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Bank Competition, Agency Costs and the Performance of the Monetary Policy*

Leonardo Soriano de Alencar**

Márcio I. Nakane***

Abstract

This paper extends the general equilibrium literature on bank competition in order to evaluate its role on the performance of the monetary policy. A new formulation of a financial contract taking into consideration both market power by banks as well as costly state verification is proposed here. Numerical simulations with the model economy parameterized to the Brazilian case are performed. Two cases are examined: One in which the banking sector is perfectly competitive and the other one when banks have market power. The main conclusions of the paper are the following: (1) Greater competition in the loan market enhances the response of the real economy to an interest rate shock; (2) Increased competition and/or a more efficient verification technology reduce the reaction of both the default rate and of the bank interest spread to an interest rate shock; and (3) The influence of the verification technology in the economy's dynamic response is greater when banks operate under perfect competition.

Keywords: bank competition, agency costs, monetary policy
JEL classification numbers: E44, E50, G21

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1. Introduction

An increasing concentration in the banking industry has been observed in Brazil [Corazza (2000)] and in many other countries in the recent past. Sapienza (2002), for example, reports that 3,600 mergers and acquisitions took place in the U.S. financial sector between 1979 and 1994. A similar behavior was observed in Europe and in Japan. Perhaps in connection to these facts, Cetorelli (2001) observes an increasing interest both in the research and in the public debate related to the role played by bank competition in the overall economy. The bulk of this literature, however, relies on partial equilibrium analysis. Only recently, general equilibrium approaches focusing on the influence of the banking sector market structure in the economic performance started to be developed. Amongst such studies, Guzman (2000) and Cetorelli (1997) examined the role of banking competition in the capital accumulation process and in the economic growth. In another paper, Smith (1998) addressed the role of bank's market power in the business cycles and in the income level determination.

The aim of this paper is to extend this general equilibrium literature in order to examine how the market structure in the banking sector affects the performance of the monetary policy. To be more precise, we examine how key variables from a model economy react to an interest rate shock under two alternative scenarios: One when the banking industry operates under perfect competition, and the other one when banks have market power. Also related to this issue, we analyze whether or not the banking sector market structure plays a role on the influence of the verification technology in the transmission of the monetary policy.

The verification technology follows the costly state verification approach, as pioneered by Townsend (1979). There are information asymmetries between lenders and borrowers. That is, the borrower can costless observe the outcome of his production, but the lender has to bear some costs in order to observe such outcome. A model of a loan contract between entrepreneurs that require external finance and banks will be presented. Following Gale and Hellwig (1985), the entrepreneur's budget constraint is formulated as a contract problem. In the contract developed in the paper, the entrepreneur's budget constraint will be affected by bank's market power. As in Gale and Hellwig (1985), such budget constraint does not necessarily require that the entrepreneur fully pays his debt. Moreover, the impact of verification costs in the distribution of rents between the entrepreneur and the financial intermediary will be stronger than in the contract devised by Gale and Hellwig (1985), who only deals with the case of a perfect competitive financial intermediary.

The roles played by bank competition and by the verification technology will be examined in a model akin to what Repullo and Suarez (2000) call the *broad credit channel*, also known as the balance sheet channel [Bernanke and Gertler (1995)], following the literature initiated by Bernanke and Gertler (1989). The issues raised here adapt quite well to this branch of the literature, which has emphasized the role played by imperfections in financial markets in the transmission of monetary shocks. In particular, this literature has shown that the impact of such shocks depends, to some extent, on the net worth of the borrowers.

The model economy developed in the paper is a dynamic general equilibrium model designed to study responses to a monetary policy shock. Money is introduced through the assumption that real balances yield utility to the household. Prices are perfectly flexible. Monetary policy is modeled as an interest rate rule.

One feature of the model economy is the existence of endogenous verification costs in the production of capital goods. These goods will be sold at a premium over its production costs to pay for the deadweight loss of the expected insolvency. When the banking sector has market power, it will capture part of the rents generated in the context of the verification costs, which will reduce the response of the capital goods production to a change in the interest rate. An increase in the borrowing requirements will, *ceteris paribus*, raise the verification costs as well as the external finance premium, as is traditional in the balance sheet channel literature.

The major contribution of the model is the examination of the role played by bank competition in the transmission of the monetary policy in the context of the broad credit channel approach. In addition, the model structure also allows one to examine how the effects of information asymmetries change according to bank competition. To the best of our knowledge, this investigation is new in the literature. The feature of the model that makes the investigation of such issues possible is the loan contract devised in the paper, which allows for the presence of banks with market power in a context of asymmetric information.

An article close in scope to ours is the one due to Smith (1998). However, his model structure does not allow one to investigate the effects of bank competition in the transmission of monetary policy. The way market power is modeled is also different. Smith (1998) introduces market power through a circular economy as in Salop (1979), with geographic entry restrictions and switching costs. In the model developed here, market power is introduced as in Monti (1972) and Klein (1971), although we also restrict entry of new banks.

The only other model we are aware of that incorporates a banking sector in a broad credit channel environment, and also examines the role of monetary policy, is the one developed by Fuerst (1995). However, his bank sector is restricted to be perfect competitive, and his model is one of limited participation where the monetary policy is set according to money aggregates. By contrast, we examine interest rate rules.

The model presented here is parameterized to the Brazilian economy. Different simulations are performed under different assumptions for the verification technology and for the bank competition. Impulse-response functions of the key variables are computed.

The paper is structured as follows. Following this Introduction, Section 2 develops the general equilibrium model. Section 3 briefly presents the model parameterization. Section 4 shows the dynamic simulations and comments the results. The paper ends with brief conclusions.

2. The Model

The model economy is composed by five types of agents, namely: households, entrepreneurs, firms, banks, and the government. There is a *continuum* of identical families and identical entrepreneurs, indexed in the unit interval. There are λ entrepreneurs, and $1-\lambda$ households, $\lambda \in (0,1)$. There are numerous firms producing the final consumption goods, and some banks that intermediate among the households, the entrepreneurs, and the firms. Banks have access to a bond market where the government also participates. There is a monetary authority within the government who determines the interest rate of public bonds as well as the reserve requirements on bank deposits. Reserve requirements are kept by the monetary authority with no payment of interest.

2.1 Households

Households are infinitely lived. In each period of their lives, each household is endowed with one unit of time. The household aims to maximize the present expected value of his utility flow given by:

$$E_t \sum_{j=0}^{\infty} \beta^j U\left(c_{t+j}, \frac{m_{t+j+1}}{P_{t+j}}, 1 - h_{t+j} \right) \quad (1)$$

where E_t is the conditional expectation operator, conditioned on the information set available in period t, $\beta \in (0,1)$ is the intertemporal discount rate, $c_{t+j} \geq 0$ is the household real consumption in period t+j, $m_{t+j+1} \geq 0$ represents the nominal money balances kept by the household at the end of period t+j, $P_{t+j} \geq 0$ is the money price of the final goods in period t+j, $h_{t+j} \in [0,1]$ represents the time dedicated to work, and $1 - h_{t+j}$ is the time dedicated to leisure, both in period t+j. $U\left(c_{t+j}, m_{t+j+1}/P_{t+j}, 1 - h_{t+j}\right)$ is a function representing time separable preferences, and satisfying some usual conditions:[1] $U_1(t+j)>0$, $U_{11}(t+j)<0$, $U_2(t+j)>0$, $U_{22}(t+j)<0$, $U_3(t+j)>0$, $U_{33}(t+j)<0$, $U_{12}(t+j)\geq 0$, $U_{13}(t+j)\geq 0$, and $U_{23}(t+j)\geq 0$.

Households can lend their resources to banks by holding bank deposits, d_t. Banks pay a gross deposit rate given by $(1+R_{Dt})$. Both the principal as well as the interest payments are paid to the household at the beginning of the following period. We assume that each family owns an equal share of the banks, receiving part of their profits, π_t^{Bf}, at the beginning of the next time period.

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[1] The $C_i(t)$ notation indicates the partial derivative of the C(.) function with respect to its i-th argument, evaluated in period t. Analogous interpretation applies for $C_{ii}(t)$.

Households own the capital stock, $k_t \geq 0$, and rent their capital holdings to final goods producers at the real price[2] $r_t \geq 0$. Capital goods are produced by entrepreneurs and bought by households at the real price $q_t \geq 0$. However, new capital goods are only available for renting by the firms in the next time period.

The household budget constraint in period t can be expressed as:

$$c_t = w_t h_t + r_t k_t + \pi_{t-1}^{Bf} + (1 + R_{Dt-1}) d_{t-1} \frac{P_{t-1}}{P_t} - d_t + \frac{m_t}{P_t} - \frac{m_{t+1}}{P_t} - i_t^f - \tau_t \qquad (2)$$

where $w_t \geq 0$ is the real wage, $i_t^f \geq 0$ is the investment in new capital goods, and τ_t is the *lump sum* tax paid to the government.

The optimization problem faced by the household is to maximize the discounted utility flow (1) subject to the budget constraint (2), and to the capital accumulation equation:

$$k_{t+1} = (1-\delta) k_t + \frac{i_t^f}{q_t} \qquad (3)$$

The static first order condition governing the relation between the household labor supply and its consumption is given by:

$$\frac{U_3(t)}{U_1(t)} = w_t \qquad (4)$$

The remaining first order conditions can be summarized by the following Euler equations:

$$q_t U_1(t) = \beta E_t \left\{ U_1(t+1) q_{t+1} \left[(1-\delta) + \left(\frac{r_{t+1}}{q_{t+1}} \right) \right] \right\} \qquad (5)$$

[2] Real prices are quoted in units of the final good. All variables are in real terms, with the exception of nominal money balances, m_t, and, obviously, the monetary price, P_t.

$$U_1(t) = \beta E_t \left\{ U_1(t+1)(1+R_{Dt}) \frac{P_t}{P_{t+1}} \right\} \quad (6)$$

$$\frac{U_2(t)}{U_1(t)} = \frac{R_{Dt}}{(1+R_{Dt})} \quad (7)$$

where capital accumulation is governed by equation (5), the optimal decision concerning bank deposits is given by equation (6), and equation (7) regulates the optimal real balances held by the household.

2.2 Firms

Firms produce the final good under competitive conditions. Each firm has access to a constant returns to scale technology production. This technology employs labor and capital goods as productive factors. In the aggregate, one observes:

$$Y_t = F(K_t, H_t, H_t^e) \quad (8)$$

where $Y_t \geq 0$ is the aggregate production of the final good, $K_t \geq 0$ is the aggregate capital stock, $H_t \geq 0$ is the aggregate labor supply of households, and $H_t^e \geq 0$ is the aggregate labor supply of entrepreneurs. The production function is assumed to be neoclassical, i.e., for positive input values, this technology is increasing and concave with respect to each factor of production – $F_1(t) > 0$, $F_2(t) > 0$, $F_3(t) > 0$, $F_{11}(t) < 0$, $F_{22}(t) < 0$, $F_{33}(t) < 0$ –, and this technology also satisfies the Inada conditions: $\lim_{k\to\infty}(F_1(t)) = \lim_{h\to\infty}(F_2(t)) = \lim_{h^e\to\infty}(F_3(t)) = 0$, and $\lim_{k\downarrow 0}(F_1(t)) = \lim_{h\downarrow 0}(F_2(t)) = \lim_{h^e\downarrow 0}(F_3(t)) = \infty$.

Labor has to be paid before production starts. Thus, at the beginning of each period, the firm needs to find a bank to finance its payroll bill. This loan will be paid back at the end of the period at a gross rate $(1+R_{Lt}^F)$. It is also assumed that firms can pay the rent on capital goods after the production. So, firms do not need to seek credit to finance this component of their costs.

Input markets are competitive. Thus, in equilibrium, capital rent is equal to capital marginal product, $r_t = F_1(t)$. By the same token, the financing constraint implies that wages are given by $w_t = (F_2(t))/(1+R^F_{Lt})$, and $n_t = (F_3(t))/(1+R^F_{Lt})$, where $n_t \geq 0$ is the wage paid by entrepreneur's work.

2.3 Entrepreneurs and information asymmetries

When entrepreneurs are allowed to live for many periods, one needs to consider a possible heterogeneity in the amount of internal funds available to them. However, it is not a trivial task to deal with the distribution of the internal funds and the way this distribution affects the aggregate economy. In order to overcome such difficulties, Carlstrom and Fuerst (1997, p. 894) assume that both the entrepreneur's production function and the verification costs are linear. This assumption allows that only the aggregate value of the internal funds affects the equilibrium. However, under such assumption, the model developed in the present paper would not have a solution for the financial contract once banks are allowed to have market power. It is therefore required that either the entrepreneur's production function or the verification technology (or both) show decreasing returns. In what follows, we assume that there are decreasing returns in the verification technology. Moreover, following Fuerst (1995), it is assumed that each entrepreneur lives only for one period.[3]

Following Fuerst (1995, p.1324), new entrepreneurs are born at the beginning of each period and they die at the end of it. Each entrepreneur is endowed with one unit of time, which they inelastically supply to the firms in exchange for a wage rate equal to n_t. The wage rate n_t represents the net worth or the internal funds of each entrepreneur.

Entrepreneurs have risk neutral preferences over consumption and they have access to a stochastic technology that transforms, within each time period, consumption goods into capital goods. To be more precise, i^e_t units of consumption goods are

[3] According to Christiano, Eichenbaum and Evans (1997), an empirical stylized fact is that default rates decline during economic booms. However, models where the entrepreneur lives for many periods - as e.g. Carlstrom and Fuerst (1997, 1998, 2001) - predict that the default rate increases during economic booms. This behavior is due to the initial response of internal funds. Since such funds are primarily formed by previously accumulated capital, their reaction is not immediate. The increased production therefore requires a substantial amount of external finance and, as a consequence, the default ratio increases.

transformed into $\kappa_t i_t^e$ units of capital, where $i_t^e \in [0,\infty)$. κ is an idiosyncratic productivity shock, which is i.i.d. along the periods as well as among the entrepreneurs. Its support is non-negative. Its distribution function, Φ(κ), and its density function, φ(κ), are known by all agents. The density function φ(κ) is strictly positive and continuously differentiable in the interval [0,∞).

There are information asymmetries in the sense that each entrepreneur is better informed about the outcome of his production than any other agent. Formally, κ can be privately and costless observed by the entrepreneur, while other agents have to pay a cost of $C(i^e)$ units of capital to observe this outcome, where $C:\Re_+ \rightarrow \Re_+$, $\left(dC/di^e\right) \geq 0$, $\left(d^2C/di^{e2}\right) \geq 0$, $\forall\ i^e > 0$. A particular decreasing returns functional form is assumed for the verification technology, given by: $C\left(i_t^e\right) = \mu i_t^{e2}$.

In order to make the problem of asymmetric information relevant in the model, we assume that n_t is sufficiently small. Thus, entrepreneurs need to seek external finance. This credit will be provided by the banking sector. It is assumed that each entrepreneur borrows from only one bank.

The entrepreneur borrows $l_t^{be}\left(= i_t^e - n_t\right)$ units of consumption goods before starting its production project. He is then willing to pay $\left(1 + R_{Lt}^e\right) l_t^{be}$ units of capital goods at the end of the period. However, given the stochastic nature of his technology, he will not be able to meet his financial obligations if the idiosyncratic productivity shock κ_t turns out to be lower than:

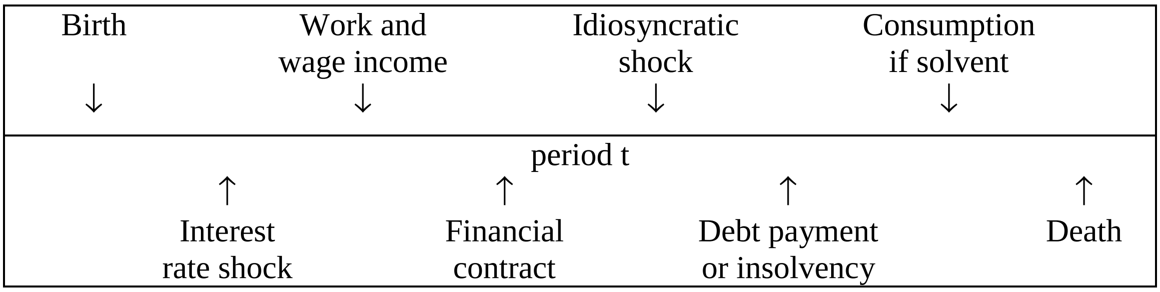
$$\kappa_t^* \equiv \frac{\left(1 + R_{Lt}^e\right) l_t^{be}}{i_t^e} \qquad (9)$$

κ_t^* can be interpreted as a critical insolvency level. When $\kappa_t < \kappa_t^*$, the bank monitors the project outcome paying a cost of μi_t^{e2} units of capital, and confiscates all the entrepreneur's production. The financial contract offered by the entrepreneur to the bank will therefore be a standard debt contract.

It is interesting to observe that expression (9) implies that an increase in the loan interest rate leads, *ceteris paribus,* to an increase in the critical insolvency level. The model therefore implies a positive relation between the default ratio and the loan interest rate.

Figure 1 summarizes the sequence of the entrepreneur's activities along any period t.

Figure 1. Timing sequence of an entrepreneur's activities in period t



2.4 Banks

Banks play the role of financial intermediaries between families on one side and firms and entrepreneurs on the other. Banks receive deposits from the first group and lend to the last ones. On the loan side, it is assumed that each bank holds a sufficiently large portfolio such that the idiosyncratic risk is completely diversified away. Thus, the loan portfolio of each bank yields a non-stochastic return. Each bank makes also transactions in the public bonds market.

Following an industrial organization approach [see e.g. Freixas and Rochet (1997, ch.3)], bank activity is modeled as involving the production of deposit and loan services. Bank technology is represented by the cost function C(D, L), which is interpreted as the resource costs of managing a volume D of deposits and a volume L of loans. The simplifying assumption that all banks have the same cost function is adopted here. The banking literature has used different functional forms to represent the cost function.[4] We follow Diáz-Giménez *et al.* (1992) and assume constant returns to scale as well as additive separability. Thus, there is a η_D cost per unit value of deposits and a η_L cost per unit value of loans.

With separability ($\partial^2 C/\partial D \partial L = 0$) and null cross effects, the model implies that the decision problem the bank faces is separable across the two markets. Thus, the optimal deposit interest rate does not depend on features of the loan market; similarly, the optimal loan interest rate is independent of the deposit market [see Freixas and Rochet (1997, p.59)].

Banks participate in three markets: loans, deposits, and bonds. In the loan market, banks discriminate prices between two categories of borrowers: one, who are subject to asymmetric information, namely the entrepreneurs; and, the other, who are not, namely the firms. When lending to firms, banks act in imperfect competition, Cournot style. When lending to entrepreneurs, banks sign financial contracts where their first order condition for maximum profits is being attended. The loan demand curve is negatively sloped in both cases. Let the inverse demand curves be $R_{Lt}^{F} = f\left(L_t^F\right)$ and $R_{Lt}^{e} = g\left(l_t^{be}\right)$, where R_{Lt}^{F} is the net loan interest rate to firms, R_{Lt}^{e} is the net loan interest rate charged from an entrepreneur "e", L_t^F is the total amount of loans to firms, and l_t^{be} is the volume of loans from a bank "b" to an entrepreneur "e".

The focus of this paper is on the information asymmetries in the loan market. Thus, to simplify matters, it is assumed that the technology for deposits is freely accessible and each bank acts as in perfect competition in this market. Each bank assumes that the deposit interest rate R_{Dt} is given by the market. The bank decision variables are the amount of loans and the amount of deposits it accepts. In the bonds market, banks take the public bonds interest rate R_t as a policy instrument that is set by the monetary authority.

[4] For instance, Edwards and Végh (1997, p.246-247) assume complementarity between deposits and loans in the sense that $C_{DL}(.)<0$. In addition to complementarity, Catão and Rodriguez (2000, p.20) present a cost function that implies a convex relation between the loan interest spread and the loan supply. These authors believe that such features are stylized in the literature. By contrast, English (2000, p.10), among others, make the extreme assumption that banking intermediation activity is costless.

Bank profits can be written as the sum of the intermediation margins the bank expects from loans and deposits, minus the costs. After taking into account the asymmetric information, the expected profit for a bank "b" is given by:

$$\pi_t^b = q_t \left\{ \int_0^J \left[\int_{\kappa_t^*(j)}^{\infty} \left(1 + R_{Lt}^e(j)\right) l_t^{be}(j) \phi(\kappa) d\kappa + \int_0^{\kappa_t^*(j)} \kappa \left(l_t^{be}(j) + n_t(j)\right) \phi(\kappa) d\kappa - \right. \right.$$
$$\left. \left. \int_0^{\kappa_t^*(j)} \mu \left(l_t^{be}(j) + n_t(j)\right)^2 \phi(\kappa) d\kappa \right] dj \right\} - \left(1 + R_t\right) \int_0^J l_t^{be}(j) dj + \left(R_{Lt}^F - R_t\right) l_t^{bF} + \qquad (10)$$
$$\left[(1-\alpha) R_t - R_{Dt}\right] d_t^b - \eta_L \left(l_t^{bF} + \int_0^J l_t^{be}(j) dj \right) - \eta_D d_t^b$$

where $J \in (0, \lambda]$ represents the measure of entrepreneurs borrowing from bank b, $\kappa_t^*(j) \geq 0$ is the critical insolvency level for entrepreneur $j \in (0, J]$, $R_{Lt}^e(j) > 0$ is the interest rate charged from entrepreneur j, $l_t^{be}(j) \geq 0$ is the amount of loans from bank b to entrepreneur j, $n_t(j) \geq 0$ is the amount of internal funds of entrepreneur j, $l_t^{bF} \geq 0$ is the amount of loans from bank b to the firms, $d_t^b \geq 0$ is the amount of deposits at bank b, $\alpha \geq 0$ is the reserve requirements rate on deposits set by the monetary authority, and $R_t \geq 0$ is the net basic interest rate, also set by the monetary authority.

In equation (10), $q_t \left\{ \int_0^J \left[\int_{\kappa_t^*(j)}^{\infty} \left(1 + R_{Lt}^e(j)\right) l_t^{be}(j) \phi(\kappa) d\kappa \right] dj \right\}$ is the expected return from the solvent entrepreneurs. The expected return on the bankrupt entrepreneurs is given by $q_t \left\{ \int_0^J \left[\int_0^{\kappa_t^*(j)} \kappa \left(l_t^{be}(j) + n_t(j)\right) \phi(\kappa) d\kappa - \int_0^{\kappa_t^*(j)} \mu \left(l_t^{be}(j) + n_t(j)\right)^2 \phi(\kappa) d\kappa \right] dj \right\}$. The sum of these two amounts net of $\left(1 + R_t\right) \int_0^J l_t^{be}(j) dj$ represents the intermediation margin on loans to entrepreneurs. On the other hand, $\left(R_{Lt}^F - R_t\right) l_t^{bF}$ and $\left[(1-\alpha) R_t - R_{Dt}\right] d_t^b$ are the intermediation margins on loans to firms, and on deposits, respectively. Finally, total operational bank costs are given by $\eta_L \left(l_t^{bF} + \int_0^J l_t^{be}(j) dj \right) + \eta_D d_t^b$.

The first order conditions for optimization are given by:

$$R^{e}_{Lt}(j) = \left(\frac{\kappa^{*}_{t}(j) n_{t}(j)}{l^{be}_{t}(j)} - 1 \right) + \left(\int_{\kappa^{*}_{t}(j)}^{\infty} \phi(\kappa) d\kappa \right)^{-1} \times \left\{ \frac{\eta_{L} + 1 + R_{t}}{q_{t}} - \int_{0}^{\kappa^{*}_{t}(j)} \left[\kappa - 2\mu \left(l^{be}_{t}(j) + n_{t}(j) \right) \right] \phi(\kappa) d\kappa \right\} \quad , \forall j \in (0,J] \tag{11}$$

$$R^{F}_{Lt} = \left(1 - \frac{l^{bF}_{t}}{L^{F}_{t} \varepsilon_{L} \left(R^{F}_{Lt} \right)} \right)^{-1} \left(R_{t} + \eta_{L} \right) \tag{12}$$

$$R_{Dt} = (1-\alpha) R_{t} - \eta_{D} \tag{13}$$

where $\varepsilon_{L}(R^{F}_{Lt})$ is the interest loan demand elasticity for firms, given by:

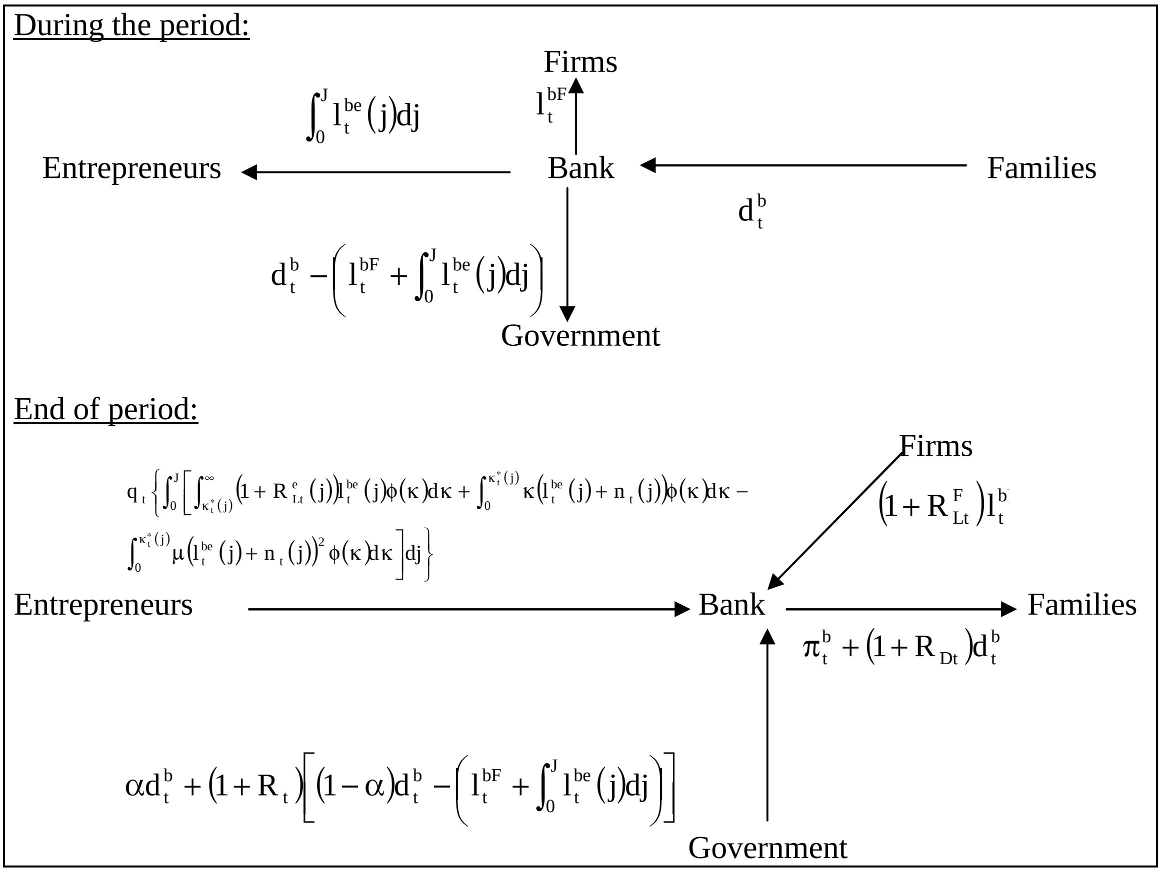
$$\varepsilon_{L}\left(R^{F}_{Lt}\right) = \frac{R^{F}_{Lt}}{\left(1 + R^{F}_{Lt}\right)} \tag{14}$$

Expressions (11)-(13) indicate that if the interest rate on public bonds increases, *ceteris paribus* interest rates on both loans and deposits also increase. One can also observe that an increase in the loan market competition, as measured by a more elastic loan demand curve, reduces the loan interest rate for firms and, as a result, also reduces the interest spread,[5] $R^{F}_{Lt} - R_{Dt}$.

Figure 2 shows a diagram with the activities of a bank "b" during and at the end of a period t.

[5] The interest spread for loans to entrepreneurs is given by: $q_{t}\left(1 + R^{e}_{Lt}\right) - \left(1 + R_{Dt}\right)$.

Figure 2. Activities of bank “b” in period t



2.5 Financial contract

The entrepreneur goes to the credit market and offers a debt contract that will, hopefully, be demanded by some bank. Following, to some extent, the financial contract devised by English (2000, p.11), we consider that the entrepreneur decides how much to borrow by maximizing his expected return taking into consideration the constraint that the bank maximization condition has to be satisfied. If this constraint were not satisfied, then the bank, which has market power, would not be maximizing its profits. Moreover, if the expected return of the entrepreneur is not maximized subject to this constraint, then it is conceivable that some other bank could come out with another debt contract that would be more attractive to the entrepreneur and yet would be maximizing the bank's profits.[6] The optimal contract offered by the entrepreneur to the bank is given by the vector (l_t^{be}, R_{Lt}^{e}, κ_t^*) satisfying:

$$\max_{l_t^{be},\kappa_t^*}\left\{q_t\int_{\kappa_t^*}^{\infty}\left[\kappa\left(l_t^{be}+n_t\right)-\left(1+R_{Lt}^{e}\right)l_t^{be}\right]\phi(\kappa)d\kappa\right\} \tag{15}$$

subject to:

$$R_{Lt}^{e}=\left(\frac{\kappa_t^* n_t}{l_t^{be}}-1\right)+\left(\int_{\kappa_t^*}^{\infty}\phi(\kappa)d\kappa\right)^{-1}\times\left\{\frac{\eta_L+1+R_t}{q_t}-\int_0^{\kappa_t^*}\left[\kappa-2\mu\left(l_t^{be}+n_t\right)\right]\phi(\kappa)d\kappa\right\} \tag{16}$$

where identity (9) holds for entrepreneur j.

It is interesting to observe that the entrepreneur is not going to decide the amount of loans to be demanded given the loan interest rate. Instead, the entrepreneur is going to choose the amount of loans and the optimal default probability subject to the satisfaction of the first order condition of the bank. The loan interest rate is simultaneously determined through condition (9). It is also important to note that we are assuming a limited liability constraint, i.e. the entrepreneur cannot pay to the bank more than his final assets (final production), ruling out the possibility of negative consumption.

The solution to the contract problem is given by two implicit functions:

$$l_t^{be}=l\left(q_t,n_t,R_t\right) \tag{17}$$

$$\kappa_t^*=\kappa\left(q_t,n_t,R_t\right) \tag{18}$$

where q_t and n_t are both determined in the economy's general equilibrium, and R_t is exogenous.

[6] This argument is analogous to one presented by Gale and Hellwig (1985, p.651). Besides, it is interesting to note that English (2000) examines the differences in outcomes when the borrower considers and when he does not consider the constraint regarding the profit maximization of the financial intermediary on his optimization problem.

2.6 Government

Both government spending and the interest payment on public debt are financed through money emission, $M_{t+1}^{s} - M_{t}^{s}$, and by *lump sum* taxes levied on the households, T_t. The government budget constraint is given by:

$$P_t G_t = P_t T_t + M_{t+1}^{s} - M_{t}^{s} + P_t B_t - (1 + R_t) P_t B_t \tag{19}$$

where $G_t \geq 0$ is the amount of government spending, and B_t is the amount of public debt. It is assumed that public bonds are issued at the beginning of each period and redeemed at the end of the same period, when the interest payments are also made. To simplify matters, it is assumed that government spending has effect neither in the utility functions nor in the production functions.

Monetary and fiscal policies give support to the nominal interest rate policy, R_t. Since monetary policy is modeled as an interest rate rule, money supply endogenously adjusts to accommodate the demand for real balances by the households at any given interest rate.

2.7 Equilibrium

The model is evaluated at a symmetric equilibrium. Market clearing conditions for each market can be written as:

Labor market for households:

$$H_t = (1-\lambda) h_t \tag{20}$$

Labor market for entrepreneurs:

$$H_t^{e} = \lambda \tag{21}$$

Market for final goods:

$$\Pi_t^{e} + (1-\lambda) c_t + \lambda i_t^{e} + G_t = Y_t \tag{22}$$

Market for capital goods:

$$K_{t+1} - (1-\delta)K_t = \lambda\left[i_t^e - \Phi(\kappa_t^*)\mu i_t^{e2}\right] \quad (23)$$

Loan market for entrepreneurs:

$$\lambda(i_t^e - n_t) = N\int_0^J l_t^{be}(j)dj \quad (24)$$

Loan market for firms:

$$w_t H_t + n_t H_t^e = N l_t^{bF} \quad (25)$$

Deposit market:

$$Nd_t^b = (1-\lambda)d_t \quad (26)$$

Bond market:

$$(1-\alpha)Nd_t^b - N\left[\int_0^J l_t^{be}(j)dj + l_t^{bF}\right] = B_t \quad (27)$$

Money market:

$$(1-\lambda)m_t = M_t^s \quad (28)$$

where N is the number of banks in the economy, and $\Pi_t^e \geq 0$ is the aggregate consumption by the entrepreneurs (equal to their profits).

A dynamic general equilibrium is defined by decision rules for K_{t+1}, d_t, R_{Dt}, (M_{t+1}/P_t), π_t^b, c_t, H_t, q_t, R_{Lt}^F, (P_t/P_{t-1}), κ_t^*, i_t^e, Y_t, R_{Lt}^e, l_t^{be}, Π_t^e, B_t, l_t^{bF}, T_t, where these decision rules are stationary functions of $(R_t, K_t, d_{t-1}, R_{Dt-1}, (M_t/P_{t-1}), \pi_{t-1}^b)$ satisfying:

$$Y_t = F(K_t, H_t, H_t^e) \quad (29)$$

$$\begin{aligned}(1-\lambda)c_t = {} & \frac{F_2(K_t, H_t, \lambda)}{(1+R_{Lt}^F)}H_t + F_1(K_t, H_t, \lambda)K_t + N\pi_{t-1}^b + \frac{M_t}{P_{t-1}}\frac{P_{t-1}}{P_t} - \frac{M_{t+1}}{P_t} + \\ & (1-\lambda)(1+R_{Dt-1})d_{t-1}\frac{P_{t-1}}{P_t} - (1-\lambda)d_t - q_t(K_{t+1} - (1-\delta)K_t) - T_t\end{aligned} \quad (30)$$

$$\frac{U_3(t)}{U_1(t)} = \frac{F_2(K_t, H_t, \lambda)}{(1+R_{Lt}^F)} \quad (31)$$

$$q_t U_1(t) = \beta E_t\left\{U_1(t+1)q_{t+1}\left[(1-\delta) + \left(\frac{F_1(K_{t+1}, H_{t+1}, \lambda)}{q_{t+1}}\right)\right]\right\} \quad (32)$$

$$U_1(t) = \beta E_t\left\{U_1(t+1)(1+R_{Dt})\frac{P_t}{P_{t+1}}\right\} \quad (33)$$

$$\frac{U_2(t)}{U_1(t)} = \frac{R_{Dt}}{(1+R_{Dt})} \tag{34}$$

$$R^F_{Lt} = \left(1 - \frac{1}{N\varepsilon_L\left(R^F_{Lt}\right)}\right)^{-1}(R_t + \eta_L) \tag{35}$$

$$R_{Dt} = (1-\alpha)R_t - \eta_D \tag{36}$$

$$l^{be}_t = l\left(q_t, \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}, R_t\right) \tag{37}$$

$$\kappa^*_t = \kappa\left(q_t, \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}, R_t\right) \tag{38}$$

$$K_{t+1} - (1-\delta)K_t = \lambda\left[i^e_t - \Phi(\kappa^*_t)\mu i^{e2}_t\right] \tag{39}$$

$$\Pi^e_t + (1-\lambda)c_t + \lambda i^e_t + G_t = Y_t \tag{40}$$

$$(1-\alpha)Nd^b_t - Nl^{bF}_t - \lambda l^{be}_t = B_t \tag{41}$$

$$\frac{F_2(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}H_t + \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}\lambda = Nl^{bF}_t \tag{42}$$

$$P_tG_t = P_tT_t + M^s_{t+1} - M^s_t + P_tB_t - (1+R_t)P_tB_t \tag{43}$$

$$\kappa^*_t \equiv \frac{\left(1+R^e_{Lt}\right)l^{be}_t}{i^e_t} \tag{44}$$

$$l^{be}_t = i^e_t - \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)} \tag{45}$$

$$\Pi^e_t = \lambda q_t \int_{\kappa^*_t}^{\infty}\left[\kappa\left(l^{be}_t + \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}\right) - \left(1+R^e_{Lt}\right)l^{be}_t\right]\phi(\kappa)d\kappa \tag{46}$$

$$\begin{aligned}\pi^b_t = {} & q_t\frac{\lambda}{N}\left[\int_{\kappa^*_t}^{\infty}\left(1+R^e_{Lt}\right)l^{be}_t\phi(\kappa)d\kappa + \int_0^{\kappa^*_t}\kappa\left(l^{be}_t + \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}\right)\phi(\kappa)d\kappa - \right. \\ & \left.\int_0^{\kappa^*_t}\mu\left(l^{be}_t + \frac{F_3(K_t, H_t, \lambda)}{\left(1+R^F_{Lt}\right)}\right)^2\phi(\kappa)d\kappa\right] - \frac{\lambda}{N}(1+R_t)l^{be}_t + \left(R^F_{Lt} - R_t\right)l^{bF}_t + \\ & \left[(1-\alpha)R_t - R_{Dt}\right]d^b_t - \eta_L\left(l^{bF}_t + \frac{\lambda}{N}l^{be}_t\right) - \eta_D d^b_t\end{aligned} \tag{47}$$

where (29) is the production function of final goods, (30) is the household budget constraint, (31) to (34) are the first order conditions for the households, (35) and (36) are the first order conditions for the banks, (37) and (38) come from the first order conditions of the financial contract, (39) is the movement law for the capital stock, (40) is the market clearing condition for final goods, (41) is the market clearing condition in the bond market, (42) is the market clearing condition in the loan market for firms, (43) is the government budget constraint, (44) defines the critical insolvency level, (45) is the entrepreneur's budget constraint, (46) is the aggregate entrepreneurs' profits (consumption), and (47) is the profit for a particular bank.

3. Parameterization

The household utility function is assumed to take the following functional form:

$$U\left(c_t, \frac{m_{t+1}}{P_t}, 1-h_t\right) = \ln(c_t) + \zeta \ln\left(\frac{m_{t+1}}{P_t}\right) + \xi \ln(1-h_t) \quad (48)$$

where $\zeta = 0.0159$, and $\xi = 1.4317$. The intertemporal discount rate is set at $\beta = 0.9140$.[7]

The population share of entrepreneurs can be considered as an arbitrary normalization without practical consequences for the qualitative conclusions of the model economy. We then set $\lambda = 0.05$.

The functional form for the production function for final goods is taken to be a Cobb-Douglas:

$$Y_t = K_t^{\alpha_1} H_t^{\alpha_2} H_t^{e\alpha_3} \quad (49)$$

where the capital income share is $\alpha_1 = 0.49$, a similar value to the ones reported by Araújo and Ferreira (1999, p.141), and by Bugarin and Ellery Jr. (2002) for the Brazilian economy. The share of household income is set at $\alpha_2 = 0.50$, and the share of entrepreneur income is set at $\alpha_3 = 0.01$. This last value assures that the entrepreneur's internal funds are positive.

[7] The values for these parameters for the Brazilian economy were estimated by GMM in Alencar and Nakane (2003). The reported values are the median estimates found for the logarithmic utility function.

The technology for capital goods production is stochastic. Following Fuerst (1995, p.1325), it is assumed that the distribution function for the productivity shock, $\Phi(\kappa)$, follows a uniform distribution in the interval [0.5; 1.5]. The quarterly depreciation rate for the capital stock is set at $\delta = 0.0164$, following Araújo and Ferreira (1999, p.143).

There were 160 commercial banks operating in Brazil by December 2001, according to Central Bank figures. However, not all of them can be qualified as typical retail banks, as our model implies. A great number of them have their core activities in the bonds markets and not in the credit markets. Retail banks usually have large branch networks. Out of 160, only 41 banks had more than 10 branches in the country by December 2001. The total number of banks in the simulations is then set to 40.

There are no available estimates for operational costs associated to the loan and deposit activities for Brazilian banks. We then use the estimates reported by Diaz-Gimenez *et al.* (1992, p.551) for the U.S. The marginal cost of deposits is η_D = 0.11875%, and the marginal cost of loans is η_L = 0.5625%. The reserve requirement ratio on deposits is set at $\alpha = 0.45$, which is close to the average values observed in Brazil.

With regard to the verification technology parameter, we examine the economy's behavior when μ changes from 0.3 to 0.2. A reduction in this parameter can be interpreted as a more efficient verification technology available to the banks, or else as a reduction in information asymmetries.

Some other assumptions related to the steady state values for some variables are also made. First, it is assumed that government spending and tax revenues are equal in steady state. Second, the steady state inflation rate is zero. Third, it is assumed that households allocate 35% of their time to work activities, a figure consistent with available survey evidence from IBGE (Instituto Brasileiro de Geografia e Estatística). Fourth, the volume of bonds represents 86% of the final goods production, and real money balances amount to 46% of household's consumption. These last ratios are in agreement with what one observes for Brazil in 2001 according to data available from IBGE and from the Brazilian Central Bank.

4. Simulations

In order to study the dynamic properties of the model, the equilibrium equations are first log-linearized around the steady state solution. Once the log-linearized system is obtained, the method due to Uhlig (1999) is employed to compute the movement laws of the recursive equilibrium as well as to generate the impulse-response functions that describe the dynamic behavior of the economy.

All the dynamic simulations performed here try to track the response to an unexpected reduction of a one-standard deviation in the basic interest rate, which follows the following stochastic process:

$$\log R_t = (1-\rho) \log R + \rho \log R_{t-1} + \varepsilon_t, \quad (50)$$

where R is the steady state value of the net interest rate, ρ is the persistence term for the interest rate, and ε_t is a random shock, serially uncorrelated with zero mean and finite variance.

Both the persistence term as well as the standard deviation for the random shock were taken from the estimates reported by Maziero and Nakane (2002). Using Brazilian quarterly data for the 1994:3 to 2001:2 period, they report an estimated value for ρ equal to 0.52, and a standard deviation of 0.0274 for the random shock.

Government spending, G_t, is held fixed in all the simulations. On the other hand, taxes, T_t, vary together with money supply and bond issue to give support to the interest rate policy. Similar assumptions are made by Bernanke *et al.* (1999), and by Gertler *et al.* (2003).

We report the simulations related to the main variables of interest in Figures 3 to 5 enclosed at the end of the paper. These figures show the impulse-response functions for different variables given a one-standard deviation reduction in the basic interest rate in period 0. The economy is, initially, in a steady-state equilibrium. All the figures present the percent deviation from the steady state values for each period following the shock.

Figure 3 compares the impulse response when the verification cost parameter is reduced from $\mu = 0.30$ to $\mu = 0.20$ in the case when banks have market power.[8] As a general comment, one can see that all the variables change in the expected direction. A second general comment is that the changes in the dynamic responses due to different verification technologies are small. Better verification technology slightly increases the reaction of the final good production, and of the household labor. The variables more directly related to the sector where information asymmetries occur show a greater response in view of the change towards more efficient verification technology. This can be illustrated by the responses of the capital stock, the entrepreneur's investment, the entrepreneur's borrowing, the entrepreneur's net worth, and the aggregate profits of the entrepreneurs. By contrast, a better verification technology reduces the dynamic response of both the default rate, and of the interest loan spread to the entrepreneurs.

We will now try to provide some intuition for the results shown in the figures.

4.1 Household labor, production of final goods, and entrepreneur net worth

The *household labor* reaction – and, to some extent, the *production of final goods* – can be better understood when one considers the movements in the demand for and the supply of labor in the (H_t, w_t) space, following an argument analogous to the one developed by Christiano and Eichenbaum (1992, p.348). The producer of final goods chooses the optimum amount of labor by equating the marginal product of labor

[8] The choice for such values for μ is arbitrary. One can observe, however, that when μ takes smaller values, the steady state default rate reduces. For the chosen values for μ, the steady state default rate is in the range of 29%, considerably higher than the values found for the Brazilian economy. One possible explanation for the high default rate implied by the model is the low quarterly intertemporal discount rate, $\beta = 0.914$, which implies an extremely high value for the steady state interest rate, equal to 89.47 % per year, which, in turn, has a negative impact on the equilibrium default rate.

to its marginal cost. Given the working capital constraint stating that the firm needs to borrow to meet its payroll expenses, a reduction in interest rates shifts the labor demand to the right. On the other side, equation (4) is equivalent to a static labor supply function. This expression is not affected by the interest rate reduction, conditioned on a fixed value for the marginal utility of consumption. Thus, a reduction in the interest rate shifts the labor demand to the right without any compensatory movement in the labor supply. In general equilibrium, this movement explains the increase in both the household labor and in the real wage. It also helps to explain the increase in the production of final goods. An analogous argument justifies the increase in the *entrepreneur's net worth*, which is measured by his wage.

4.2 Capital stock, real price of capital, and entrepreneur's investment

The effects of interest rates on the *capital stock* are also better traced out when one considers the supply and demand schedules in the (K_t, q_t) space. The expected capital supply at the end of period t is given by:

$$K^S\left(q_t, n_t, R_t, \kappa_t^*\right) = (1-\delta)K_t + \lambda\left\{i^e\left(q_t, n_t, R_t, \kappa_t^*\right) - \mu\left[i^e\left(q_t, n_t, R_t, \kappa_t^*\right)\right]^2 \Phi\left(\kappa_t^*\right)\right\} \quad (51)$$

where $i^e\left(q_t, n_t, R_t, \kappa_t^*\right)$ is the value of the investment of the capital goods producer – the entrepreneur –, which is determined, in partial equilibrium terms, in the financial contract that solves (17) and (18).[9] The supply of expected new capital in the symmetric equilibrium is given by $\lambda\left\{i^e\left(q_t, n_t, R_t, \kappa_t^*\right) - \mu\left[i^e\left(q_t, n_t, R_t, \kappa_t^*\right)\right]^2 \Phi\left(\kappa_t^*\right)\right\}$. It is quite intuitive that the presence of asymmetric information generates a positive sloped supply for capital goods since, *ceteris paribus*, a higher production of capital goods requires more external finance, which increases the production costs. Such intuitive outcome can actually be numerically computed by making use of the implicit function theorem in the steady state equilibrium.[10] When $\mu = 0.30$, for example, $\left(\partial K^S / \partial q_t\right) \cong 1.11 > 0$ in the steady state. This same procedure can be applied with respect to shifts in the interest rate. When $\mu = 0.30$ one obtains $\left(\partial K^S / \partial R_t\right) \cong -1.73 < 0$, and when $\mu = 0.20$ one obtains

[9] Recall that $i_t^e = l_t^{be} + n_t$.

[10] The system of equations used for the computations are given by (17), (18), and (3).

$\left(\partial K^{S} / \partial R_{t}\right) \cong -2.13 < 0$ – both evaluated at the steady state. These results imply that, *ceteris paribus*, an interest rate fall shifts the expected capital supply schedule to the right, and the shift is greater when $\mu = 0.20$, which is what is actually observed in Figure 3.

The capital demand curve is given by expression (32) and it is not directly influenced by interest rates. Thus, a reduction in interest rates leads, at least in partial equilibrium, to an increase in the production of capital goods and to a reduction in the real price of such goods. Figure 3 shows that these effects are not reverted in general equilibrium, which also helps explain the movements for the *entrepreneur's investment*.[11]

4.3 Entrepreneur's borrowing

The production of capital goods is partially financed by banks. Thus, a natural outcome of the expansion in the production of capital goods is an increase in the demand for loans by entrepreneurs.

4.4 Household consumption

Household consumption is affected by several factors. On one side, the fall in interest rates leads to a negative wealth effect, which helps to reduce consumption. On the other side, the substitution effect leads to higher present-to-future consumption ratios. For the logarithmic utility specification used in the paper these two effects cancel each other out. However, there are other effects working to raise the family wealth, notably a fall in lump sum taxes, and an increase in the dividends paid by banks. Thus, in general equilibrium, the fall in interest rates leads to an increase in consumption.

[11] Notice that capital stock is predetermined in the period when interest rate changes. The demand for capital by households, however, increases in the initial period; therefore, in this period, one observes an increase in the real price of capital.

4.5 Default rate, and loan interest spread for entrepreneurs

Figure 3 shows that both the *default rate* as well as the *interest spread for loans to the entrepreneurs* reduce with the fall in interest rates. Similar results were obtained by Cooley and Nam (1998, p.612). A possible reason for the fall in the default rate is the fact that the increase in the entrepreneur's net worth was proportionately greater than the increase in the borrowed loans. The premium on external funds was then reduced. With regard to the interest spread to the entrepreneurs, the observed reduction is due to the joint effect of the reduction in the premium on external funds, a lower default rate, and a lower real price for capital.

4.6 Bank profits, and entrepreneurs' aggregate profits

Christiano *et al.* (1997) have found empirical evidence that profits from different economic sectors fall after a positive interest rate shock. The movements of *bank profits* and of *entrepreneurs' aggregate profits* reported in Figure 3 are in line with this evidence.

4.7 Additional comments

The movement observed for the real price of capital goods in Figure 3 is the opposite of the one reported by Carlstrom and Fuerst (2001, p.17). In their paper, the fall in interest rates leads to an increase in the real price of capital goods. This outcome is, to some extent, unexpected since a greater capital stock would reduce its marginal productivity as well as its unit expected return. The difference between our results and theirs is probably due to the way the financial intermediary is modeled in the two papers. The basic interest rate is not an opportunity cost for the financial intermediary in Carlstrom and Fuerst's model. As a result, the basic interest rate does not directly affects the capital supply schedule, as it does in our model. Without such effect, the general equilibrium result is an increase in the capital goods real price, probably due to the higher agency cost caused by an increased investment by the entrepreneurs.

4.8 Perfect competition in loan markets

We now modify the model by making the assumption that banks operate in perfect competition not only in the deposit market but also in the loan market. The assumption of entry barriers in the banking sector can now be relaxed. The number of banks in equilibrium is the one that is consistent with zero profits for banks. The relevance of this extension is that we can directly compare our results with the traditional CSV literature that assumes perfect competition in financial markets. One can therefore investigate if the assumption of market power qualitatively changes the influence of information asymmetries in the economy.

A first modification in the model is related to the optimum loan interest rate to the firms. The bank's first order condition related to loans to the firms – equation (12)/(35) – has to be replaced by:

$$R_{Lt}^{F} = \left(R_t + \eta_L\right) \tag{52}$$

A second modification occurs in the loan market for the entrepreneurs. The financial contract offered by the entrepreneur to the bank is not constrained by the satisfaction of the bank's first order condition anymore. Instead, the new financial contract aims at maximizing the expected return to the entrepreneur subject to the constraint that the expected profit for the bank in such contract is zero. In other terms, the financial contract is given by the vector (l_t^{be}, R_{Lt}^{e}, κ_t^*) that is the solution to the following problem:

$$\max_{l_t^{be},\kappa_t^*}\left\{q_t \int_{\kappa_t^*}^{\infty}\left[\kappa\left(l_t^{be}+n_t\right)-\left(1+R_{Lt}^{e}\right)l_t^{be}\right]\phi(\kappa)d\kappa\right\} \tag{53}$$

subject to:

$$q_t\left\{\int_{\kappa_t^*}^{\infty}\left(1+R_{Lt}^{e}\right)l_t^{be}\phi(\kappa)d\kappa+\int_0^{\kappa_t^*}\left[\kappa\left(l_t^{be}+n_t\right)-\mu\left(l_t^{be}+n_t\right)^2\right]\phi(\kappa)d\kappa\right\}-\left(1+R_t\right)l_t^{be}-\eta_L l_t^{be}=0 \tag{54}$$

where identity (9) has to be satisfied.

The solution to the contract problem is also given by two implicit functions:

$$l_t^{be} = \gamma(q_t, n_t, R_t) \quad (55)$$

$$\kappa_t^* = \varphi(q_t, n_t, R_t) \quad (56)$$

Expressions (55) and (56) replace the corresponding expressions (37) and (38) in the system of equations representing the model economy.

Figure 4 presents the economy's dynamic responses when there is perfect competition in the loan market. The variables' responses are again in the expected directions. As a general comment, one can see that the influence of the bank verification technology on the dynamic responses is greater in the perfect competition case than in the previous one. The influence of the verification technology on the variables more directly affected by the information asymmetry – e.g. capital stock, real price of capital goods, entrepreneur's investment, entrepreneur's borrowing –, which was already quite clear in Figure 3, become now even more pronounced. The exceptions to this general pattern are the responses of the default rate and of the interest loan spread to entrepreneurs. A possible reason for such responses is that in the market power case, with the increase in the internal funds, a worsening in the verification technology would create a greater share of rents from agency costs to the entrepreneur.

Figure 5 shows the effects of bank competition in the propagation of the monetary policy shock. Overall, the effect of increased competition is to enhance the reaction of the variables to the shock. The exceptions are represented by the reactions of the default rate, of the loan interest spread to entrepreneurs, and of entrepreneurs' aggregate profits. In order to understand such exceptions, it is worthy recalling that banks can appropriate part of the agency rents when they have market power. With the increase in the internal funds following a reduction in the basic interest rate, the opportunity for banks to appropriate such rents reduces. Likewise, entrepreneurs capture a larger share of such rents. Hence, the greater negative response of both the default rate as well as of the interest spread and the greater positive response of the entrepreneur's profits are justified.

A possible explanation for the greater economy's response under perfect competition is that this market structure is more conducive to the production of capital goods by allowing that all the rents from agency costs be kept by the entrepreneurs. The greater response of the capital goods production with the greater fall in their prices translate into greater responses of the other variables, with the exception of those discussed in the previous paragraph.

The greater economic response to a monetary policy shock under perfect competition of the banking sector is, to some extent, the opposite of the result found by Smith (1998). This author examines a version of Bernanke and Gertler's (1989) model with a banking sector, and reaches the conclusion that bank competition reduces economic fluctuations.[12] The structure of Smith's economy is quite distinct from the one developed here. Amongst the several differences, the combination of the assumptions related to the banking sector and to the entrepreneurs seems to be at the heart of the discrepancies in our results. On one hand, Smith (1998) takes the opportunity cost of the entrepreneur's internal funds as being given by the bank deposit interest rate, which is fixed in perfect competition but anticyclical under imperfect competition. On the other hand, the number of productive entrepreneurs is a decreasing function of the deposit interest rate. The conjugation of such assumptions amplifies the economic fluctuations when the banking industry is in imperfect competition. However, the anticyclical response of the deposit interest rate leads also to an anticyclical behavior of bank profits, which is against the empirical observation as noted by Smith (1998, p.810).

5. Conclusions

This paper developed a dynamic general equilibrium model with a banking sector and agency costs to investigate the responses to a monetary policy shock. All the variables showed dynamic responses in the expected directions. An unexpected interest rate reduction was followed by increases in the production of final goods, in the hours

[12] It has to be noticed, however, that Smith (1998) examined the economy's response to technology shocks rather than to monetary policy shocks, as stressed here.

worked by the households, in the capital stock, in the household consumption, and in the entrepreneur’s investment, borrowing, profits, and net worth. The reduction in the interest rates leads also to reductions in the real price of capital goods, in the default rate, and in the interest lending spread to entrepreneurs.

The examination of the dynamic simulations allows also one to state that increased competition amongst banks, or improved verification technology of the defaulted loans are both associated to enhanced responses of the real economy to interest rate shocks, and to less pronounced responses of the default rate and of the interest spread to the same shocks. Moreover, it was also possible to observe that the assumption of market power in the financial intermediary does not qualitatively change the results related to the role played by information asymmetries in the propagation of shocks. Nevertheless, there is a quantitative difference in the sense that the influence of the verification technology in the economy’s dynamic response is greater when the loan market works under perfect competition. Apparently, this last result is new in the literature.

Figure 3
Effects of the Verification Technology in the Propagation of an Interest Rate Shock when Banks have Market Power

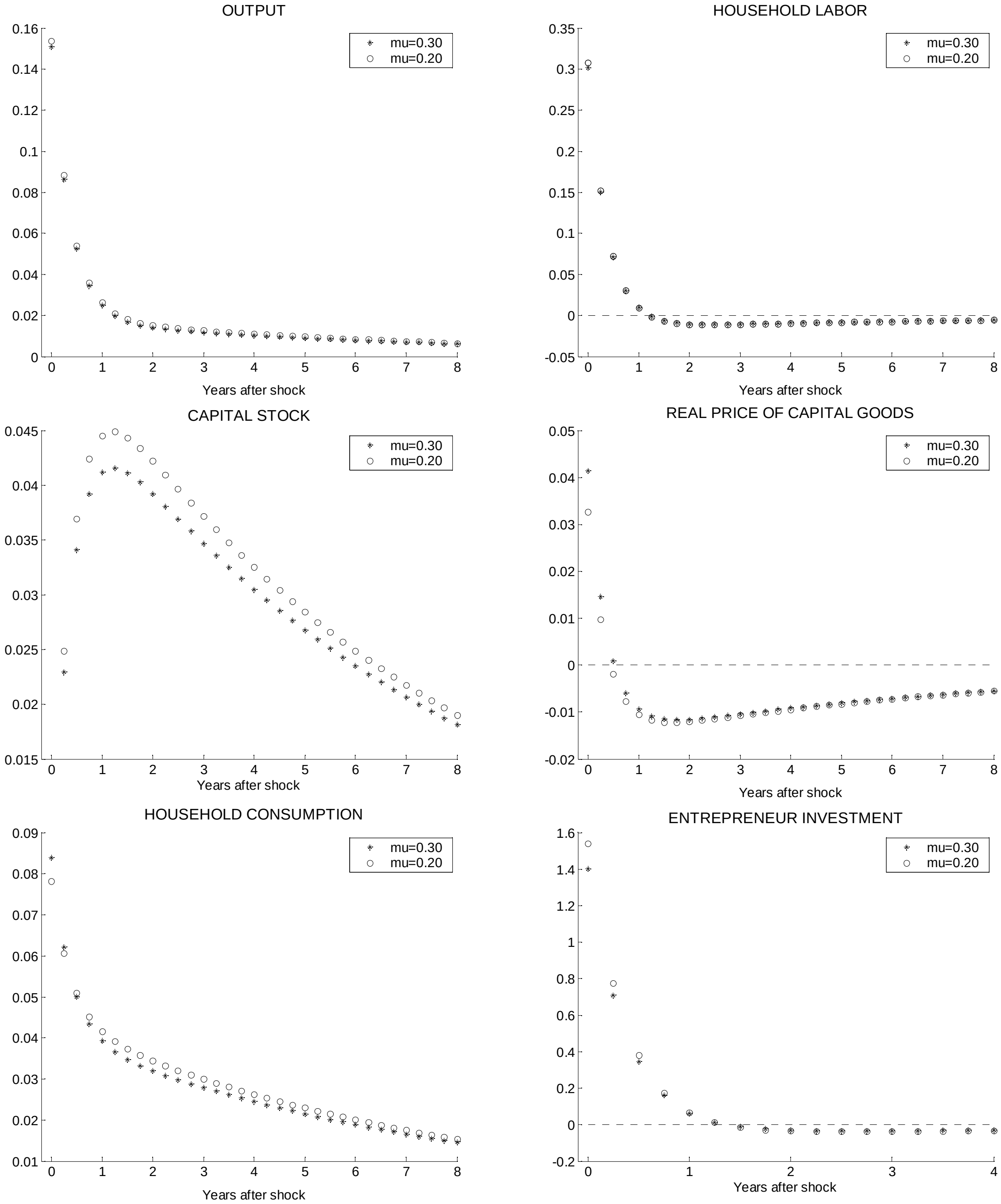


Figure 3
(Continuation)

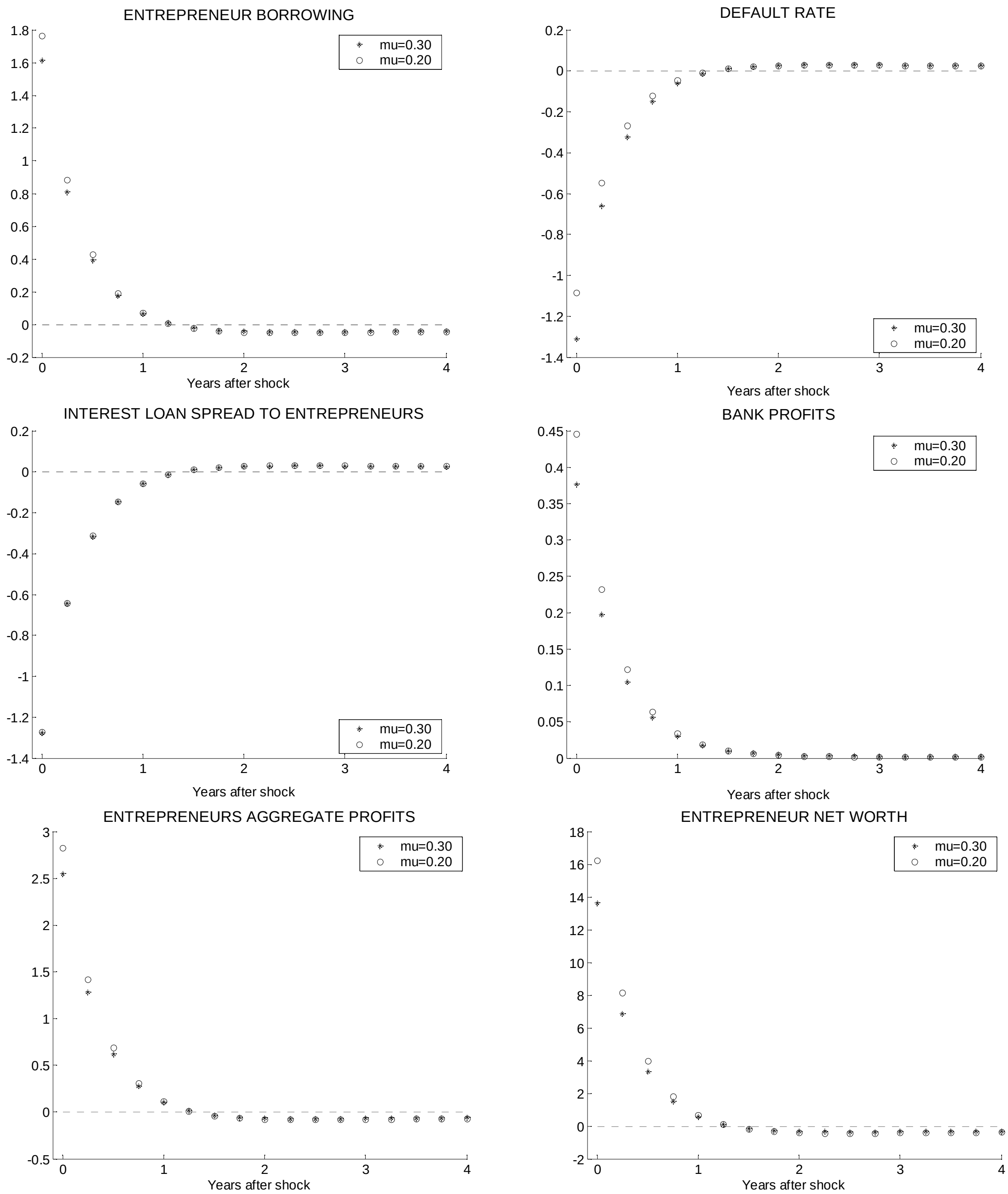


Figure 4
Effects of the Verification Technology in the Propagation of an Interest Rate Shock when Banks work in Perfect Competition

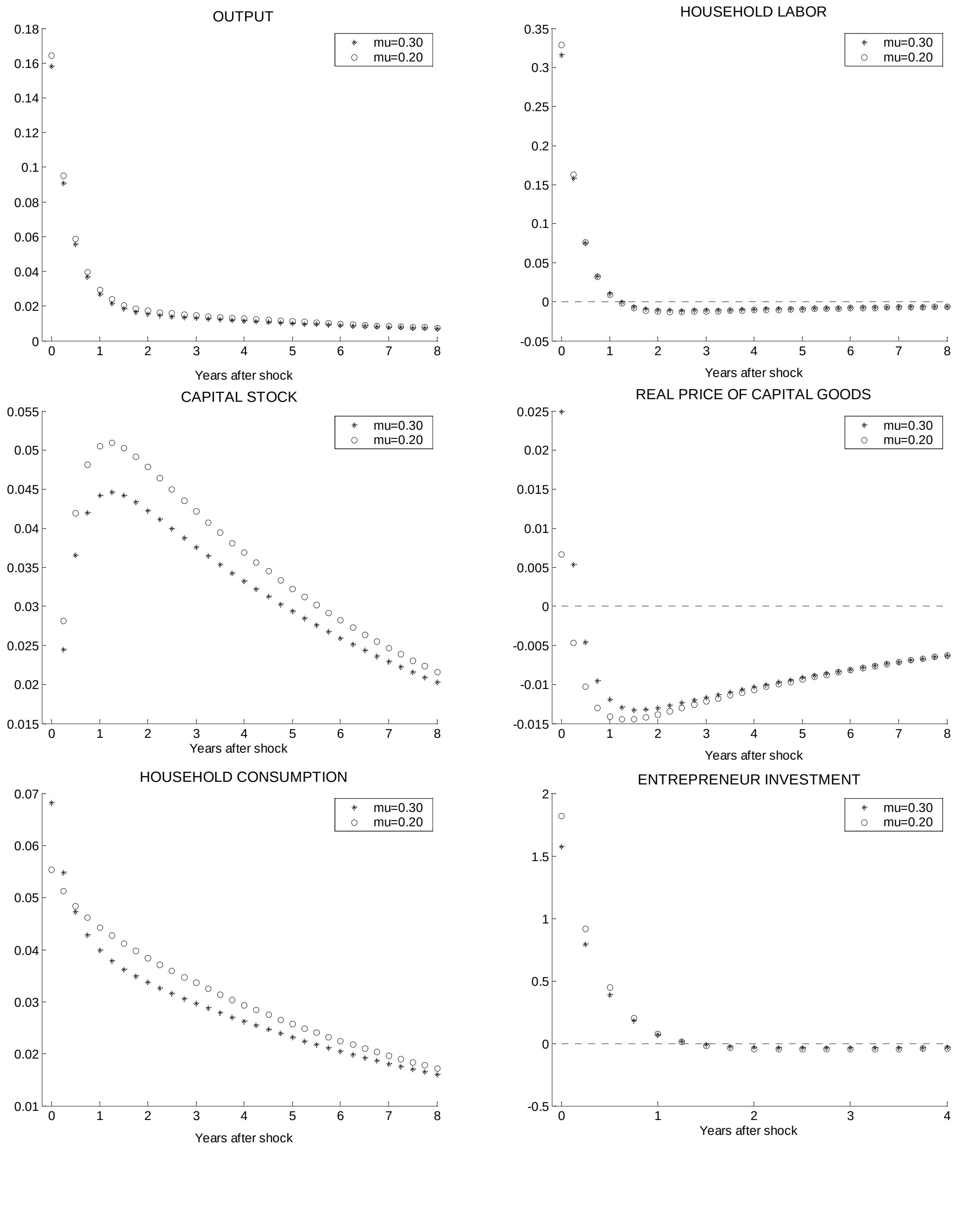


Figure 4
(Continuation)

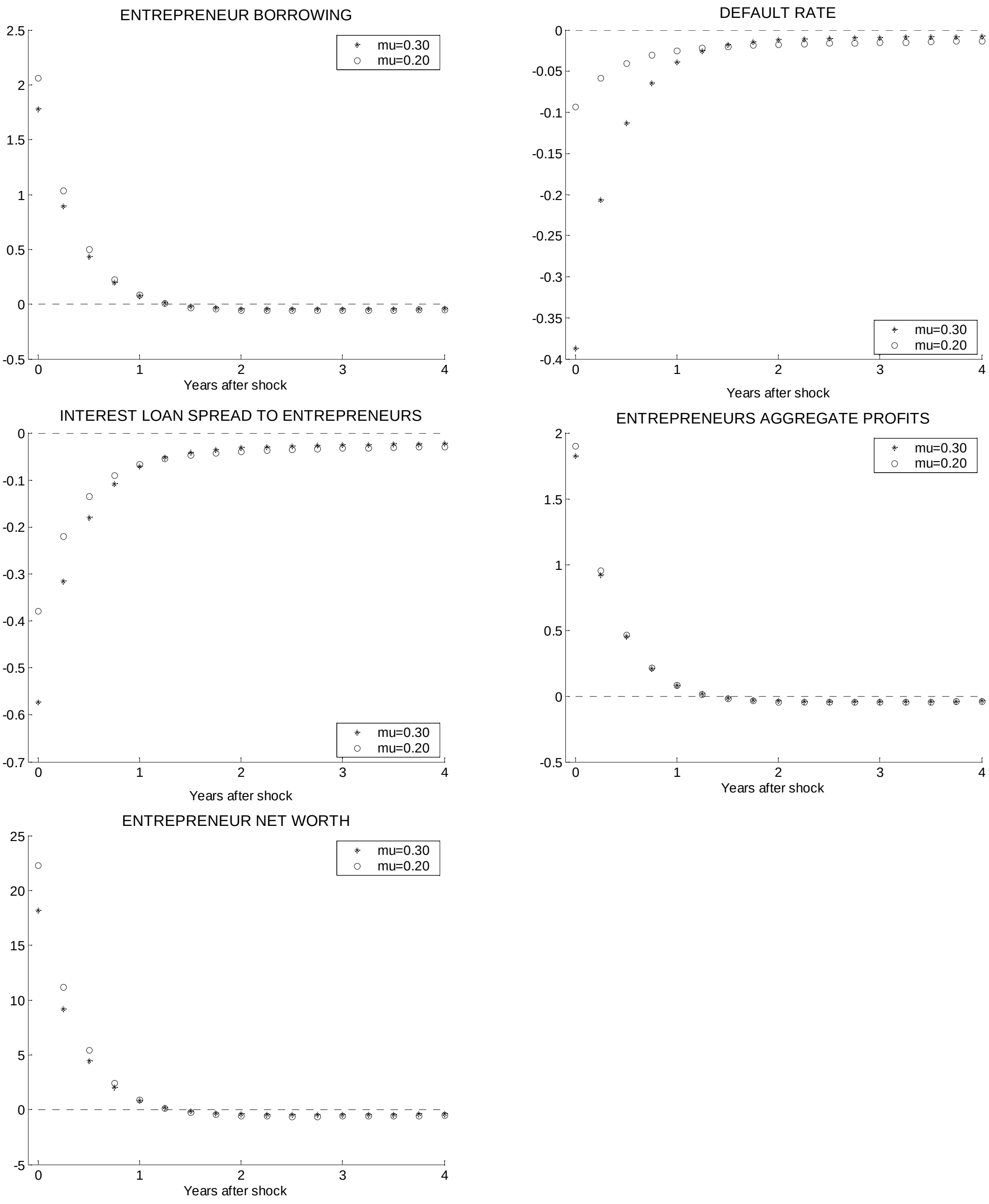


Figure 5
Effects of Bank Competition in the
Propagation of an Interest Rate Shock

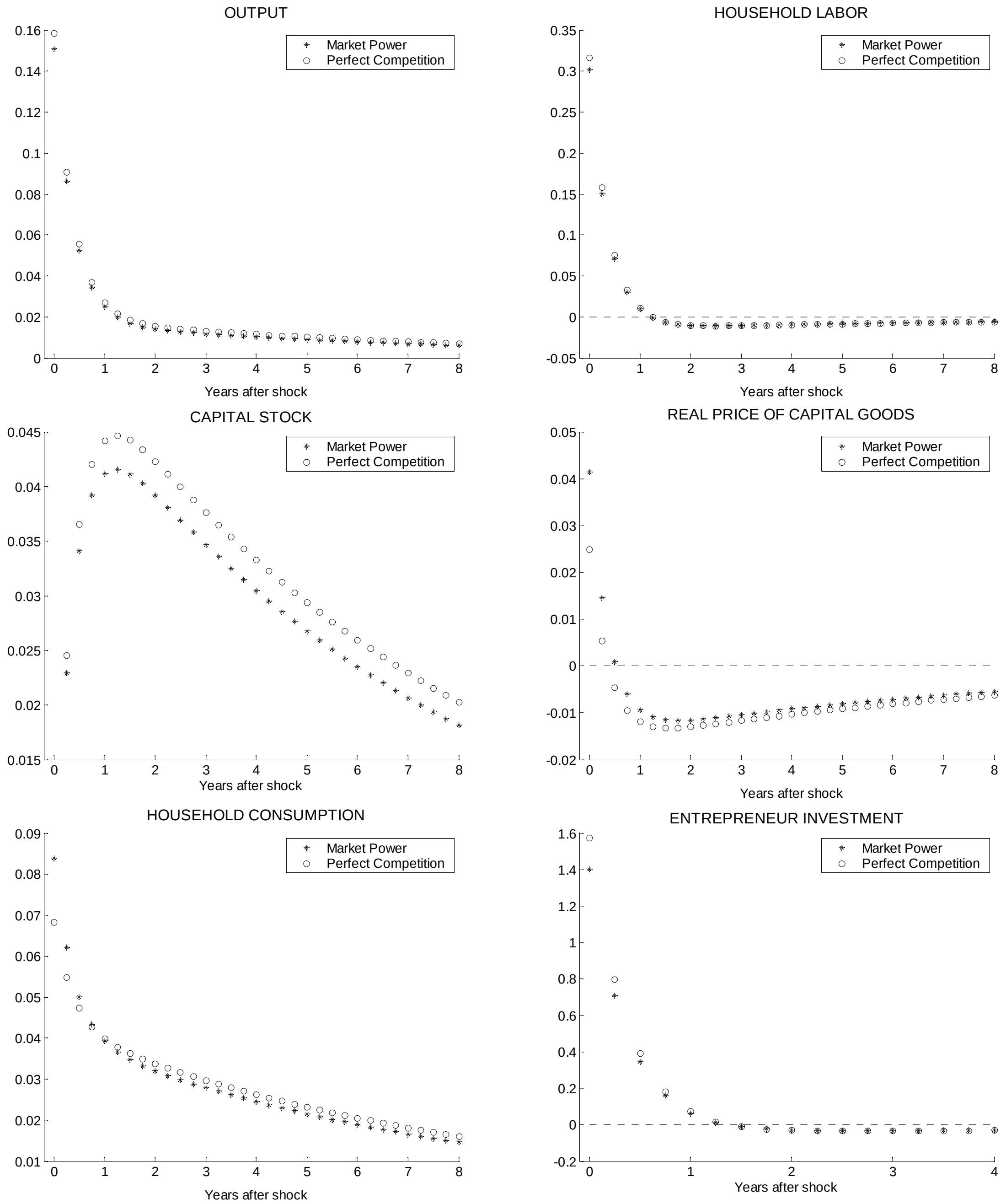
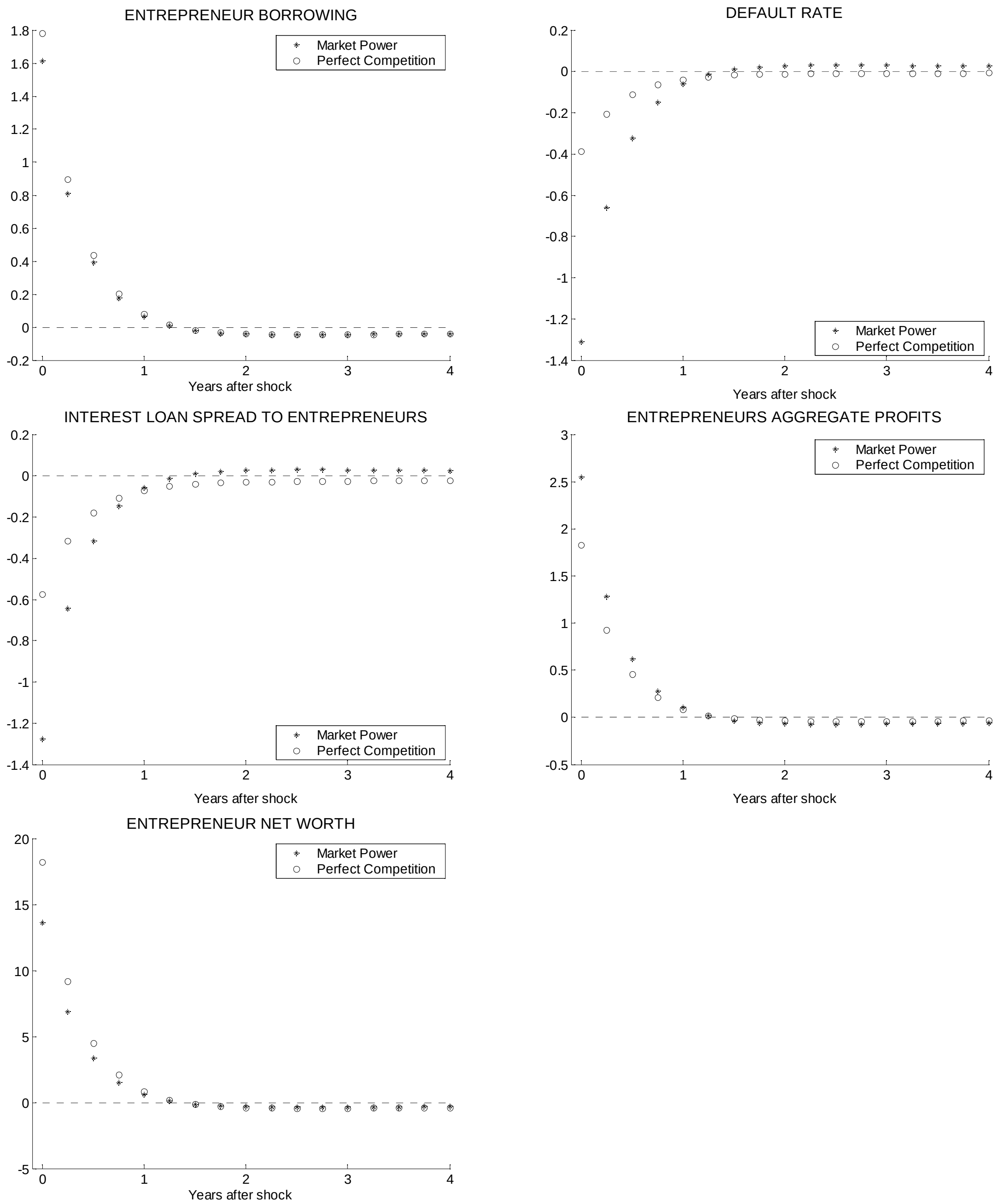


Figure 5
(Continuation)



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