985$. Depreciation rates of capital and housing goods are set to $\delta_k = 0.02$ and $\delta_\chi = 0.0125$, respectively. The elasticity of capital in the entrepreneur's production function is set equal to 0.34 following the work of García-Verdú (2005). The inflation target $\overline{\pi}$ is set equal to 3 % (in annual terms) which corresponds to the inflation target of Banco de Mexico since 2001. The steady state policy rate is set equal to 7 % (in annual terms). The parameter μ is set equal to one, implying an elasticity of substitution between domestic and foreign goods of 2. The degree of home bias is set to $\eta = 0.6$. The markup for wages μ_w equals 0.1 implying a 10% steady state markup over wages. The measure of the patient households is set to $\gamma_P = 0.65$.

Tables 2 and 3 show the prior distributions along with the mean and the posterior mode of the estimated parameters.

3.3 Robustness

One estimation result which is noteworthy comes from the analysis of the marginal likelihood of the model with and without working capital. The model with working capital reports a marginal likelihood of -747

[3] Real imports and exports are not treated in the same fashion. Since both variables show relatively higher growth rates in the sample than the average growth rate of GDP, these were detrended using the average sample growth for the exports. The Mexican inflation and monetary policy interest rates received a particular treatment. During the first three years of the sample period, inflation was above today's permanent 3 % target because this period corresponds to the beginning of a disinflation process in Mexico. Therefore, we subtracted to these nominal variables the "excess target" from the first years of the sample in order to make them consistent with an inflation target of 3 %, as in the rest of the sample.

while the model without working capital reports a value of -777. This implies that working capital is an important feature to consider in the model in order to better capture the properties of the Mexican data.

4 Properties of the estimated model: impulse response analysis

In this section we analyze the response of the economy to two main types of shocks: i) monetary policy shock and ii) banking sector shocks. The purpose of the analyses of the first type of shock is twofold: to provide a standard assessment of the estimated model dynamics and to inspect the role of the working capital channel in the propagation of shocks into the model economy. The second type of shocks is used to analyze how exogenous shocks that generate banking distress are propagated to the real side of the economy.[4]

Before examining the transmission of shocks into the economy, we briefly discuss how the working capital channel affects the response of the economy to the different types of shocks. First, from the optimality condition associated to hiring an extra unit of labor (expression [46] below) we can observe that there exists a labor wedge. $\lambda_{c,t}^{E}$ refers to the marginal utility of consumption of the entrepreneur while μ_t^F refers to the shadow price associated with the borrowing constraint of the firm. Notice that by restraining the availability of resources to finance working capital, a labor wedge is generated in the entrepreneur's decision to hire an additional unit of labor. At the beginning of the production period, firms have to pay the entire amount of payroll in advance, however, the existence of enforceability problems constraints firms in the maximum amount of resources that they can obtain for this purpose.[5] Thus, when entrepreneurs consider the cost of an additional unit of labor, not only they take into account the market cost of labor but also the shadow price associated with the limit in the amount of available resources that could be used to pay for this factor of production. Thus, when the economy faces a shock that relaxes the collateral constraint, ceteris paribus, there is a decrease in the cost of labor which induces an increase in the hiring of labor services, that, in turn, may affect the real supply side of the economy. Hence, shocks that relax (tighten) the collateral constraint have non-trivial real effects.

$$\frac{(\lambda_{c,t}^{E}+\mu_t^F)w_t}{\lambda_{c,t}^{E}} = \left[(1-\alpha)\, P_t^w A_t \left(u_t k_{t-1}\right)^{\alpha} \left(n_t\right)^{-\alpha}\right] \tag{46}$$

4.1 Monetary Policy Shock

Figure 4 depicts the impulse response function of the economy to a contractionary shock in the monetary policy rate (i.e. an increase in the policy rate). As can be observed, macroeconomic variables go in the expected directions (i.e. output and inflation decrease). However, notice that when the working capital channel is at work, the initial response of real variables is dampened and the volatility of responses decreases. The key mechanism through which working capital operates in order to yield this result consists in one in which the usual response to this shock relaxes the borrowing constraint of the entrepreneurs. A positive shock in the monetary policy rate decrease the amount of labor supply and wages; this change decrease the amount of payroll that needs to be financed, thus leading to a relaxation of the collateral constraint. This last effect, decrease the cost of labor and motivates entrepreneurs to dampen the decrease in the labor demand. Also, the relaxation of the collateral constraint allows entrepreneurs to decrease the initial fall in the demand for final goods, namely investment and consumption. In addition, the fall of the price of capital is dampened by the decrease in the initial fall for investment. In the margin, this relaxes even more the collateral constraint. With respect to those variables related to the credit sector, we observe the expected decrease in loans to impatient households as a usual reaction of the increase in the monetary policy rate. However, the reaction of loans to entrepreneurs behaves in opposite directions conditional on the existence of working capital. In particular, in the model with working capital, the reduction in the amount of payroll payments that must be financed allows entrepreneurs to accumulate a greater level of intertemporal debt.[6]

[4] It is noteworthy to mention that the baseline model with a working capital channel has different steady state values than the model without this feature. So, when it comes to compare these two models this should be kept in mind.

[5] We assume that firms cannot use their end-of-period, revenues to pay for this needs.

[6] Notice that the estimated model does not contradict evidence shown in models with similar characteristics. In fact the reaction of loans to firms in the model without working capital is similar to the one shown in Gerali et al. (2011). However these authors recognize that they contradict empirical VAR evidence which shows that lending to firms tends to increase after

4.2 Banking shocks

4.2.1 Shock to flow of funds directed from households to the interbank market

Figure 5, shows a negative shock in the amount of resources that intermediate banks introduce into the interbank market. This shock can be thought of as an exogenous decrease in the interest rate that patient households face. The figure shows that this increases real variables as well inflation. The decrease in the interest rate faced by lender households increases their consumption in final goods which, in turn, increase total production. Notice that the demand effect of patient households is non-trivial since its size is considerably high. In this scenario the monetary policy reacts to buffer the increase in output.

Overall, the responses of the model with working capital are similar to those of the model without this feature. However, the model with working capital is less reactive to the shock on impact. This difference is explained because the increase in the demand for final goods requires an increase in the hiring of factors of production (capital and labor). There is an increase in the cost of payroll services which in turn tightens the financial constraint of entrepreneurs. This tightening increases even more the internal cost of labor faced by entrepreneurs. The last effect is translated into smaller increase in the demand for labor when compared to that in the model without working capital. Thus, in a world where a working capital channel is at work, entrepreneurs face higher costs to hire labor, therefore reducing the demand for this production factor and, ultimately, slowing the reaction of the economy.

Even when this shock disrupts the flow of credit in the economy, it activates a demand channel strong enough to activate economic activity.

4.2.2 Shock to the flow of funds directed to households

Figure 6 shows a negative shock in the flow of funds that intermediate banks can obtain the interbank market and allocate to households. This shock can be interpreted as an increase in the interest rate faced by impatient households. This shock generates a small reaction in the magnitudes of the responses of real variables and inflation. The increase in this interest rate tightens the borrowing constraint faced by impatient households, decreasing the price of housing goods, and tightening even more this constraint. The decrease in the discounted future price of housing decreases the agent's will to hold this asset, thus households increase their consumption of final goods. The decrease in the price of housing generates downward pressure on inflation to which monetary policy reacts by decreasing monetary policy interest rate. However, the decrease in both, the interest rates and current housing prices create a wealth effect on patient households who consume more housing and final goods. The boost in the consumption of this last group of consumers drives an increase in output.

The only seemingly effect of the working capital channel in this case occurs when looking at loans to firms. In both types of models, there is a decrease in the price of capital which tightens the constraint thus reducing the amount of loans. However, in the model with working capital, there is an increase in wages which tightens the borrowing constraint even more which, in turn, reduces the amount of loans to firms.

4.2.3 Shock to the flow of funds directed to firms

Figure 7 shows a negative shock in the flow of funds that intermediate banks can obtain from the interbank market and allocate to firms. This shock can be thought of as an increase in the lending interest rate for firms. The figure shows a decrease in total output, investment and inflation, as well as increases in consumption. This shock decreases demands for loans to firms hence decreasing the demand for capital. The price of capital also falls which, in turn, decreases capital investment. The monetary policy authority decreases the interest rate, thus patient households increase their consumption driving an increase in aggregate consumption. Overall, the decrease in investment outweighs the increase in consumption, thus decreasing output.

The figure also shows that in the presence of the working capital channel the economy is more reactive to this shock. The rationale behind this result is that in the model with working capital the borrowing constraint relaxes while in the model without working capital it tightens. Given a fall in payroll payments, the relaxation of the borrowing constraint changes the internal relative prices faced by the entrepreneur: on one hand it decrease the cost of labor, but on the other hand the price of capital increases. In this estimation

a monetary policy tightening.

the former effect dominates, thus in the working capital economy, entrepreneurs reduce their capital stock even more and decrease its labor demand almost by the same amount than its counterpart model.

5 Conclusion

We estimated a new Keynesian small open economy model for the Mexican economy which incorporates financial frictions, in the form of collateral constraints and a working capital channel, as well as a monopolistic competitive banking sector featuring interest rate stickiness. We analyze the magnitude of macroeconomic and credit variables' responses to different types of shocks.

First, we study the transmission of a contractionary monetary policy shock with and without a working capital channel. We find that macroeconomic variables are more responsive when the working capital channel is excluded; this is due to the fact that, in the model with working capital subject to a collateral constraint, the shock decreases the need for financing payroll expenses, thus relaxing the credit constraint, which, in turn, decreases the costs of firms to hire other factors of production.

Secondly, we study the transmission of shocks generated through distress in sectorial banks. A key result about the analysis of this propagation is that sectorial shocks originated in the financial block of the model induce a response from the monetary policy that affects, in the end, the whole economy. Therefore, there is an aggregate response to a sectorial shock with general consequences. This happens because the monetary policy is short sighted. If there is a demand shock that increases the price of an asset and ultimately generates inflation, the monetary authority will respond by rising the policy interest rate. The increase of the policy rate will depress demand in other sectors which could eventually decrease aggregate output. Then, it could be the case that the policy interest rate may be an instrument that exacerbates the reaction of the whole economy to mitigate a sectorial shock.

The policy interest rate is a blunt instrument and the conduction of the monetary policy may harm the whole economy if it reacts in a traditional way. This fact raises two questions. First, whether the conduction of monetary policy should take into account more factors to respond to a financial shock, and not only the inflation and output gap. Second, whether there are other instruments that could address these shocks in a better way. The next step in this project would be to extend the modeling of the banking sector in order to introduce capital in the balance sheets of the banks. This would allow to a better characterizing of the shocks that originate in the banking sector and that a macroprudential authority could emerge using as instrument the banks' capital requirements. Also given previous findings, a tentative research, apart from this research network, should go, first, to develop a plausible measure of welfare for the whole economy and to incorporate an optimal monetary policy whose aim is maximizing welfare. This could give more insight in how the monetary policy should act in order to stabilize the economy when it suffers a sectorial financial shock. To develop a welfare measure for the whole economy is not trivial as it should consider the utility of heterogeneous agents -patient households, impatient households and entrepreneurs- and the different ways to add these utilities, for example in a utilitarian way.

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A Baseline Model

A.1 Equilibrium conditions

$$\lambda_{c,t}^{P} = \varepsilon_t^u \frac{(c_t^P - hc_{t-1}^P)^{-\sigma_c}}{P_t} \tag{47}$$

$$\lambda_{c,t}^{P} = E_t \left\{ \frac{\beta_P R_{D,t}^H \lambda_{c,t+1}^P}{\pi_{t+1}} \right\} \tag{48}$$

$$\varepsilon_t^{\varkappa}(\chi_t^P)^{-\sigma_\chi} - \lambda_{c,t}^P P_t^\chi + \beta_P \lambda_{c,t+1}^P (1-\delta_\chi) P_{t+1}^\chi = 0 \tag{49}$$

$$\pi_t^\chi = \frac{P_t^\chi}{P_{t-1}^\chi}$$

$$\lambda_{c,t}^{I} = \varepsilon_t^u \frac{(c_t^I - hc_{t-1}^I)^{-\sigma_c}}{P_t} \tag{50}$$

$$\frac{E_t\left\{\lambda_{c,t+1}^I\right\}}{\lambda_{c,t}^I} = \frac{1}{\beta_I R_{L,t}^H}\left[1 - \frac{\mu_t^H}{\lambda_{c,t}^I} R_{L,t}^H\right] \tag{51}$$

$$\frac{\varepsilon_t^{\varkappa}(\chi_t^I)^{-\sigma_\chi}}{P_t^\chi} - \lambda_{c,t}^I + \mu_t^H m_t^H E_t\left\{\pi_{t+1}^\chi\right\}(1-\delta_\chi) + \beta^I \lambda_{c,t+1}^I (1-\delta_\chi)\pi_{t+1}^\chi = 0 \tag{52}$$

$$\begin{aligned} & \left(1-\gamma^P\right) P_t c_t^I + \left(1-\gamma^P\right) P_t^\chi \left(\chi_t^I - (1-\delta_\chi)\chi_{t-1}^I\right) + R_{L,t-1}^H L_{t-1}^H \\ = \; & \left(1-\gamma^P\right)\left(1-\Phi\left(\pi_{w,t}^I\right)\right) P_t w_t^I n_t^I + L_t^H - \left(1-\gamma^P\right) T \end{aligned} \tag{53}$$

$$R_{L,t}^H L_t^H = m_t^H E_t\left[P_{t+1}^\chi (1-\delta_\chi)\chi_t^I\right] \tag{54}$$

$$\lambda_{c,t}^{E} = \varepsilon_t^u \frac{(c_t^E - hc_{t-1}^E)^{-\sigma_c}}{P_t} \tag{55}$$

$$\frac{E_t\left\{\lambda_{c,t+1}^E\right\}}{\lambda_{c,t}^E} = \frac{1}{\beta_E R_{L,t}^F}\left[1 - \frac{\mu_t^F}{\lambda_{c,t}^E} R_{L,t}^F\right] \tag{56}$$

$$w_t\left(\lambda_{c,t}^E + \mu_t^F\right) = \lambda_{c,t}^E\left[(1-\alpha) P_t^w A_t \left(u_t k_{t-1}\right)^\alpha \left(n_t\right)^{-\alpha}\right] \tag{57}$$

$$P_t \Psi'(u_t) = \alpha P_t^w A_t \left(u_t(i) k_{t-1}\right)^{\alpha-1}\left(n_t\right) \tag{58}$$

$$\lambda_{c,t}^E - \mu_t^F m_t^F (1-\delta_k) E_t\left\{\pi_{t+1}^k\right\} = \beta_E E_t\left\{\lambda_{c,t+1}^E \left[\begin{array}{c} \frac{P_{t+1}^W}{P_{t+1}^k}\left(\alpha \frac{y_{w,t}}{k_t}\right) \\ +(1-\delta_k)\frac{P_{t+1}^k}{P_t^k} - P_{t+1}\left(\frac{\Psi(u_t)}{P_t^k}\right) \end{array}\right]\right\} \tag{59}$$

$$\pi_t^k = \frac{P_t^k}{P_{t-1}^k} \tag{60}$$

$$P_t c_t^E + P_t w_t n_t + P_t^k\left(k_t - (1-\delta_k)k_{t-1}\right) + P_t \psi\left(u_t\right) k_{t-1} + R_{L,t-1}^F L_{t-1}^F = P_t^w y_t^w + L_t^F \tag{61}$$

$$R_{L,t}^F L_t^F + w_t n_t = m_t^F E_t\left[P_{t+1}^k (1-\delta_k) k_t\right] \tag{62}$$

$$y_t^w = A_t \left(u_t k_{t-1}\right)^\alpha \left(n_t\right)^{1-\alpha} \tag{63}$$

$$1 = \frac{P_t^k}{P_t}\left[\left(1 - S_k\left(\frac{i_{k,t}}{i_{k,t-1}}\right) - S_k'\left(\frac{i_{k,t}}{i_{k,t-1}}\right)\frac{i_{k,t}}{i_{k,t-1}}\right)\right] + \beta_P E_t\left\{\frac{P_{t+1}^k}{P_{t,t+1}}\left(S_k'\left(\frac{i_{k,t}}{i_{k,t-1}}\right)\right)\right\} \tag{64}$$

$$k_t = (1-\delta_k)k_{t-1} + \left(1 - S_k\left(\frac{i_t^k}{i_{t-1}^k}\right)\right)i_t^k \tag{65}$$

$$1 = \frac{P_t^\chi}{P_t}\left[\left(1 - S_\chi\left(\frac{i_{\chi,t}}{i_{\chi,t-1}}\right) - S_\chi'\left(\frac{i_{\chi,t}}{i_{\chi,t-1}}\right)\frac{i_{\chi,t}}{i_{\chi,t-1}}\right)\right] + \beta_P E_t\left\{\frac{P_{t+1}^\chi}{P_{t,t+1}}\left(S_\chi'\left(\frac{i_{\chi,t}}{i_{\chi,t-1}}\right)\right)\right\} \tag{66}$$

$$\chi_t = (1-\delta_\chi)\chi_{t-1} + \left(1 - S_\chi\left(\frac{i_t^\chi}{i_{t-1}^\chi}\right)\right)i_t^\chi \tag{67}$$

$$y_{H,t} = \eta\left(\frac{P_{H,t}}{P_t}\right)^{-\frac{1+\mu_H}{\mu_H}} y_t \tag{68}$$

$$y_{F,t} = (1-\eta)\left(\frac{P_{F,t}}{P_t}\right)^{-\frac{1+\mu_F}{\mu_F}} y_t \tag{69}$$

$$y_{H^*,t} = (1-\eta^*)\left(\frac{P_{F,t}}{P_t}\right)^{-\frac{1+\mu_F}{\mu_F}} y_t \tag{70}$$

$$1 = \left[\eta\left(\frac{P_{H,t}}{P_t}\right)^{-\frac{1}{\mu}} + (1-\eta)\left(\frac{P_{F,t}}{P_t}\right)^{-\frac{1}{\mu}}\right]^{-\mu} \tag{71}$$

$$P_{H,t}^{new} = \frac{E_t \sum_{s=0}^{\infty}(\beta_P\theta_H)^s \lambda_{t+s} y_{H,t+s}\left(\frac{P_{H,t+s}}{\Pi_{i=1}^s[(1-\zeta_H)\overline{\pi}+\zeta_H\pi_{t+s-1}]}\right)(p_{w,t+s}(1+\mu_H))}{E_t \sum_{s=0}^{\infty}(\beta_P\theta_H)^s \lambda_{t+s} y_{H,t+s}\left(\frac{P_{H,t+s}}{\Pi_{i=1}^s[(1-\zeta_H)\overline{\pi}+\zeta_H\pi_{t+s-1}]}\right)(\Pi_{i=1}^s[(1-\zeta_H)\overline{\pi}+\zeta_H\pi_{t+s-1}])} \tag{72}$$

$$P_{H,t} = \left[(\theta_H)\left(P_{H,t-1}[(1-\zeta_H)\overline{\pi}+\zeta_H\pi_t]\right)^{-\frac{1}{\mu_H}} + (1-\theta_H)(P_{H,t}^{new})^{-\frac{1}{\mu_H}}\right]^{-\mu_H} \tag{73}$$

$$P_{F,t}^{new} = \frac{E_t \sum_{s=0}^{\infty}(\beta_P\theta_F)^s \lambda_{t+s} y_{F,t+s}\left(\frac{P_{F,t+s}}{\Pi_{i=1}^s[(1-\zeta_F)\overline{\pi}+\zeta_F\pi_{t+s-1}]}\right)(e_{t+s}P_{t+s}^*(1+\mu_H))}{E_t \sum_{s=0}^{\infty}(\beta_P\theta_F)^s \lambda_{t+s} y_{F,t+s}\left(\frac{P_{F,t+s}}{\Pi_{i=1}^s[(1-\zeta_F)\overline{\pi}+\zeta_F\pi_{t+s-1}]}\right)(\Pi_{i=1}^s[(1-\zeta_F)\overline{\pi}+\zeta_F\pi_{t+s-1}])}$$

$$P_{F,t} = \left[(\theta_F)\left(P_{F,t-1}[(1-\zeta_H)\overline{\pi}+\zeta_F\pi_t]\right)^{-\frac{1}{\mu_F}} + (1-\theta_H)(P_{F,t}^{new})^{-\frac{1}{\mu_F}}\right]^{-\mu_F} \tag{74}$$

$$P_{H,t}^{*,new} = \frac{E_t \sum_{s=0}^{\infty}(\beta_P\theta_{H^*})^s \lambda_{t+s} y_{H,t+s}^*\left(\frac{P_{H^*,t+s}}{\Pi_{i=1}^s\left[(1-\zeta_H)\overline{\pi}^*+\zeta_H\pi_{t+s-1}^*\right]}\right)\left(\frac{p_{w,t+s}}{e_{t+s}}(1+\mu_{H^*})\right)}{E_t \sum_{s=0}^{\infty}(\beta_P\theta_H)^s \lambda_{t+s} y_{H,t+s}^*\left(\frac{P_{H^*,t+s}}{\Pi_{i=1}^s[(1-\zeta_{H^*})\overline{\pi}^*+\zeta_{H^*}\pi_{t+s-1}]}\right)(\Pi_{i=1}^s[(1-\zeta_H)\overline{\pi}+\zeta_H\pi_{t+s-1}])} \tag{75}$$

$$P^*_{H,t} = \left[(\theta_{H^*}) \left(P^*_{H,t-1} \left[(1-\zeta_H)\overline{\pi}^* + \zeta_H \pi^*_t \right] \right)^{-\frac{1}{\mu_{H^*}}} + (1-\theta_H)(P^{*,new}_{H,t})^{-\frac{1}{\mu_{H^*}}} \right]^{-\mu_{H^*}} \tag{76}$$

$$E_t \sum_{s=0}^{\infty} \beta_P^{s+1} \theta_D^s \frac{\lambda^p_{t+s}}{\lambda^p_t} \left[\begin{array}{c} R_{t+s} z^H_{D,t+s} \left(\frac{1+\mu^H_D}{\mu^H_D} \right) \left(\frac{1}{R^H_{D,t+s}} \right)^{\frac{1+\mu^H_D}{\mu^H_D}} \left(R^D_{t+s} \right)^{\frac{1}{\mu^H_D}} D^H_{t+s}(i^H_D) \\ - \left(\frac{1+2\mu^H_D}{\mu^H_D} \right) \left(\frac{R^{D,new}_t}{R^H_{D,t+s}} \right)^{\left(\frac{1+\mu^H_D}{\mu^H_D} \right)} D^H_{t+s}(i^H_D) \end{array} \right] = 0 \tag{77}$$

$$R^D_t = \left[\theta_D R^D_{t-1} + (1-\theta_D)(R^{D,new}_t)^{-\frac{1}{\mu^H_D}} \right]^{-\mu^H_D} \tag{78}$$

$$E_t \sum_{s=0}^{\infty} \beta_P^{s+1} \theta_L^s \frac{\lambda^p_{t+s}}{\lambda^p_t} \left[\left(\frac{R^{H,new}_{L,t}}{R^H_{L,t+s}} \right)^{\frac{1}{\mu^H_L}} L^H_{t+S} \right] \left\{ \left(\frac{1+\mu^H_L}{\mu^H_L} + 1 \right) \frac{R^{H,new}_{L,t}}{R^H_{L,t+s}} - R_{t+s} \left(\frac{1+\mu^H_L}{\mu^H_L} \right) \right\} = 0 \tag{79}$$

$$R^H_{L,t} = \left[\theta_L R^H_{L,t-1} + (1-\theta_L)(R^{H,new}_{L,t})^{-\frac{1}{\mu^H_L}} \right]^{-\mu^H_L} \tag{80}$$

$$E_t \sum_{s=0}^{\infty} \beta_P^{s+1} \theta_L^s \frac{\lambda^p_{t+s}}{\lambda^p_t} \left[\left(\frac{R^{F,new}_{L,t}}{R^F_{L,t+s}} \right)^{\frac{1}{\mu}} L^F_{t+S} \right] \left\{ \left(\frac{1+\mu^F_L}{\mu^F_L} + 1 \right) \frac{R^{F,new}_{l,t}}{R^F_{l,t+s}} - R_{t+s} \left(\frac{1+\mu^F_L}{\mu^F_L} \right) \right\} = 0 \tag{81}$$

$$R^F_{L,t} = \left[\theta_L R^F_{L,t-1} + (1-\theta_L)(R^{F,new}_{L,t})^{-\frac{1}{\mu^F_L}} \right]^{-\mu^F_L} \tag{82}$$

$$\frac{R_t}{\overline{R}} = \left(\frac{R_{t-1}}{\overline{R}} \right)^{\gamma_R} \left(\left(\frac{\pi_t}{\overline{\pi}} \right)^{\gamma_\pi} \left(\frac{\widetilde{y}_t}{\overline{\widetilde{y}}} \right)^{\gamma_y} \right)^{1-\gamma_R} \varepsilon_{R,t} \tag{83}$$

$$R_t = e_t R^*_t \rho_t \tag{84}$$

$$\rho_t = \exp\left(\varrho \frac{e_t L^*_t}{P_t \widetilde{y}_t} \right) \varepsilon^\rho_t \tag{85}$$

$$G_t = T_t \tag{86}$$

$$c_t + i_{k,t} + i_{\chi,t} + g_t + \psi(u_t) k_{t-1} = y_t \tag{87}$$

$$c_t = \left(1-\gamma^P\right) c^I_t + \gamma^P c^P_t + c^E_t \tag{88}$$

$$\chi_{t-1} = \left(1-\gamma^P\right) \chi^I_t + \gamma^P_t \chi^P_t \tag{89}$$

$$y_{H,t} + y^*_{H,t} = y^w_t \tag{90}$$

$$P_{F,t} y_{F,t} + e_t R^*_{t-1} \rho_{t-1} L^*_{t-1} = e_t P^*_{H,t} y^*_{H,t} + e_t L^*_t \tag{91}$$

$$P_t \widetilde{y}_t = P_t y_t + e_t P^*_{H,t} y^*_{H,t} - P_{F,t} y_{F,t} \tag{92}$$

$$
\begin{aligned}
0 &= \frac{1+\mu_w}{\mu_w}\varepsilon_t^n \left(n_t^P\right)^{\sigma_n} \frac{n_t^P}{w_t^P} \\
&\quad -\lambda_{c,t}^P \left[\left(1-\Phi_t\left(\pi_{w,t}^P\right)\right)\frac{n_t^P}{\mu_w}\right] - \lambda_{c,t}^P \frac{w_t^P}{w_{t-1}^P}\Phi_t'\left(\pi_{w,t}^P\right)\pi_t \\
&\quad +E_t\left\{\beta_P\lambda_{c,t}^P\left(\frac{w_{t+1}^P}{w_t^P}\right)^2 n_{t+1}^P\Phi_t'\left(\pi_{w,t+1}^P\right)\pi_{t+1}\right\}
\end{aligned} \tag{93}
$$

$$
\begin{aligned}
0 &= \frac{1+\mu_w}{\mu_w}\varepsilon_t^n \left(n_t^I\right)^{\sigma_n} \frac{n_t^I}{w_t^I} \\
&\quad -\lambda_{c,t}^I \left[\left(1-\Phi_t\left(\pi_{w,t}^I\right)\right)\frac{n_t^I}{1-\rho_w}\right] - \lambda_{c,t}^I \frac{w_t^I}{w_{t-1}^I}\Phi'\left(\pi_{w,t}^I\right)\pi_t \\
&\quad +E_t\left\{\beta_I\lambda_{c,t}^I\left(\frac{w_{t+1}^I}{w_t^I}\right)^2 n_{t+1}^I\Phi'\left(\pi_{w,t+1}^I\right)\pi_{t+1}\right\}
\end{aligned} \tag{94}
$$

$$
n_t^P = \left(\frac{w_t^P}{w_t}\right)^{-\frac{1+\mu_w}{\mu_w}} n_t \tag{95}
$$

$$
n_t^I = \left(\frac{w_t^I}{w_t}\right)^{-\frac{1+\mu_w}{\mu_w}} n_t \tag{96}
$$

$$
1 = \gamma^P\left(\frac{w_t^P}{w_t}\right)^{-\frac{1}{\mu_w}} + \left(1-\gamma^P\right)\left(\frac{w_t^I}{w_t}\right)^{-\frac{1}{\mu_w}} \tag{97}
$$

$$
\pi_w^P = \frac{w_t^P}{w_{t-1}^P}\pi_t \tag{98}
$$

$$
\pi_w^I = \frac{w_t^I}{w_{t-1}^I}\pi_t \tag{99}
$$

with exogenours processes of the form

A.2 Steady State

In this subsection of the appendix, we will compute the steady state in the model. In particular, we show the steady state value of the relationships which are used in order to solve the log-linearized version of the model. Given the calibrated values for$\left\{\eta, \mu, \frac{y_F}{\widetilde{y}}, \frac{l^*}{\widetilde{y}}, R, \pi\right\}$ and from 69, 91 and 92 we calibrate values for$\left\{\frac{y_F}{y}, p_F, \frac{qy_{H^*}}{\widetilde{y}}, \frac{y}{\widetilde{y}}\right\}$ by solving the following system of equations:

$$
\frac{y_F}{y} = \frac{y_F}{\widetilde{y}}\left(\frac{1}{\frac{y}{\widetilde{y}}}\right) \tag{100}
$$

$$
p_F = \left[\left(\frac{1}{1-\eta}\right)\frac{y_F}{y}\right]^{-\frac{\mu}{1+\mu}} \tag{101}
$$

$$
\frac{qy_{H^*,t}}{\widetilde{y}} = \left[p_F\frac{y_F}{\widetilde{y}} + \frac{l^*}{\widetilde{y}}\left(\frac{R}{\pi}-1\right)\right] \tag{102}
$$

$$
1 = \frac{y}{\widetilde{y}} + \frac{qy_{H^*,t}}{\widetilde{y}} - p_F\frac{y_F}{\widetilde{y}} \tag{103}
$$

using $\frac{y}{\widetilde{y}}$ and $\frac{y_F}{\widetilde{y}}$ and from () and () we can obtain a value for $\frac{y_{H^*,t}}{\widetilde{y}}$ using the following equation

$$\frac{y_{H^*,t}}{\widetilde{y}} = 1 - \frac{y}{\widetilde{y}} + \frac{y_F}{\widetilde{y}} \tag{104}$$

In order to obtain a value for p_H, we can use p_F and 71 in order to derive the following relationship:

$$p_H = (\eta^{\mu}) \left(1 - (1-\eta)(p_F^{-\frac{1}{\mu}})\right)^{-\mu} \tag{105}$$

Given this value of p_h and from 68 we can solve for $\frac{y^h}{\widetilde{y}}$

$$\frac{y_H}{\widetilde{y}} = \eta p_H^{(-\frac{1+\mu}{\mu})} \frac{y}{\widetilde{y}} \tag{106}$$

$$y_H = \frac{\frac{y_H}{\widetilde{y}}}{\left(\frac{y_H}{\widetilde{y}} + \frac{y_{H^*}}{\widetilde{y}}\right)} \tag{107}$$

$$y_{H^*} = 1 - y_H \tag{108}$$

The value of the intermediate production in terms of GDP can be obtained from 59

$$\frac{p^w y^w}{\widetilde{y}} = \frac{1}{\alpha\beta^I}\left[1 - m^F(1-\delta_k)\left(\frac{\pi}{R_F} - \beta^I\right) - (1-\delta_K)\right]\frac{k}{\widetilde{y}} \tag{109}$$

The labor income as a percentage of output can be determined by the use of $\frac{p^w y^w}{\widetilde{y}}$ from the first order condition of labor for the entrepreneurs:

$$\begin{aligned} w &= (1-\alpha)p^w A\left(\frac{k}{l}\right)^{\alpha}\left(\frac{\lambda_c^E + \mu^F}{\lambda_c^E}\right) \\ \Longrightarrow & \frac{wn}{\widetilde{y}} = (1-\alpha)\frac{p^w y^w}{\widetilde{y}}\left(\frac{\lambda_c^E + \mu^F}{\lambda_c^E}\right) \end{aligned}$$

From the first order condition of loans for entrepreneurs we can obtain a relationship between λ_c^E and μ^F so the labor income as a percentage of output in steady state would be

$$\frac{wn}{\widetilde{y}} = (1-\alpha)\frac{p^w y^w}{\widetilde{y}}\frac{R_L^F}{R_L^F + 1 - \beta^i R_L^F} \tag{110}$$

From the housing accumulation relationship we can derive a value for the housing level

$$\frac{\chi^I}{\widetilde{y}} = \frac{i_\chi}{\delta_\chi} \tag{111}$$

From the borrowing constraint of the impatient household we can obtain the level of investment in housing for this agent

$$\frac{i_\chi^I}{\widetilde{y}} = \frac{1}{\gamma^I}\left(\frac{1}{m^H(1-\delta_\chi)}\pi\right) R_H \frac{l_H}{\widetilde{y}} \tag{112}$$

with the previous two relationship we can derive a value for the investment of the patient household

$$\frac{i_{\chi}^{P}}{\widetilde{y}} = \frac{1}{\gamma^{I}}\left(\frac{\chi}{\widetilde{y}} - \gamma^{I}\frac{\chi^{I}}{\widetilde{y}}\right) \tag{113}$$

From 58 we can obtain the parameter $\Psi'(u)$

$$\Psi'(u) = \alpha\left(\frac{p_W y_W}{\widetilde{y}}\right)\frac{1}{\frac{k}{\widetilde{y}}} \tag{114}$$

$$\frac{c^{E}}{\widetilde{y}} = \frac{1}{\gamma^{E}}\left(\frac{p_W y_W}{\widetilde{y}} + \frac{l^{F}}{\widetilde{y}} - (1-\alpha)\frac{p_W y_W}{\widetilde{y}} - \frac{i_K}{\widetilde{y}} - R^{F}\frac{l^{F}}{\widetilde{y}}\right) \tag{115}$$

In order to determine the consumption of patient c^P and impatient c^I households we can exploit a relationship between χ^I and χP by using 49 and 52. In order to arrive to this relationship, lets define the following terms

$$D_1 \equiv (1-(1-\delta_{\chi})(\beta_I + m^{H}(\frac{\pi}{R_F} - \beta^{I})))^{\frac{1}{\sigma_c}} \tag{116}$$

$$D_2 \equiv (1-(1-\delta_{\chi})(\beta_P))^{\frac{1}{\sigma_c}}$$

$$D_3 \equiv \frac{\frac{\chi^{I}}{\widetilde{y}}}{\frac{\chi^{P}}{\widetilde{y}}} \tag{117}$$

$$D_4 \equiv \left(D_3^{\frac{\sigma_{\chi}}{\sigma_c}}\right)\frac{D_1}{D_2} \tag{118}$$

Combinining 49 and 52 we can obtain an expression for the level of c^I in terms of c^P which can be simplified by using previous definitions

$$\frac{c^{I}}{\widetilde{y}} = D_4\frac{c^{P}}{\widetilde{y}} \tag{119}$$

Given we have a value for $\frac{c}{\widetilde{y}}$ and from the aggregate consumption 88 and using previous relationship, we can obtain a level for the patient household consumption:

$$\frac{c^{P}}{\widetilde{y}} = \frac{1}{\gamma^{P} + \gamma^{I}D_4}\left(\frac{c}{\widetilde{y}} - \gamma^{E}\frac{c^{E}}{\widetilde{y}}\right) \tag{120}$$

Notice that we can use the value for $\frac{c^P}{\widetilde{y}}$ and obtain a value for $\frac{c^I}{\widetilde{y}}$.

From 87 we can obtain a value for $\frac{g}{\widetilde{y}}$

$$\frac{g}{\widetilde{y}} = \frac{y}{\widetilde{y}} - (\frac{c}{\widetilde{y}} + \frac{i_k}{\widetilde{y}} + \frac{i_{\chi}}{\widetilde{y}}) \tag{121}$$

notice that using previos definition and from 86 we can obtain a value for $\frac{T}{\widetilde{y}}$.

From the 53 we can obtain

$$\frac{w^{I}n^{I}}{\widetilde{y}} = \left(\frac{1}{\gamma^{I}}\right)\left(\gamma^{I}\frac{c^{I}}{\widetilde{y}} + \gamma^{I}\frac{\chi^{I}}{\chi}\frac{i_{\chi}}{\widetilde{y}} + \left(\frac{R_H}{\pi} - 1\right)\frac{l^{H}}{\widetilde{y}} + \gamma^{I}\frac{T}{\widetilde{y}}\right) \tag{122}$$

and using the condition of zero profit for the labor packer we have

$$\frac{w^{P}n^{P}}{\widetilde{y}} = \left(\frac{1}{\gamma^{P}}\right)\left(\frac{wn}{\widetilde{y}} - \gamma^{I}\frac{w^{I}n^{I}}{\widetilde{y}}\right) \tag{123}$$

From 95

$$n^P = \left(\frac{w^P}{w}\right)^{\frac{-(1+\mu_w)}{\mu_w}} n \Longrightarrow \frac{w^P n^P}{\widetilde{y}} = \frac{w^P}{w}\left(\frac{w^P}{w}\right)^{\frac{-(1+\mu_w)}{\mu_w}} \frac{wn}{\widetilde{y}} = \left(\frac{w^P}{w}\right)^{\frac{-1}{\mu_w}} \frac{wn}{\widetilde{y}}$$

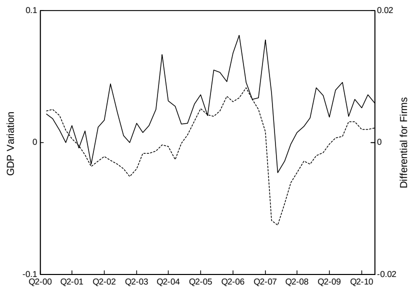
$$\Longrightarrow \frac{w^P}{w} = \left(\frac{\frac{w^P n^P}{\widetilde{y}}}{\frac{wn}{\widetilde{y}}}\right)^{-\mu_w} \tag{124}$$

Similarly from 96

$$\frac{w^I}{w} = \left(\frac{\frac{w^I n^I}{\widetilde{y}}}{\frac{wn}{\widetilde{y}}}\right)^{-\mu_w} \tag{125}$$

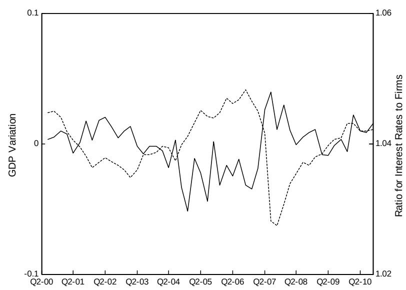
B Figures and Tables

Figure 1: Credit Market and Business Cycle[7]

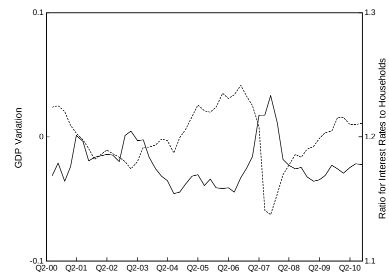


Credit differential for firms

Credit Differentials for households



Ratio of the interest rates faced by firms to monetary policy interest rate



Ratio of the interest rates faced by households to monetary policy interest rate

[7] Output is represented as percentage deviations of its sample mean.

C Model structure

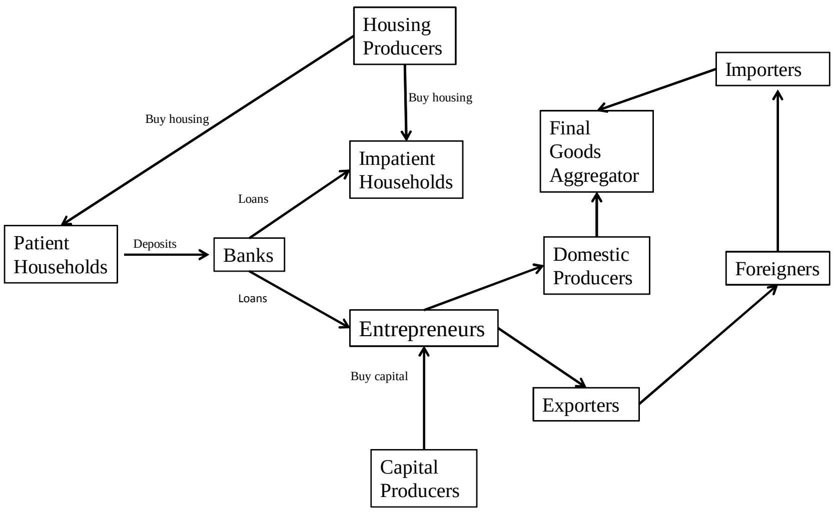


Figure 2: Complete Model Structure

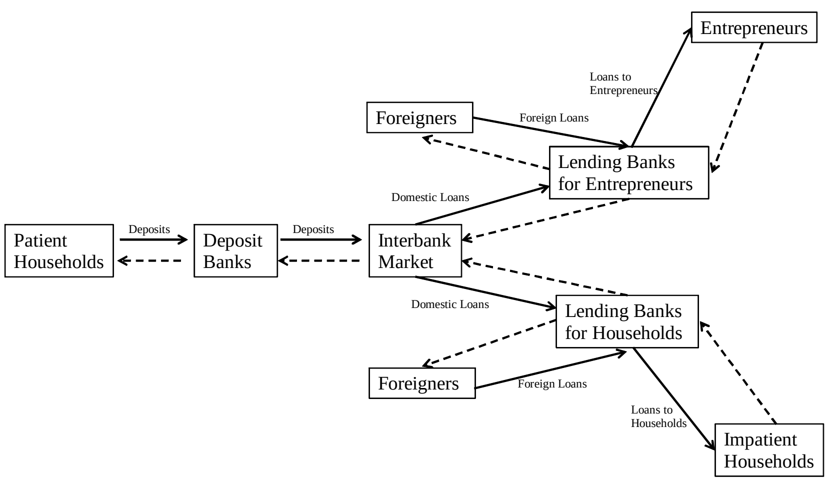
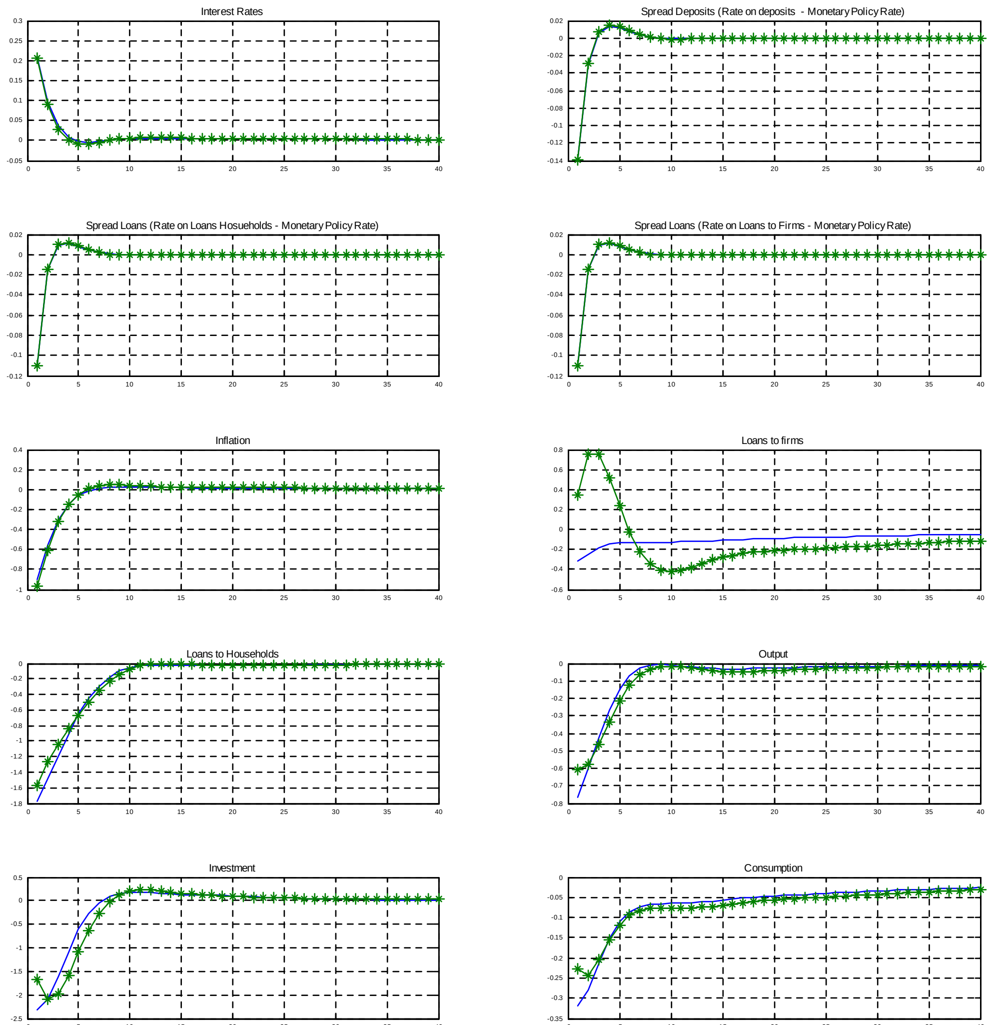


Figure 3: Banking System Structure

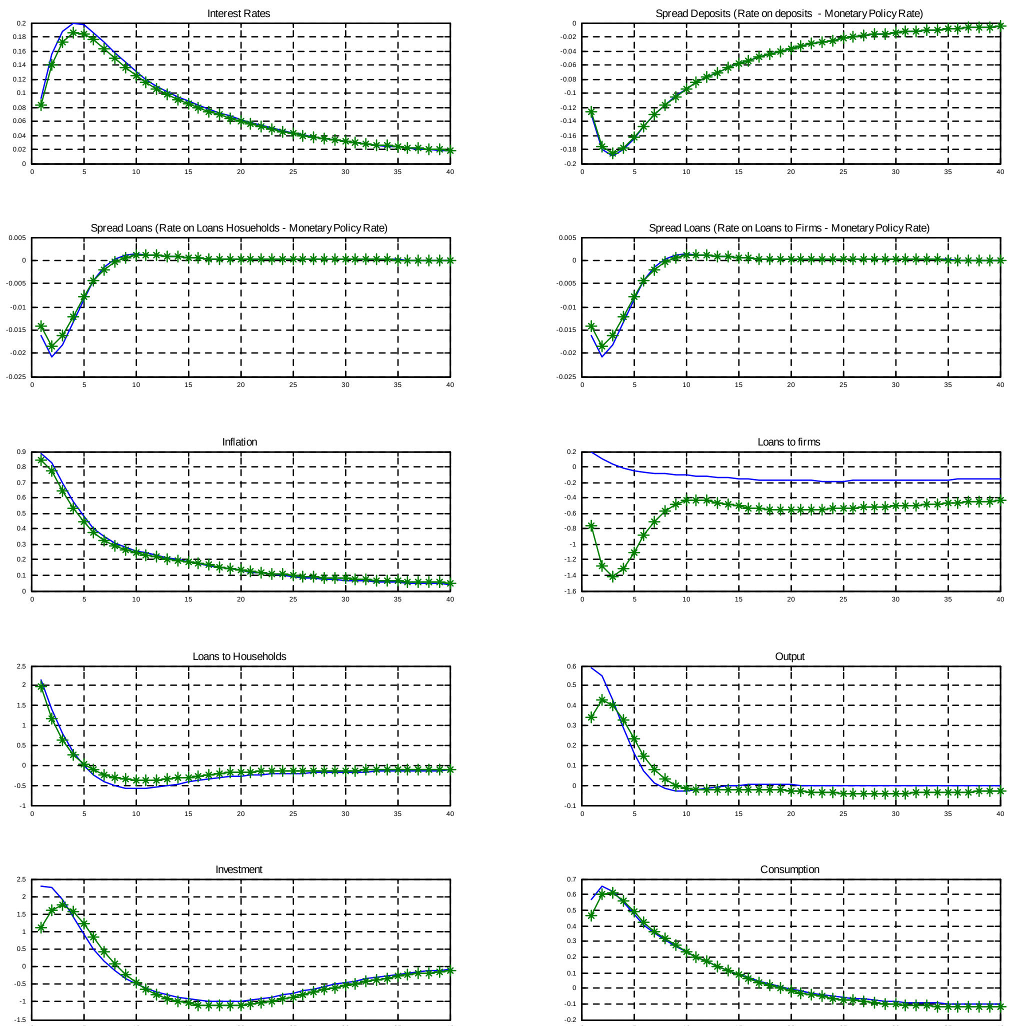
D Impulse Response Functions

Figure 4: IRF to a Monetary Policy Shock



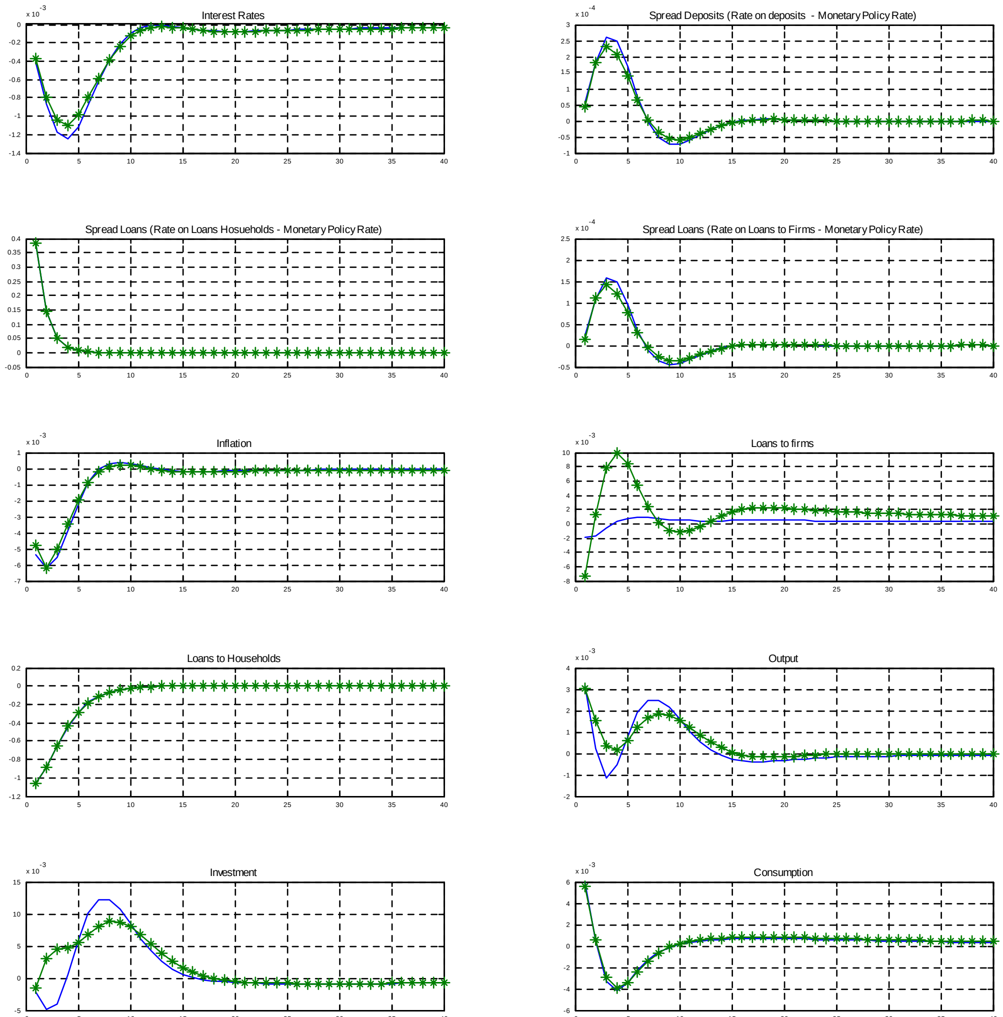
The solid continuous line represents the model without working capital while the complementary starry line represents the model with working capital.

Figure 5: IRF to a Banking Shock in Deposits



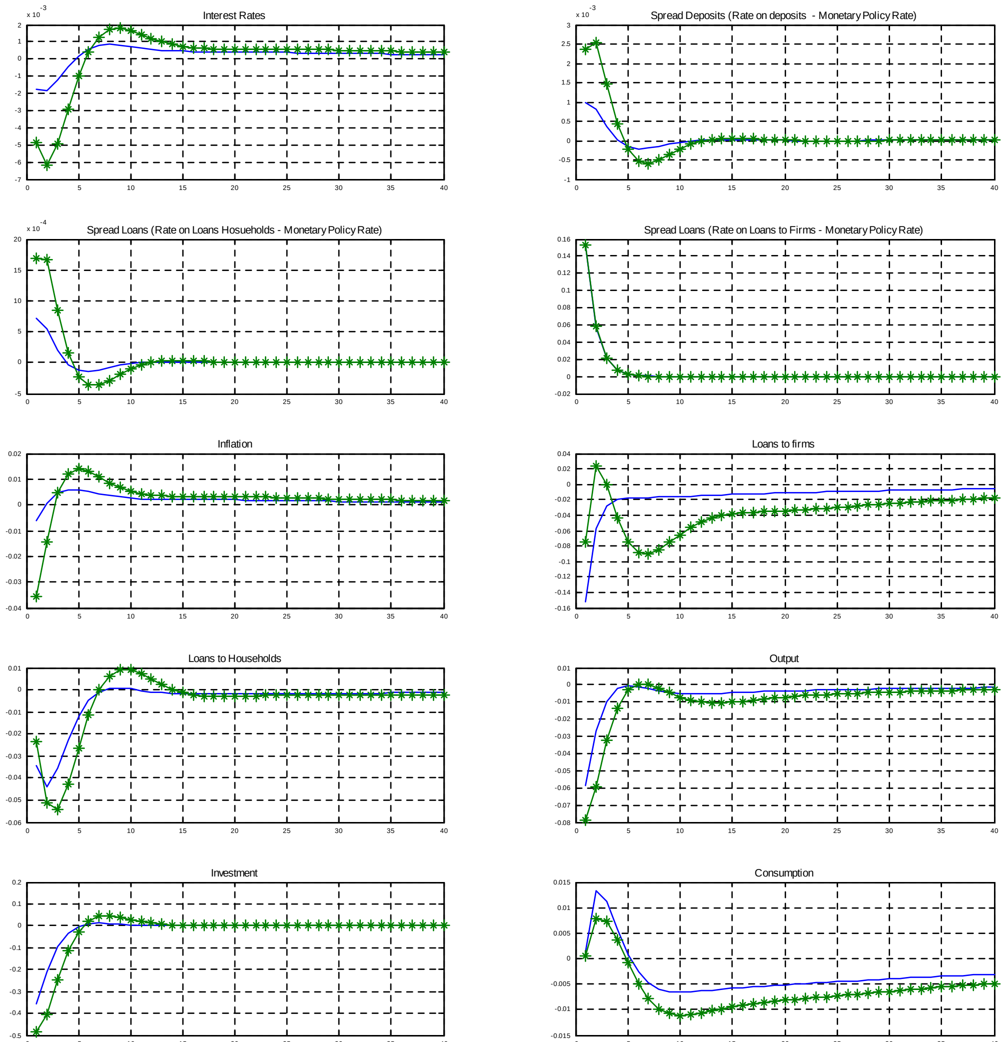
The solid continuous line represents the model without working capital while the complementary starry line represents the model with working capital.

Figure 6: IRF in a Banking Shock in Loans to Households



The solid continuous line represents the model without working capital while the complementary starry line represents the model with working capital.

Figure 7: IRF in a Banking Shock in Loans to Firms



The solid continuous line represents the model without working capital while the complementary starry line represents the model with working capital.

Table 1: Correlations with GDP

Credit differential for firms	0.575
Credit differentials for households	0.558
Ratio of the interest rates faced by firms to the policy rate	-0.569
Ratio of the interest rates faced by households to the policy rate	-0.658

E Estimation Results

Table 2: Estimated Parameters 1

Parameter	Definition	Prior			Posterior		
		Distribution	Mean	S. D.	Mode	Mean	S. D.
h	Habit in consumption	Beta	0.500	0.100	0.4856	0.5034	0.0998
σ_χ	Housing utility	Normal	2.000	0.100	1.9793	1.9886	0.1004
σ_c	Consumption utility	Normal	1.000	0.100	1.0454	1.0443	0.0960
σ_n	Disutility of working	Normal	1.000	0.100	0.9700	0.9553	0.0999
κ_k	Investment adjustment cost: capital	Gamma	0.200	1	5.1346	5.6017	1.2659
κ_χ	Investment adjustment cost: housing	Gamma	0.200	1	2.0654	2.4127	0.9553
κ_w^p	Wage adjustment cost for patient	Gamma	50.000	25	49.6617	57.1336	26.4333
κ_w^I	Wage adjustment cost for impatient	Gamma	50.000	25	49.5880	50.8387	28.7879
μ_H^*	Markup of exported goods	Inverse Gamma	1.401	1.5811	0.6282	0.7394	0.1535
$\varrho_{\frac{l^*}{\tilde{y}}}$	Risk premium elasticity	Inverse Gamma	0.014	0.0158	0.0144	0.019	0.0073
ψ''	Capital utilization cost parameter	Inverse Gamma	0.280	0.3162	0.1755	0.2622	0.0535
θ_H	Calvo probability for home goods	Beta	0.750	0.100	0.7568	0.7492	0.0246
θ_F	Calvo probability for imported goods	Beta	0.750	0.100	0.5107	0.4999	0.0437
θ_h^*	Calvo probability for exported goods	Beta	0.750	0.100	0.8763	0.8786	0.0210
ζ_H	Indexation to past inflation for home producers	Beta	0.500	0.250	0.0455	0.1123	0.0605
ζ_F	Indexation to past inflation for importers	Beta	0.500	0.250	0.0881	0.1653	0.1020
ζ_H^*	Indexation to past inflation for exporters	Beta	0.500	0.250	0.9285	0.8791	0.0860
θ_D	Calvo probability in deposit rates	Beta	0.500	0.100	0.4852	0.4971	0.0394
θ_L	Calvo probability in lending rates	Beta	0.500	0.100	0.3703	0.3778	0.0704
γ_R	Interest rate smoothing	Beta	0.750	0.100	0.7547	0.7516	0.0336
γ_y	Central Bank reaction to inflation deviation	Gamma	1.500	0.100	1.4712	1.5071	0.0912
γ_y	Central Bank reaction to output deviation	Gamma	0.125	0.100	0.0850	0.1077	0.0341
ρ_c	A.C.consumption preference shock	Beta	0.700	0.200	0.7071	0.6721	0.1076

Table 3: Estimated Parameters 2

Parameter	Definition	Prior			Posterior		
		Distribution	Mean	S. D.	Mode	Mean	S. D.
ρ_χ	A.C. housing preference shock	Beta	0.700	0.200	0.9911	0.9677	0.0109
ρ_n	A.C. labor preference shock	Beta	0.700	0.200	0.8484	0.7084	0.1579
ρ_A	A.C. TFP shock	Beta	0.700	0.200	0.8119	0.6401	0.0822
ρ_ϱ	A.C. risk premium shock	Beta	0.700	0.200	0.8167	0.6782	0.1815
ρ_G	A.C. government shock	Beta	0.700	0.200	0.7038	0.7022	0.1045
ρ_{m^h}	A.C. households loan to value shock	Beta	0.700	0.200	0.8774	0.7076	0.2183
ρ_{m^f}	A.C. firms loan to value shock	Beta	0.700	0.200	0.5505	0.6298	0.2443
$\rho_{z_d^h}$	A.C. interest rate spread in deposits	Beta	0.700	0.200	0.9096	0.8754	0.0248
$\rho_{z_l^h}$	A.C. interest rate spread in loans to households	Beta	0.700	0.200	0.6380	0.5277	0.1220
$\rho_{z_l^f}$	A.C. interest rate spread in loans to firms	Beta	0.700	0.200	0.3193	0.3086	0.1514
ρ_Y^*	A.C. foreign output	Beta	0.700	0.200	0.9440	0.9327	0.0319
ρ_π^*	A.C. foreign inflation	Beta	0.700	0.200	0.5380	0.4749	0.0669
ρ_R^*	A.C. foreign interst rate	Beta	0.700	0.200	0.5035	0.4762	0.0994
σ_c	SD consumption preference shock	Inverse Gamma	2.171	Inf	3.8886	4.2665	0.8027
σ_χ	SD housing preference shock	Inverse Gamma	2.171	Inf	2.8140	5.8836	1.2246
σ_n	SD labor preference shock	Inverse Gamma	2.171	Inf	1.0003	2.0758	0.4092
σ_A	SD TFP shock	Inverse Gamma	2.171	Inf	1.4659	1.8545	0.3454
σ_ϱ	SD risk premium shock	Inverse Gamma	0.109	Inf	0.0492	0.1030	0.0196
σ_G	SD government shock	Inverse Gamma	2.171	Inf	6.4901	7.0763	0.7017
σ_{m^h}	SD households loan to value shock	Inverse Gamma	4.342	Inf	2.0013	3.7157	0.8180
σ_{m^f}	SD firms loan to value shock	Inverse Gamma	4.342	Inf	2.9209	2.7943	0.6433
$\sigma_{z_d^h}$	SD interest rate spread in deposits	Inverse Gamma	0.543	Inf	0.1143	0.1216	0.0111
$\sigma_{z_l^h}$	SD interest rate spread in loans to households	Inverse Gamma	0.543	Inf	0.2208	0.2946	0.0720
$\sigma_{z_l^f}$	SD interest rate spread in loans to firms	Inverse Gamma	0.543	Inf	0.1644	0.1781	0.0361
σ_R	SD shocks in the monetary authority rule	Inverse Gamma	0.326	Inf	0.3057	0.3177	0.0334
σ_{y^*}	SD shocks in the foreign output	Inverse Gamma	2.171	Inf	0.6614	0.6840	0.0634
σ_{π^*}	SD shocks in the foreign inflation	Inverse Gamma	2.171	Inf	1.1042	1.2244	0.1766
σ_{R^*}	SD shocks in the foreign interest rate	Inverse Gamma	2.171	Inf	0.7811	0.8170	0.1617