Macroeconomic Implications of Market Power in Banking*

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Abstract

A strand of the banking literature studies switching costs for borrowers as a source of market power for banks. This paper embodies switching costs à la Klemperer (1995) and customer relationships that allow banks to price discriminate between old and new customers into a dynamic stochastic general equilibrium model. These costs generate a customer "lock-in" effect and rents for banks.

Modelling the banking sector in this way allows us to obtain countercyclical price-cost margins in line with the empirical evidence in Aliaga-Díaz and Olivero (2005), Mandelman (2005) and Chen, Higgins and Mason (2005). The reason is that with the customer "lock-in" effect, when lowering the interest rate on their lending banks face a trade-off between lower current profits and gaining bigger future market share. An increase in the level of economic activity increases the importance of future market share relative to that of current profits and induces banks to offer lower interest rates on their lending to attract new customers that will be "locked-in" in the future.

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We then use the model to study the role of these countercyclical price-cost margins as a mechanism for the propagation of macroeconomic shocks. For goods markets, the role of this countercyclicality was first recognized by Rotemberg and Woodford (1991 and 1992), who were followed by an extensive literature. In the market for bank credit this has received little theoretical and empirical attention. Countercyclical price-cost margins may act as "financial accelerators". When margins vary endogenously in response to aggregate shocks, they can serve as a propagation device for these shocks. Relative to economies with constant margins, recessions trigger an increase in the cost of credit. Our conjecture is that this makes firms delay their production, employment and investment decisions even further, which might make the recession worse and last longer. We interpret the mechanism in our paper as an alternative to the financial accelerator à la Bernanke, Gertler and Gilchrist.

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1 Introduction

Recent work provides empirical evidence on the countercyclicality of price-cost margins in the banking sector (see Mason et al (2005) and Aliaga-Díaz and Olivero (2005) for the United States and Mandelman (2005) for a cross-section of countries). This work complements the vast evidence on countercyclical markups for goods markets (Domowitz et al (1986), Lebow (1992), Chevalier and Scharfstein (1995 and 1996), Galeotti and Schiantarelli (1998) and Bloch and Olive (2001), among others). For the latter markets, there also exists a vast theoretical literature that studies how endogenous price-cost margins can become an additional channel through which aggregate shocks affect the economy (Rotemberg and Woodford (1991 and 1992), Gali (1994) and Ravn, Schmitt-Grohé and Uribe (2006)).

However, there is still very little work on how in the financial sector countercyclical price-cost margins can also provide this additional channel. With firms in most economies being heavily reliant on credit to finance investment, and with the inefficiency implied by price-cost margins being stronger during recessions, recessions may become worse and last longer if firms delay their investment and employment decisions during them. Bernanke and Gertler (1989) and Bernanke, Gertler and Gilchrist (1996 and 1998) study the role of an endogenously countercyclical external finance premium as an amplifier of business fluctuations. In their principal-agent model, the borrowers' net worth acts as a source of output dynamics because it is inversely related to the premium. A negative TFP shock lowers net worth, increases the agency cost of financing real capital investment, and the effects of the aggregate shock are amplified as a result. It is an informational asymmetry what generates endogenous price-cost margins in their model.

The Bernanke et al framework assumes a perfectly competitive financial sector. However, for the banking sector in particular, the assumption of perfect competition may not seem really appropriate (Freixas and Rochet, 1997). There seems to be a consensus in the literature on the existence of market power in banking.

To our knowledge, only Mandelman (2005) looks at the role of imperfect competition in banking to model the micro-foundations of endogenously countercyclical price-cost margins in the market for bank credit. Mandelman (2005) shows that a monopolistic banking sector increases the volatility of real variables and amplifies the business cycle. He models a highly segmented banking system with limit pricing and free entry. Each bank faces a cost of serving a niche that depends on the amount of credit that is financed. An increase in aggregate investment, raises the size of all niches and the competitive pressure of new entrants. Incumbents are forced to offer lower markups as a result.

With the same goal of studying the role of countercyclical margins driven by market power in banking in the propagation of business cycles, we use a different framework to model an imperfectly competitive banking sector. Borrowing from Kim, Kliger and Vale (2003) and Greenbaum, Kanatas and Venezia (1989), we model two different frictions: informational asymmetries among lenders[1] in the market for bank loans and customer switching costs à la Klemperer (1995).

The costs of switching lenders have been extensively studied by the banking literature as a source of market power for banks. The existence of these costs can be rationalized in three ways. First, it has been argued that switching costs contribute and result from long-term relationships and repeated contacts between firms and their customers. Thus, when borrowers switch banks, they are also faced with the loss of the capitalized value

[1]That is, information is asymmetric among agents on the same side of the market.

of an established relationship. This seems to be particularly true in the market for bank loans. Second, customers may need to pay fixed technical costs when changing banks (start-up fees, for example). Informational asymmetries provide a third reason. Due to the asymmetry of information that typically exists between borrowers and lenders, when banks start a relationship with a customer, they start accumulating information about its creditworthiness. When considering to switch to a different bank, customers will need to take into account the cost of signalling this information again to the new financier. New lenders will also need to spend time and resources in screening this information. Information might be asymmetric also among banks, in particular, between incumbents and potential competitors[2]. All these types of switching costs generate a "lock-in" effect that deters borrowers switching and gives banks market power. Banks may exploit this to extract profits later on in the relationship.

We then embed these two frictions for the banking sector into an otherwise standard dynamic stochastic general equilibrium, real business cycle model of a closed economy. Banks behave competitively in the market for deposits, they use households savings as an input to produce loans. Perfectly competitive firms demand bank credit to finance their purchases of capital goods.

The fact that it is costly for borrowers to change banks makes customers "locked-in". As a result, the demand for financial services faced by each bank in each period is a function of the previous period demand. For our purposes, the main implication is the

[2] There is also vast evidence on product differentiation as a source of rents for banks. They use different product packages and the extensiveness and location of their branches, personalized service, accessibility to the institution's executives, hours of operation and ATM and remote access availability, banks' reputation, etc. to differentiate their services. However, we abstract from product differentiation in this paper.

countercyclicality of price-cost margins. With the customer "lock-in" effect, when rising the interest rate on their lending banks face a trade-off between higher current profits and losing future market share. An increase in the level of current economic activity raises the importance of future market share relative to that of current profits and induces banks to offer lower interest rates to attract new customers that will be locked-in in the future.

We believe our framework provides an appealing way to model market power in banking in the US as well as in some other developed countries. Contrary to what is prevalent in less developed economies, where market power goes hand in hand with high concentration, in the US there is a large number of banks and concentration measures are very small. There were 1,563 banks[3] with 62,264 domestic and 713 foreign branches in the US as of the end of 2005. The Herfindahl-Hirschman index in the market for loans averaged 0.01 over the period 1979:I-2005:I[4]. We take this as evidence that it is not high market shares and/or strategic price collusion what acts as a source of rents for banks. Switching costs seem to provide a more compelling story.

We use this model with endogenously countercyclical price-cost margins in the market for credit to study their role in the propagation of TFP shocks in a standard business cycle model of a closed economy. Modest switching costs change the optimal pricing policy of the bank, with interest rate spreads increasing during recessions. We show that after a negative TFP shock, investment, the capital stock, employment and output all fall by a larger percentage when switching costs are larger. Qualitatively, our results seem

[3]These are insured commercial banks with consolidated assets of $300 million or more.

[4]Calculated using the total loans variable (rcfd1400) in the Report of Condition and Income data. However, market concentration is bigger when measured as the market share in total assets held by banks in the 95th percentile of the asset distribution and up. It averaged 78% in the period 1979-2005.

to indicate that countercyclical margins act as a financial accelerator: they amplify the effects of aggregate shocks and make recessions deeper. Also, macroeconomic aggregates become more volatile as switching costs increase. It is worth noting that the difference in real effects across alternative values of S is quantitatively small.

We believe our results have interesting policy implications. Due to the effect of countercyclical margins in the market for bank credit on the strength and duration of recessions, they may provide additional grounds for stabilization policy. The need for welfare analyses that study the optimality of such a policy is guaranteed.

The rest of the paper is organized as follows. Section 2 develops the model. Section 3 presents the simulation results for the general equilibrium model. Section 4 discusses some extensions and concludes.

2 The Model

The model is one of a closed economy featuring a household sector, a production sector and financial intermediaries (hereafter called banks). Households take consumption-saving and labor-leisure decisions to maximize their expected lifetime utility. Firms make investment decisions and produce goods and services using labor and capital. They need external borrowing to fund investment projects. Banks produce loans using households savings as an input. Switching costs give them market power in the market for loans, but they behave competitively in the market for deposits.

We borrow from Greenbaum, Kanatas and Venezia (1989) and Kim, Kliger and Vale (2003) to model the banking sector and its pricing decisions when switching banks is costly for customers, and when there are informational asymmetries across banks. These costs seem to be specially prevalent in the market for bank loans due to the cost of losing the value of an established bank-customer relationship, transaction-related costs of closing and opening accounts, and informational asymmetries[5].

The existence of switching costs makes loans from different banks that are ex-ante homogeneous products become ex-post heterogeneous from the point of view of their customers, the borrowing firms. It also confers market power on banks. Banks will face a compromise between low prices to attract new customers and high prices to gain supra-normal profits from the customers that they have already “locked-in”. When the level of economic activity rises it is easier to gain new customers and the first motive becomes more important. Thus, banks start offering lower interest rates to attract customers from their competitors. The incumbent banks need to lower the interest rate they charge to their old customers to lower the likelihood of losing them. Thus, this feature of the model is key to reproduce the countercyclicality of price-cost margins observed in the data.

Our model is able to explain the benefits of forming a bank-customer relationship in a competitive environment. Repeated lending allows banks to have private (although still imperfect) information about a customer’s probability of repayment. At the same time, customers face some costs of switching to a different bank. These two features imply banks have market power in the market for loans, and provide inertia in the bank-client relationship.

In most models switching costs only create a threshold which causes customers not to switch firms in equilibrium. However, in reality borrowers do switch banks. To allow

[5] The “lemons” problem arises in banking when banks with imperfect information on the default risk of borrowers pool customers of high creditworthiness together with others of low creditworthiness. Then, the former are charged higher rates than otherwise.

for switching to actually take place in equilibrium, in our model banks price discriminate between clients who have borrowed repeatedly from them and new customers. When asked for an offer by their rivals' customers, banks will offer a lower interest rate to lure these new clients and enjoy future monopoly power over them[6]. Therefore, if switching costs are small enough, some customers will actually switch banks.

We now proceed to present the optimization problems for all agents in the economy.

2.1 Firms

We model an informational asymmetry in the market for bank loans following Greenbaum, Kanatas and Venezia (1989). Each bank possesses private information regarding the probability of repayment of its customers. This information is symmetric between each customer and its bank. We denote with p the credit applicant's repayment probability.[7] However, information is asymmetric across banks because competitor banks do not observe p for a particular firm. When considering the application by a new potential customer, competitor banks only observe a signal $\tilde{p}$ which they take as their best guess of the firm's type. This signal is not necessarily informative of the true firm's type. For example, $\gamma(\tilde{p}) \sim U[\underline{p}, \bar{p}]$. We elaborate more on the informational asymmetry in subsection 2.2.

Firms are heterogeneous in their default risk and indexed by a type p_k, where $k \in$

[6]Models without price discrimination present a problem because when switching costs are internal to the firm the bank's optimization problem is no longer time-consistent. In such a specification, the current demand for each particular variety of loan services is a function of both current and future expected relative prices. As a result, banks have incentives to renege on their current optimizing price promises and charge higher interest rates to "locked-in" consumers in the future.

[7]By the Law of Large Numbers $p < 1$ is the mass of firms that actually repay their debt in every period.

$\{1, 2, ..., K\}$. Now, the informational asymmetry across banks implies another source of heterogeneity in firms. That is, two firms of the same type, say p_k, will be viewed as different when submitting their credit applications because their signal $\tilde{p}$ may differ from one another. Thus, we assume that there is a continuum of mass 1 of firms of each type p_k indexed by j.

While they are borrowing from their incumbent bank firms always ask for an offer Ψ from another bank. Upon request of the potential customer, competitor banks issue offers which depend on the perceived type (i.e. $\Psi(\tilde{p})$). Thus, this offer is a function of a random variable with cumulative distribution $F(\Psi)$. We assume the density function $f(\Psi) \sim U[\Psi(\bar{p}), \Psi(\underline{p})]$. As we will see later, this assumption implies that the higher p_k (i.e. the lower the default rate on the firms' side), the more likely is a firm getting a good offer ($\psi(\tilde{p}) < \psi(p_k)$) and thus the higher the probability of switching banks. This is a testable implication from this assumption that could be validated from empirical evidence.[8]

Whenever firms decide to borrow from a bank different from the one from which they are currently borrowing, they need to pay a switching cost, as they need to provide the new bank with references and other information to signal their creditworthiness. We assume that this switching cost is added to the interest rate offer made by the new bank. Switching takes place in equilibrium in this model and switching costs are actually paid by borrowers. Therefore, they enter the economy's resource constraint.

Given the interest rate charged by their incumbent bank, the offer made by a potential new bank and the switching cost, firms decide how much and from which bank to borrow.

The probability that having borrowed from a particular bank i in period $t-1$ a firm decides to stay with this bank when it charges R_{it} in period t is denoted by: $G(R_{it} - S) =$

[8] Alternatively, we could have had $f(\Psi_k) \sim U[\psi(\bar{p}_k), \psi(\underline{p}_k)]$ without this implication.

$1 - F(R_{it} - S)$. The probability that a firm that borrowed from a rival bank (we will use the subindex iR to indicate any bank other than the incumbent i) in period $t-1$ switches to bank i is $F(R_{iR} - S)$.

In each period t firm j of type k sells goods in a competitive market. It makes investment decisions (I_t^{kj}), borrows (L_{it+1}^{kj}) from a bank i to finance its capital purchases (K_{t+1}^{kj}) and demands labor (h_t^{kj}) to maximize the expected present discounted value of its lifetime profits. Unless strictly necessary, in what follows we will drop the superscript k.

Its optimization problem is given by[9]:

$$\max_{I_t^j, h_t^j, L_{it+1}^j} \quad E_0 \quad \sum_{t=0}^{\infty} \prod_{z=0}^{t} q_z \pi_t^j \qquad q_z = \beta^z \frac{U_{C_z}}{U_{C_{z-1}}}$$

$$s.t.$$

$$\begin{aligned} \pi_t^j &= p_k A_t F(K_t^j, h_t^j) - w_t h_t^j - I_t^j + L_{it+1}^j - \imath_t \times p_k (1 + R_{it-1}) L_{it}^j - \\ &- (1 - \imath_t) \times p_k (1 + \psi_{it-1}^j + S) L_{it}^j \qquad (1) \\ K_{t+1}^j &= I_t^j + (1 - \delta) K_t^j \qquad (2) \\ \phi K_{t+1}^j &\leq L_{it+1}^j \qquad \phi \leq 1 \qquad (3) \\ lnA_{t+1} &= \rho lnA_t + \epsilon_t \qquad (4) \end{aligned}$$

Equation (1) corresponds to firm j's cash flow, where w_t is the wage rate, R_{it} is the interest rate contracted with bank i in the current period, to be paid in period $t+1$ and $\imath_t$ is an indicator variable that equals 1 if the firm was borrowing from the same bank in the previous period (i.e. $R_{it} - S < \psi_{iRt}$) and 0 otherwise. It defines a firm j's of type k

[9]Firms in this economy are owned by households and therefore, their discount factor is given by the households' intertemporal marginal rate of substitution.

profits in period t as sales revenues plus what the firm obtains from borrowing minus the sum of labor, investment and borrowing costs.

Equation (2) gives the law of motion for the firm's capital stock, where δ represents the depreciation rate. Equation (3) introduces the need for bank financing into the model. Each firm needs to finance at least a fraction ϕ of its capital purchases with external borrowing.[10] Last, equation (4) describes the exogenous process followed by total factor productivity, where the shock ϵ_t follows an i.i.d. distribution with mean zero and standard deviation σ_ϵ.

Depending on whether a firm j is switching banks or not, the Euler equations governing investment decisions are:

$$(1-\phi) = E_t\left\{q_{t+1}\left[p_k\left(A_{t+1}F_K(K_{t+1}^j, h_{t+1}^j) - (1+R_{it})\phi\right) + (1-\delta)\right]\right\} \quad (5)$$

$$(1-\phi) = E_t\left\{q_{t+1}\left[p_k\left(A_{t+1}F_K(K_{t+1}^j, h_{t+1}^j) - (1+\psi_{it}+S)\phi\right) + (1-\delta)\right]\right\} \quad (6)$$

The demand for labor is given by:

$$w_t = A_t F_h(K_t^j, h_t^j) \quad (7)$$

2.2 The Banking Sector

There are N banks indexed by i in this economy where $i \in \{1, 2, ..., N\}$. They are competitive in the market for deposits.

[10] With $1 + R_{it-1} \geq q_t^{-1}$ banks will always prefer to finance investment with internal rather than with external resources and borrowing will be zero if this condition is not imposed. Therefore, equation (3) always binds in equilibrium.

Each bank i serves m_i^k firms of type $p_k \in \{p_1, p_2, ..., p_K\}$. We assume m_i is constant across types of firms, such that $m_i^k = m_i$ for all k. Since the total mass of firms in the economy is normalized to 1, m_i denotes the market share of bank i.

Each bank i will serve a mass of customers that it has "locked-in" from the previous period (m_i^L, where we have used the superscript L to denote "locked-in" borrowers) and some new customers lured from rival banks (m_i^N, where we have used the superscript N to denote new borrowers), such that $m_i^L + m_i^N = m_i$. Since the probability of a firm staying with its bank is given by $G(R_{it-1} - S)$, by the Law of Large Numbers, the measure of firms remaining locked-in in bank i in every period is $m_{it}^L = G(R_{it-1} - S)(m_{it-1}^L + m_{it-1}^N)$. By the same token, the mass of firms switching from rivals to bank i is $(1 - G(R_{iRt-1} - S)) = F(R_{iRt-1} - S)$. So the total share of the market for loans for bank i evolves according to:

$$m_{it+1} = G(R_{it} - S)m_{it} + F(R_{iRt} - S)m_{iRt} \tag{8}$$

As in Greenbaum, Kanatas and Venezia (1989), there is asymmetric information across banks, such that bank i perfectly observes the type of its customers p_k, but cannot perfectly observe the type of rivals' customers. It can only observe a noisy signal $\tilde{p}$ which is random variable with pdf $\gamma(p)$. No agent in the economy knows this pdf.

If the customers of banks i's rivals ask for an offer from bank i, then bank i makes an offer $\psi_{it}(\tilde{p})$ in period t. We assume that in each period firms hear only one offer from a bank from which they are not already borrowing. To ask for an offer each firm chooses a bank randomly. Search costs that are high enough and prevent firms from applying to more than one alternative bank can be used as a rationalization for this assumption.[11] Thus,

[11] We have chosen not to specifically model these search costs because that would add unnecessary complications to our switching costs model.

by law of large numbers each bank makes $\frac{1}{N}$ offers to rivals' customers in each period for each type k. The total number of offers by each bank is therefore $\frac{K}{N}$. As we will show later, given the informational asymmetry across banks, when making an offer to a rival's customer some banks will make positive profits and some negative[12].

In each period t bank i chooses its demand for deposits (D_{it+1}), total supply of loans lending (L_{it+1}) and the interest rate charged on lending to both old and new customers (R_{it} and ψ^j_{it}, respectively) to maximize the expected present discounted value of lifetime profits[13]. Old customers can either accept or reject bank i's offer R_i. If they accept it, the relationship continues for at least one more period. If they reject it, the relationship is terminated and the client starts borrowing from another bank. When choosing the interest rate on loans, banks internalize that the probability of losing its customers ($F(R_i - S)$) depends on its price decision.

Therefore, bank i's optimization problem (here we omit the subscript i unless needed) is given by:

$$\max_{R_t,\psi_t,L_{t+1}} E_t \sum_{t=0}^{\infty} \prod_{z=0}^{t} q_z \sum_k \Pi_t^k \qquad q_z = \beta^z \frac{U_{C_z}}{U_{C_{z-1}}}$$

$$s.t.$$

[12] As in Greenbaum et al (1989), a bank that is trying to attract customers from a rival does not necessarily incur an expected loss if his offer is accepted. The rival will be enjoying monopoly power and charging an interest rate above its marginal cost. Thus, if all banks have the same marginal costs, when making an offer below the rate offered by the current incumbent, a bank need not be making negative expected profits.

[13] Banks face an infinitely elastic supply of deposits, there are no capacity constraints and the opportunity cost of accepting an applicant is zero. Therefore, the decision on the loan rate for each applicant is not a function of the bank's existing portfolio.

$$\Pi_t^k = \Pi_t^{kL} + \int_{\underline{\psi}_t}^{(R_{iR}-S)} \Pi_t^{kN}(\Psi) f(\Psi) d\Psi \tag{9}$$

$$\Pi_t^{kL} = (R_{t-1}^k p_k - r_{t-1}) L_t^{kL} m_t^L \tag{10}$$

$$m_{t+1} = G(R_t^k - S) m_t + F(R_{iRt}^K) m_{iRt} \tag{11}$$

$$m_t = m_t^L + \int_{\underline{\Psi}_t}^{(R_{iR}-S)} f(\Psi) d\Psi \tag{12}$$

$$\Pi_t^{kN}(\psi^{kj}) = (\psi_{t-1}^{kj} p_k - r_{t-1}) L_t^{kjN} \tag{13}$$

$$L_t^k = L_t^{kL} m_t^L + \int_{\underline{\Psi}_t}^{(R_{iR}-S)} L_t^{kN}(\Psi) f(\Psi) d\Psi \tag{14}$$

$$\sum_k L_t^k = D_{it} \tag{15}$$

Equations (9),(10) and (13) are the bank's cash flows in period t, where r_{t-1} is the common interest rate on deposits paid by all banks, contracted in period $t-1$ paid in period t. Equation (15) is bank i's balance sheet condition. Last, equation (14) is the demand faced by bank i, where L_i^L denotes the per customer fraction of that demand that corresponds to "locked-in" borrowers and L_i^N denotes the per customer fraction that comes from new borrowers.

Because of the additive nature of the objective function, as described by equation (9), we can separate the problem into two. First, the determination of the optimal R_{it} for the locked-in customers and later the optimal ψ_{it}^j offered to each new credit applicant to bank i. For the first part, the Lagrangian describing bank i's optimization problem when facing type k locked-in borrowers (here we omit superscript k) is given by[14]:

[14] We assume that households own banks in the economy so that bank i's discount factor is given by the households intertemporal marginal rate of substitution.

$$\ell = E_t \sum_{t=0}^{\infty} \prod_{z=0}^{t} q_z \left\{ (R_{it-1} p_k - r_{t-1}) L_{it}^L m_{it}^L + \nu_t \Big[G(R_{it} - S) m_{it} + F(R_{iRt} - S) m_{iRt} - m_{it+1} \Big] \right\} \tag{16}$$

The first order conditions with respect to m_{it+1} and R_{it} are respectively:

$$\frac{\partial \ell}{\partial m_{it+1}} = \prod_{z=0}^{t+1} q_z (R_{it} p_k - r_t) L_{it+1}^L - \prod_{z=0}^{t} q_z \nu_t + \prod_{z=0}^{t+1} q_z \nu_{t+1} G(R_{it+1} - S) = 0 \tag{17}$$

$$\frac{\partial \ell}{\partial R_{it}} = \prod_{z=0}^{t+1} q_z p_k L_{it+1}^L G(R_{it} - S) m_{it} + \prod_{z=0}^{t} q_z \nu_t m_{it} \frac{\partial G(R_{it} - S)}{\partial R_{it}} = 0 \tag{18}$$

Notice that banks do not internalize their effects on L_i^L and L_i^N because they are ex-ante perfectly competitive. However, they become non-competitive ex-post, due to the switching costs and the "lock-in" effect that they imply. Equations (17) and (18) can be reexpressed as:

$$E_t(q_{t+1})(R_{it} p_k - r_t) L_{it+1}^L - \nu_t + E_t \left[q_{t+1} \nu_{t+1} G(R_{it} - S) \right] = 0 \tag{19}$$

$$E_t(q_{t+1}) p_k L_{it+1}^L G(R_{it} - S) + \nu_t \frac{\partial G(R_{it} - S)}{\partial R_{it}} = 0 \tag{20}$$

Each bank's expected lifetime profits are zero. Profits are positive during the period when the bank is an incumbent and enjoys market power over its "locked-in" customers. Thus, a no entry condition must imply that each bank earns negative expected profits before becoming an incumbent. That is, in expectation banks will loose when trying to lure customers from the competition. This is the price discrimination behavior of banks in this model by which they offer lower rates to potential customer in order to attract and lock in a higher market share. Competition and free entry exerts downward pressure on these offers up to the point in which banks earn zero profits in expectation.

The offer ψ_{it}^{j} made by bank i to rival banks' customers is pinned down by the following no-entry condition:

$$E_t q_{t+1}\left[(\psi_{it}^{j}\tilde{p} - r_t)L_{it+1}^{jN} + q_{t+2}G(R_{it+1} - S)W_{t+2}^{j}(\tilde{p})\right] = 0 \tag{21}$$

where $W^j(\tilde{p})$ is the value at of the future bank-client relationship that will develop as a result of the potential customers accepting this offer. That is, W_t^j is given by:

$$W_t^j = \sum_{t=0}^{\infty} G(R_{it} - S)^t \prod_{z=0}^{t} q_z(R_{it}\tilde{p} - r_t)L_{it+1}^{L} \tag{22}$$

Since the second term in (21) is positive, clearly $E_t[\psi_{it}^{j}\tilde{p} - r_t] < 0$.

2.3 Households

A representative household takes consumption, savings and labor supply decisions in this economy. The price of the homogeneous consumption good is normalized to one. Each household derives disutility from working and it is allowed to save by accessing a competitive market for bank deposits in each period $t \geq 0$.

Households choose consumption (C_t), savings in the form of bank deposits (D_{t+1}) and work effort (h_t) to maximize their lifetime utility. Their optimization problem is given by:

$$\max_{C_t, h_t, D_{it+1}} \quad E_0 \quad \sum_{t=0}^{\infty} \beta^t U(C_t, h_t)$$

$$s.t.$$

$$C_t + \sum_{i=1}^{N} D_{it+1} = w_t h_t + (1 + r_{t-1})\sum_{i=1}^{N} D_{it} + \sum_{k=1}^{K} \int_0^1 \pi_{jt}^{k} dj + \sum_{i=1}^{N} \Pi_{it} \tag{23}$$

$$D_t = \sum_{i=1}^{N} D_{it} \tag{24}$$

and a no-Ponzi game constraint, taking as given initial deposit holdings and the processes for w_t, π_{jt}^k and Π_{it}. Also, $U_C > 0$ and $U_h < 0$, E_t denotes the expectations operator conditional on information available at time t and $\beta \in (0,1)$ is the subjective discount factor. The last two terms of the budget constraint denote firms' and banks' profits which are rebated to households in a lump-sum fashion.

The FOCs for the household problem are given by:

$$-\frac{U_h}{U_C} = w_t \tag{25}$$

$$U_{C_t} = \beta E_t \left[(1+r_t) U_{C_{t+1}} \right] \tag{26}$$

2.4 Aggregation

In this subsection we obtain the macro aggregates for the heterogeneous agents economy. First, we restrict the analysis to symmetric equilibria. Thus, we impose:

$$R_i = R_{iR} \tag{27}$$

$$m_i = m_{iR} = m = \frac{1}{N} \tag{28}$$

The aggregate capital stock is obtained in the following way:

$$K_{t+1}^N = \sum_k K_{t+1}^{kN} = \sum_k \left[\int_{\underline{\Psi}_t}^{(R_t^k - S)} K_{t+1}^k(\Psi) f(\Psi) d\Psi \right] \tag{29}$$

$$K_{t+1}^L = \sum_k \left[K_{t+1}^{kL} G(R_t^k - S) \right] \tag{30}$$

$$K_{t+1} = K_{t+1}^N + K_{t+1}^L \tag{31}$$

where K_{t+1} denotes the aggregate stock of capital. A fraction (K^N) is held by firms that change bank in the current period, and another fraction (K^L) is held by "locked-in" firms.

Similarly, the aggregate demand for labor h_t is given by:

$$h_t = h_t^N + h_t^L \tag{32}$$

$$h_t^L = \sum_k \left[h_t^k G(R_t^k - S)\right] \tag{33}$$

$$h_t^N = \sum_k \left[\int_{\underline{\Psi}_{t-1}}^{(R_{t-1}^k - S)} h_t^k(\Psi) f(\Psi) d\Psi\right] \tag{34}$$

where h_t denotes aggregate labor, h_t^N is aggregate employment in firms that have switched banks in the current period, and h_t^L is employment in firms that remain "locked-in" in the same bank.

The following set of equations defines the investment levels for the mass of firms in each of the four potential combinations of states of nature $\{N, L\} \times \{t, t+1\}$. For each type k, the investment levels are:

$$I_t^{kNN} = F(R_{t-1}^k - S)K_{t+1}^{kN} - (1-\delta)F(R_t^k - S)K_t^{kN} \tag{35}$$

$$I_t^{kLL} = G(R_t^k - S)G(R_{t-1}^k - S)[K_{t+1}^{kL} - (1-\delta)K_t^{kL}] \tag{36}$$

$$I_t^{kLN} = G(R_t^k - S)F(R_{t-1}^k - S)K_{t+1}^{kL} - (1-\delta)G(R_t^k - S)K_t^{kN} \tag{37}$$

$$I_t^{kNL} = G(R_{t-1} - S)K_{t+1}^{kN} - (1-\delta)G(R_{t-1} - S)F(R_t - S)K_t^{kL} \tag{38}$$

Aggregate investment is then:

$$I_t = \sum_k I_t^{kNN} + I_t^{kLL} + I_t^{kLN} + I_t^{kNL} \tag{39}$$

Finally, aggregate production is given by

$$Y_t = A_t \sum_k p_k \left[G(R_t^k - S) F(K_t^{kL}, h_t^{kL}) + \int_{\underline{\Psi}_{t-1}}^{(R_{t-1}^k - S)} F(K_t^k(\Psi), h_t^{kL}(\Psi)) f(\Psi) d\Psi \right] \quad (40)$$

The mass of customers served by all banks in the economy is K. Now, plugging in the expression for the N bank profits Π_{it} (from equation 9) and the K profit expressions for firms (from equation 1) into the households budget constraint (equation 23), we arrive to the resource constraint for this economy:

$$C_t + I_t + S\phi \sum_k K_t^{kN} = Y_t \quad (41)$$

2.5 Equilibrium

A competitive equilibrium is defined as a set of allocations $C_t, h_t, L_{t+1}, \nu_t, I_t, K_{t+1}, D_{t+1}$ and prices w_t, r_t, R_t, Ψ_t satisfying the workers' and firms' FOCs, the bank's pricing equations, the economy's resource constraint and the aggregation conditions.

Combining equations (17) and (18), we can derive an expression for the price-cost margin charged by non-competitive banks in this economy. Here we define the price-cost margin as the spread between the risk-adjusted interest rate on loans and that on deposits. Then, a firm of type k pays the following price-cost margin:

$$(R_t - \frac{r_t}{p_k}) = -\frac{G(R_t - S)}{G_R} - \frac{E_t \left[q_{t+1} \nu_{t+1} G(R_{t+1} - S) \right]}{E_t q_{t+1} L_{t+1}} \quad (42)$$

where $G_R = \frac{\partial G(R_t - S)}{\partial R_t} < 0$.

As in Kim et al (2003), the first term represents the current period market power of the bank. The second term represents the bank's benefits of customers that are "locked-in" for the future as of period t.

As economic activity increases, both future economic activity and the demand for loans are also expected to be high. Therefore, the benefit of attracting more customers today (and not loosing current customer base) and having them “locked-in” for future periods increases (this is captured in the term $E_t q_{t+1} \nu_{t+1}$). Thus, banks have more incentives to lower spreads in order to increase their customer base during booms.

3 Simulation Results

3.1 Parameter Values

We solve the model by log-linearizing it in the neighborhood of the deterministic steady state. In this section we present the parameter values and the functional forms that we use to simulate the model. The parameter values are shown in Table 1.

We assume the utility function in each period to be of the CRRA type. Also, we abstract from wealth effects on labor supply by modelling the utility function as $U(C,h) = \frac{(C-\theta\frac{h^{\omega}}{\omega})^{(1-\sigma)}}{(1-\sigma)}$ where $\sigma > 1$ is the inverse of the intertemporal elasticity of substitution and ω pins down the elasticity of labor supply. The parameter θ is calibrated to have households devoting 30% of their time to work. ω is calibrated to 5 to match the elasticity of labor supply. Following standard practice, σ is set to 20.

The discount factor β is set to match a 1.5% quarterly 20-year inflation-indexed interest rate on Treasury Bills. We take this rate as a measure of the long-run cost of funds for the bank and therefore, of the steady state interest rate on deposits. The interest rate R is calibrated to match the price-cost margin as measured by the difference between the bank prime loan rate and the T-bill rate as in Aliaga-Díaz and Olivero (2005).

The production function is of the Cobb-Douglas type $F(K,h) = AK^{\alpha_K}h^{\alpha_h}$ and it is assumed to exhibit decreasing returns to scale, such that $(\alpha_K + \alpha_h) < 1$[15]. The labor (capital) share α_h (α_K) is set to 0.5 (0.3). The parameters describing the exogenous process followed by TFP are set following Cooley and Prescott (1995). The capital depreciation rate is set to match the standard 0.076 investment to capital ratio.

To our knowledge, the only available estimate of switching costs in the market for bank loans is provided by Kim, Kliger and Vale (2003) for a panel data of Norwegian banks for the period 1988-1996. According to them switching costs amount to around 30% of the interest rate. Thus, in our benchmark we set S to 0.45%. The probability of firms staying with their incumbent bank $G(R-S)$ is chosen so that for the benchmark calibration, price-cost margins in banking are acyclical. S is then increased progressively, to obtain increasing degrees of countercyclicality of the margins.

The parameter ϕ is set to 0.5, which is consistent with the data and with the value used by Bernanke and Gertler (1989). The firm's probability of repayment p_k is set to 0.96. $\underline{\Psi}$ is set to the marginal cost of funds for banks $(\frac{r}{p_k})$, and $\bar{\Psi}$ is determined using banks' first order conditions and the chosen value for $G(R-S)$.

3.2 Results

We believe our framework provides an appealing way to model market power in banking in the US where it is driven more by switching costs than by high market shares.

Figure 1 shows the impulse response functions to a 1% negative shock to TFP. It can

[15] We need this assumption because with constant returns to scale, the set of firms that borrow at a lower rate and that therefore have a lower cost of production, would be able to undercut prices and drive the other firms out of business.

be seen that both interest rates are procyclical and that the default risk adjusted price cost margin is countercyclical. Consumption, investment, the capital stock, employment and output all fall by a larger percentage in the economy with larger switching costs.

Therefore, our results seem to indicate that countercyclical margins act as a financial accelerator, they amplify the effects of aggregate shocks. The fact that, relative to an economy with constant margins, the cost of credit becomes more expensive during recessions seems to make firms delay their investment, employment and production decisions. This makes recessions deeper. It is worth noting that the financial accelerator is quantitatively small. This result is robust to all parameter values.

On the bottom portion all tables show the output share of switching costs in steady state.

Table 2 shows standard deviations and correlations with GDP in the data and the simulation results for the benchmark economy and for alternative values of the switching costs. Macroeconomic aggregates are more volatile as the costs of switching banks increases. An increase in S makes the expected present discounted value of future profits increasingly procyclical, and the customer "lock-in" effect increasingly more powerful. This in turn, further increases banks' incentives to lower (raise) interest rates in expansions (recessions), and results in a higher degree of countercyclicality of margins. In booms (recessions), a larger fall (increase) in the cost of credit (relative to standard models that lack this friction) can result in a larger increase (fall) in output than otherwise. Therefore, the volatility of macroeconomic aggregates increases as margins become more countercyclical. Again, this effect is quantitatively for reasonable parameterizations of the model.

All results are robust to the choice of parameter values and available from the authors upon request.

4 Conclusions

In this paper we extend a standard real business cycle model of a closed economy by introducing customer switching costs à la Klemperer (1995) in the market for bank loans and informational asymmetries across banks. Switching costs have been extensively studied by the banking literature as sources of rents for banks. They generate a "lock-in" effect and provide market power to banks that are ex-ante perfectly competitive. There is price discrimination between old and new customers in this setup and this allows for switching to actually take place in equilibrium.

We believe our framework provides an accurate way to model imperfect competition in banking in developed countries, where market power does not go hand in hand with high concentration, but is driven by switching costs and informational asymmetries.

Our setup also implies a countercyclical behavior for the price-cost margins charged by banks, which is consistent with previous empirical evidence. Thus, the inefficiency implied by margins becomes stronger during recessions.

We use this model to study this countercyclicality as a mechanism for the propagation of aggregate TFP shocks. Quantitatively, the difference in real effects across simulations for alternative values of S is small. Qualitatively our results still show that as switching costs increase firms seem to delay their employment, investment and production decisions further after a negative TFP shock. Thus, the recession becomes deeper and lasts longer with higher S. We interpret this mechanism as an alternative to the Bernanke, Gertler and Gilchrist financial accelerator driven by endogenous fluctuations in borrowers' net worth.

References

[1] Asea, P. and B. Blomberg (1998), "Lending Cycles", *Journal of Econometrics*, Vol. 83, pp. 89-128.

[2] Bernanke, B. and M. Gertler (1989), "Agency Costs, Net Worth, and Business Fluctuations", *American Economic Review*, March, Vol. 79(1), pp. 14-31.

[3] Bernanke, B., M. Gertler and S. Gilchrist (1998), "The Financial Accelerator in a Quantitative Business Cycle Framework", *NBER working paper* 6455.

[4] Bloch, H. and M. Olive (2001), "Pricing Over the Cycle", *Review of Industrial Organization*, Vol. 19, 99-108.

[5] Boyd, J. H., and Prescott, E. C. (1986), "Financial Intermediary Coalitions", *Journal of Economic Theory*, Vol. 38, pp. 211232.

[6] Chen, Y., E. Higgins and J. Mason (2005), "Is Bank Efficiency Cyclical? The Relationship Between Economic and Financial Market Conditions and Bank Performance", Drexel University working paper, January.

[7] Chevalier, J. and D. Scharfstein (1995), "Liquidity Constraints and the Cyclical Behavior of Markups", The American Economic Review, Vol. 85(2), Papers and Proceedings of the Hundredth and Seventh Annual Meeting of the American Economic Association, Washington DC, January 6-8, May 1995, 390-396.

[8] Chevalier, J. and D. Scharfstein (1996), "Capital-Market Imperfections and Countercyclical Markups: Theory and Evidence", *The American Economic Review*, Vol. 86(4), September 1996, 703-725.

[9] Claessens, S. and L. Laeven (2003), "What Drives Bank Competition? Some International Evidence", *Policy Research Working Paper*, The World Bank.

[10] Cooley, T. and E. Prescott (1995), "Economic Growth and Business Cycles", in *Frontiers of Business Cycle Research*, T. Cooley ed., Princeton University Press 1995.

[11] Domowitz, I., G. Hubbard and B. Petersen (1986), "Business Cycles and the Relationship Between Concentration and Price-Cost Margins", *RAND Journal of Economics*, Spring 1986, 17, 1-17.

[12] Fama, E. (1985), "What's Different About Banks?", *Journal of Monetary Economics*, Vol. 15, pp. 5-29.

[13] Freixas, X. and J.C. Rochet, "Microeconomics of Banking", MIT Press 1997, Cambridge.

[14] Galeotti, M. and F. Schiantarelli (1998), "The Cyclicality of Markups in a Model with Adjustment Costs: Econometric Evidence for US Industry", *Oxford Bulletin of Economics and Statistics*, Vol. 60 (2), 121-142.

[15] Greenbaum, S., G. Kanatas and I. Venezia (1989), "Equilibrium Loan Pricing Under the Bank-Client Relationship", *Journal of Banking and Finance*, Vol. 13, pp. 221-235.

[16] Kim, M., D. Kliger and B. Vale (2003), "Estimating Switching Costs: The Case of Banking", *Journal of Financial Intermediation*, Vol. 12, pp. 25-56.

[17] King, R. and M. Watson (1996), "Money, Prices, Interest Rates and the Business Cycle", *The Review of Economics and Statistics*, Vol. 78(1), pp. 35-53.

[18] Klemperer, P. (1995), "Competition when Consumers Have Switching Costs: An Overview with Applications to Industrial Organization, Macroeconomics, and International Trade", *The Review of Economic Studies*, Vol. 62 (4), pp. 515-539.

[19] Lebow, D. (1992), "Imperfect Competition and Business Cycles: An Empirical Investigation", *Economic Inquiry*, Vol. 30(1), January 1992, 177-193.

[20] Mandelman, F. (2005), "Business Cycles: A Role for Imperfect Competition in the Banking System", working paper Boston College.

[21] Neumeyer, P. and F. Perri (2005), "Business Cycles in Emerging Economies: The Role of Interest Rates", *Journal of International Economics*, Vol. 52. pp. 345-80.

[22] Northcott, C. (2004), "Competition in Banking: A Review of the Literature", working paper 2004-24, Bank of Canada.

[23] Santos, J. and A. Winton, "Bank Loans, Bonds, and Information Monopolies Across the Business Cycle", *Journal of Finance*, forthcoming.

[24] Sharpe, S. A. (1990), "Asymmetric Information, Bank Lending and Implicit Contracts: A Stylized Model of Customer Relationships", *Journal of Finance*, Vol. 45, pp. 1069-1087.

[25] Vives, X. (2001), "Competition in the Changing World of Banking", working paper 2001/80 INSEAD.

[26] Von Thadden, E. L. (1995), "Long-term Contracts, Short-term Investment, and Monitoring", *Review of Economic Studies*, Vol. 62, pp. 557-575.

Table 1: Calibration

Preference Parameters	
β=0.985	σ=20
θ=5	ω=5
Financing Parameters	
ϕ=0.5	S=0.0045
p_k=0.96	$G(R-S)$=0.85
Production Parameters	
α_h=0.5	α_k=0.3
δ=0.023	
TFP Process	
σ_ϵ= 0.007	ρ=0.9

Table 2: Simulations Results - Sensitivity to S

S	**Data**		**0.0045**		**0.0075**	
$G(R-S)$			**0.849**		**0.8707**	
	Std. Dev.	$\rho(x,Y)$	**Std. Dev.**	$\rho(x,Y)$	**Std. Dev.**	$\rho(x,Y)$
Y	0.0172	1.0000	0.0206	1.0000	0.0209	1.0000
C	0.0086[1]	0.7700	0.0075	0.9422	0.0077	0.9449
I	0.0511[2]	0.7900	0.0870	0.9853	0.0889	0.9827
h^L	-	-	0.0077	0.5261	0.0069	0.6005
h^N	0.0063[3]	0.6200	0.0097	0.4048	0.0101	0.3636
w	0.0076[4]	0.6800	0.0165	1.0000	0.0167	1.0000
ν_t	-	-	0.0239	0.8636	0.0262	0.8365
$\frac{\nu_{t+1}G(R_{t+1}-S)}{K^L_{t+1}}$	-	-	0.0009	0.0042	0.0009	0.2309
$(Rp-r)$	0.0064[7]	**-0.2400**	**0.0047**	**-0.0041**	**0.0053**	**-0.2113**
K^L			0.0234	0.8043	0.0256	0.7804
K^N			0.0422	0.4093	0.0438	0.4040
R	0.0147[5]	0.2900	0.0013	0.0250	0.0013	-0.0301
r	0.0129[6]	0.4000	0.0010	0.0327	0.0011	0.0146
ψ	-	-	0.0004	0.0321	0.0004	0.0133
A			0.0146	0.8692	0.0146	0.8621
Steady State Values						
$\frac{S}{Y}$			1.1%		1.65%	

1- Consumption of nondurables and services; 2- nonresidential fixed investment; 3- Average weekly hours of work (household survey); 4- Average hourly earnings; 5- Bank prime loan rate; 6- 3-month T-Bill rate; 7- Spread BP - T-Bill, from Aliaga-Diaz & Olivero (2005)

Table 2(ctd.): Simulations Results - Sensitivity to S

S	**0.0105**		**0.0135**		**0.0155**	
$G(R-S)$	**0.8962**		**0.9291**		**0.9612**	
	Std. Dev.	$\rho(x,Y)$	**Std. Dev.**	$\rho(x,Y)$	**Std. Dev.**	$\rho(x,Y)$
Y	0.0211	1.0000	0.0214	1.0000	0.0215	1.0000
C	0.0080	0.9470	0.0084	0.9479	0.0089	0.9469
I	0.0903	0.9802	0.0907	0.9782	0.0893	0.9777
h^L	0.0062	0.6996	0.0057	0.8278	0.0054	0.9274
h^N	0.0106	0.2915	0.0116	0.1360	0.0144	-0.1290
w	0.0169	1.0000	0.0171	1.0000	0.0172	1.0000
ν_t	0.0289	0.8100	0.0322	0.7818	0.0348	0.7534
$\frac{\nu_{t+1}G(R_{t+1}-S)}{K^L_{t+1}}$	0.0009	0.4995	0.0009	0.7648	0.0009	0.9061
$(Rp-r)$	**0.0065**	**-0.4557**	**0.0096**	**-0.6993**	**0.0167**	**-0.8321**
K^L	0.0283	0.7566	0.0314	0.7310	0.0340	0.7049
K^N	0.0455	0.3863	0.0477	0.3315	0.0509	0.1929
R	0.0013	-0.0886	0.0013	-0.1537	0.0012	-0.2051
r	0.0011	0.0009	0.0011	-0.0028	0.0011	0.0153
ψ	0.0004	0.0067	0.0004	0.0431	0.0004	0.1844
A	0.0146	0.8536	0.0146	0.8428	0.0146	0.8330
Steady State Values						
$\frac{S}{Y}$	1.95%		1.9%		1.36%	

Figure 1: Impulse Response Functions: Real Variables

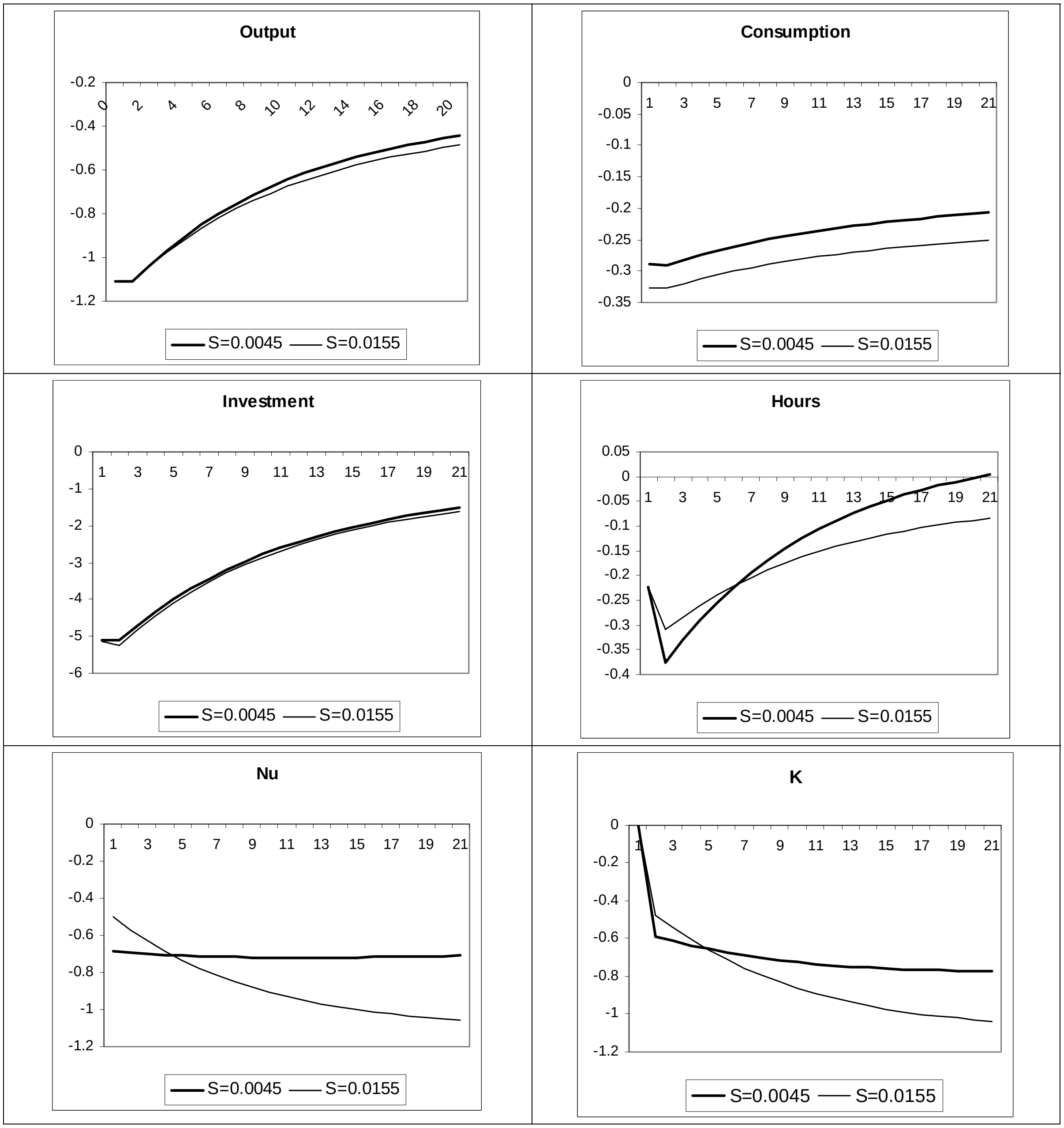

Figure 2: Impulse Response Functions: Financial Variables