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MONETARY POLICY IMPLICATIONS ON THE INVESTMENT DECISION: DO ECONOMIES OF SCOPE IN THE BANKING SECTOR MATTER?

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Abstract

In this paper, we investigate the effectiveness of monetary policy, in the context of a theoretical model that captures both the banking and the firm behavior. Following the industrial organization approach to banking, the banking sector is described by a two-stage Cournot game with scope economies. On the other hand, the firm behavior concerns the investment decision which is explained using a second order accelerator model in discrete time. Considering the interbank rate and the reserve requirements as the instruments of monetary policy, it is demonstrated that its effectiveness depends on the type of scope economies in the oligopolistic banking sector.

Key Words: interbank rate, investment decision, reserve requirements, scope economies

JEL Codes: G21, L13, D92, E52

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1. Introduction

This paper presents a model that interrelates the banking decision to offer loan and deposit services with the investment decision of firms. We model the banking sector as a two-stage Cournot game with scope economies. On the other hand, under the assumption of the existence of adjustment costs in the transformation of investment expenditure into capital, the second order accelerator (SOA) in discrete time is adopted as the mechanism of the explanation of the origination of investment cycles. The link between these two sectors is supposed to be the endogenous interest rate on loans and the level of capital. Our purpose is the investigation of the effectiveness of monetary policy for different types of economies of scope in the oligopolistic banking sector. For this reason, two instruments of monetary policy are considered: the minimum reserve requirements and the interbank rate, which are assumed to be determined exogenously by the Central Bank.

The industrial organization approach to banking (Freixas & Rochet, 2008; Van Hoose, 2010) treats banks as profit maximizing firms. The first to introduce this concept was the Monti-Klein (1971) model that examines the behavior of a monopolistic bank. This model is compared to alternative models of banking in Baltensperger (1980) and Santomero (1984). Van Hoose (1985) investigates the effect of the bank market structure on the variability of a monetary aggregate. Dalla & Varelas (2013) examine the effects of monetary policy on the optimal monopolistic bank behavior. Freixas & Rochet (2008) establish a Cournot model with a finite number of banks and show that the optimal interest rates on loans and deposits increase after an increase in the interbank rate. Similarly, Toolsema & Schoonbeek (1999) examine the effects of an exogenous change in the interbank rate in the case of asymmetry in the cost function (Cournot game) and a Stackelberg game. Stahl (1988) and Yanelle (1989) consider a Bertrand competition in the banking sector.

Varelas (2015) distinguishes between bank concentration and competition, and examines the effect of the latter on the macroeconomic performance. Fanti (2014) examines the effects of capital regulation in a dynamic Cournot model with homogeneous and heterogeneous expectations. Yamazaki and Miyamoto (2004) introduce the notion of scope economies in a two-stage Cournot game. Using this model and assuming an overlapping generation model, Varelas (2007) analyzes the effects of monetary policy via the interbank rate on the bank clients' consumption. In the same manner, Dalla et al. (2014) emphasize on the effects of monetary policy via the minimum reserve requirements on the interest rate spread. There are also eminent empirical studies in the field. Degryse et al. (2009) provide a thorough review of the empirical research on the industrial organization approach to banking.

It should be mentioned that the empirical literature in the microeconomics of banking provides evidence for the existence of scope economies at least in the European banking sector. Cavallo & Rossi (2001) suggest the existence of scope economies for 6 European banking systems (French, German, Italian, Spanish, British and Dutch) for all production levels over the period 1992-1997. Rime & Stiroh (2003) demonstrate weak evidence on economies of scope for the largest Swiss banks from 1996 to 1999. Valverde & Fernadez (2005) find economies of scope in the Spanish banking sector during the period from 1993 to 1999. Estimating scope economies in the banking sector for 12 European countries over the period 2002-2011, Dijkstra (2013) shows the presence of scope economies for all years in all countries.

Regarding the investment decision, we adopt a more microeconomic approach to model the determinants of investment expenditure (Hay & Morris, 1991). Under the assumption of the presence of adjustment costs not only to changes in the capital stock but also to changes in the level of investment, we consider a second order accelerator (SOA) model in discrete time as the context for our analysis. This mechanism provides a pure endogenous origination of the investment cycle and complies with the stylized facts that imply a major role for investment in the fluctuations of economic activity. The centerpiece in this theory is the inertia of investment, thus all the factors that cause the discrepancy among the investment expenditure and its denaturation into capital. Hillinger et al. (1992) derive a second order accelerator model for fixed investment and inventories in continuous time, considering the intertemporal minimization problem of adjustment costs by the individual firm. Hillinger (2005) discusses the SOA mechanism and presents two further derivations of SOA: the standard flexible accelerator and the inference of the observed fluctuations into dynamic equations. Hillinger & Weser (1988) and Weser (1992) use this model to study the aggregation problem in business cycles theory. Dalla & Varelas (2016) derive a SOA model for fixed investment in discrete time, using the flexible accelerator. In the same context, Dalla et al. (2016) extend the previous model, introducing an exogenous interest rate on loans as an unknown function of time.

Our research is also related to the literature on monetary policy transmission through the bank lending channel, according to which monetary policy affects bank loan supply, which in turn affects the aggregate economic activity. Several empirical studies in the field attempt to identify the bank lending channel using the liquidity, the capitalization, the size and the leverage ratio of banks (Gambacorta. 2005; Kashyap and Stein, 1997, 2000; Jimborean and Mesonnier, 2010). Other studies emphasize on the role of bank market structure on the bank lending channel. For instance, Kahn et al. (2005) indicate that the bank market's concentration has an impact on the lending rates. Brissimis et al. (2014) examine the role of bank market power on the bank lending and the risk-taking channels in the EU countries as well as in the US over the period 1997-2010. Ferri et al. (2014) examine the bank ownership as a determinant of lending in the EU. Also, Fungarova et al. (2014) show that the degree of bank competition affects the loan supply reaction to monetary policy in 12 euro area countries during the period 2002-2010. In our model monetary policy affects bank loan supply, which in turn affects the investment cycle that is generated by the second order accelerator. Hence, our analysis provides a theoretical framework for the effects of the cost structure of the individual bank on the bank lending channel in the oligopolistic banking sector.

This paper is structured as follows. Sections 2 & 3 present the banking sector and the investment decision respectively. Section 4 provides the solution of our model. Sections 5 & 6 examine the effectiveness of monetary policy with regard to the kind of scope economies in the banking sector and give a relative numerical example respectively. Section 7 concludes.

2. The Banking Sector

Following Freixas & Rochet (2008), we model banking activity as the production of loan and deposit services. In particular, we assume two banks, 1 and 2, that operate both on the markets for loans and deposits (Dalla et al., 2014). Let the inverse demand function for loans be given by

$$r_{Lt} = r_L(L_t, Y_t) = \mu_1 Y_t - b_1 L_t, \quad \mu_1, b_1 > 0 \ \& \ r_L{}'(L_t) < 0 \quad \textbf{(1)}$$

where Y_t: national income and L_t : the total volume of loans. The latter is

$$L_t = L_{1t} + L_{2t} \quad \textbf{(2).}$$

Similarly, the inverse supply function for deposits is as follows:

$$r_{Dt} = r_D(D_t) = \beta_1 + \gamma D_t, \quad \beta_1, \gamma > 0 \ \& \ r_D{}'(D_t) > 0 \quad \textbf{(3)}$$

where the total volume of deposits (D_t) is given by:

$$D_t = D_{1t} + D_{2t} \quad \textbf{(4).}$$

Now, the assets' side of the balance sheet of the individual bank contains its loans $\left(L_{it}, i=1,2\right)$ and its reserves $\left(R_{it}, i=1,2\right)$. The latter equals a proportion α of deposits. The coefficient α denotes the reserve requirements which serve as an exogenous instrument of monetary policy. It is assumed that the banks do not hold any excess requirements. On the other hand, the liabilities' side of the individual bank includes its volume of deposits $\left(D_{it}, i=1,2\right)$. The difference between the liabilities' side and the assets' side of bank i is defined as the bank's net position $\left(M_{it}, i=1,2\right)$ on the interbank market. This net position reflects the balance sheet constraint of each bank and is given by:

$$M_{it} = (1-a)\cdot D_{it} - L_{it}, \quad i=1,2, a \in (0,1) \quad \textbf{(5)}$$

Moreover, the cost function of the individual bank, that shows its management costs, is assumed to be non-linear, continuous and differentiable. Its functional form is:

$$C_{it} = C_i(L_{it}, D_{it}) = \theta(D_{it})\cdot L_{it} + \varphi D_{it}, \quad \theta(D_{it}) > 0, \varphi > 0, i=1,2 \quad \textbf{(6)}$$

where $\theta\left(D_i\right) > 0$ & $\varphi > 0$: marginal cost of loans and the unit cost of deposits respectively.

The functional form of the marginal cost of loans has as follows:

$$\theta\left(D_{it}\right) = \kappa D_{it} + m, \quad \kappa \in \Re, \ m > 0, i=1,2 \quad \textbf{(7)}$$

The first derivative of this function with respect to the quantity of deposits of bank i is equal to κ and can take any real value. The sign of κ determines the kind of scope economies (Baumol et al., 1982). The existence of economies of scope implies that the joint offer of deposits and loans by a universal bank is more efficient than their separate offer by specialized banks, that is when $\theta'\left(D_{it}\right) = \partial^2 C_i\left(L_{it}, D_{it}\right)/\partial D_{it}^2 < 0$. Thus, if $\theta'\left(D_{it}\right) = \kappa$ is negative, there are economies of scope. On the contrary, when $\theta'\left(D_{it}\right) = \kappa$ is positive, there are diseconomies of scope. Finally, if $\theta'\left(D_{it}\right) = \kappa$ is null, no economies of scope exist. The parameter m takes positive values in order to always have $\theta\left(D_{it}\right) > 0$. This functional form of $\theta\left(D_{it}\right)$ satisfies the assumption $\theta''\left(D_{it}\right) = 0$ (Varelas, 2007; Dalla et al., 2014).

Finally, the profit of the individual bank is calculated as the difference between its total revenues and total cost. Its functional form is given by:

$$\Pi_{it} = \Pi_i(L_{it}, D_{it}) = r_L(L_t, Y_t)\cdot L_{it} + r\cdot M_{it} - r_D(D_t)\cdot D_{it} - C_i(L_{it}, D_{it}), \quad i=1,2 \quad \textbf{(8)}$$

where r: the exogenous interest rate on the interbank market.

We proceed to the solution of the banks' maximization problem. The maximization problem of the individual bank can be stated as:

$$\max\ \Pi_i\left(L_{it},D_{it}\right)=r_L\left(L_t,Y_t\right)L_{it}+r\ M_{it}-r_D\left(D_t\right)D_{it}-C_i\left(L_{it},D_{it}\right)\quad \textbf{(9).}$$

In the context of a two-stage Cournot game[1], each bank is involved in a sequential portfolio problem. It should be mentioned that in each period t the individual bank acts without taking into consideration the past actions of the rival bank. Thus, in each period t, the equilibrium is the equilibrium of the static two-stage Cournot game. Now, in the first stage, the banks decide over the level of deposits simultaneously, while in the second stage they choose the volume of loans simultaneously. Assuming that the equilibrium constitutes a subgame perfect equilibrium and that the second stage has a well defined Nash equilibrium, we apply the backward induction method. Solving the above model, we obtain the equilibrium interest rate on loans as a function of national income:

$$r_{Lt}^{*}=\frac{1}{3}\Omega_1 Y_t+\frac{2}{3}\Omega_2,\quad \Omega_1,\Omega_2\in\Re\quad \textbf{(10)}$$

where

$$\Omega_1=\left[1+\frac{8\kappa^2}{4\kappa^2-27b_1\gamma}\right]\mu_1\ \&\ \Omega_2=r+m+\kappa\left[\frac{-4\kappa\left(m+r\right)-9b_1\left(r\left(1-a\right)-\beta_1-\varphi\right)}{4\kappa^2-27b_1\gamma}\right].$$

At this point, it is necessary to present a critical condition for our analysis, the second order condition for profit maximization in the first stage subgame:

$$\frac{\partial^2\Pi_i\left(D_{it}\right)}{\partial D_{it}^2}=\frac{8}{9b_1}\kappa^2-2\gamma<0,\quad i=1,2\quad \textbf{(11).}$$

The above solution presumes the existence of economies or diseconomies of scope, that is $\kappa\neq 0$. However, when no economies of scope exist $\left(\kappa=0\right)$, the cost function of the individual bank is linear and additive. Thus, the decision problem of the individual bank is separable (Freixas & Rochet, 2008). In this case, the two-stage Cournot game can be induced into a traditional one-stage Cournot game, where each bank is profit maximizing given the volumes of loans and deposits of the other bank. Therefore, banks engage in a simultaneous portfolio

[1] The solution of the two-stage Cournot game is presented analytically in the appendix.

problem. If this is the case in the banking sector, the equilibrium interest rate on loans is transformed into:

$$r_{Lt}^{*} = \frac{1}{3}\mu_1 Y_t + \frac{2}{3}(r+m) \quad \textbf{(12).}$$

From relations (10) and (12), it is obvious that in the absence of (dis)economies of scope from the banking sector monetary policy via reserve requirements has no impact on the equilibrium interest rate on loans.

3. The Investment Decision

Taking into consideration the adjustment costs related to both the capital stock and the rate of investment, we use the three-equation second order accelerator model (SOA) in discrete time as a framework to model the investment decision. The SOA mechanism is derived using the standard flexible accelerator (Hillinger et al., 1992; Hillinger, 2005). The existence of adjustment costs involved in changing the level of investment, which is referred as inertia of investment, provokes the gradual adjustment of net investment towards its desired level. This partial adjustment mechanism for fixed investment is presented by:

$$I_t - I_{t-1} = c\left(I_t^{*} - I_{t-1}\right), \quad 0 < c < 1 \quad \textbf{(13)}$$

where c: the speed of adjustment, I_t^{*}: the desired level of fixed investment, I_t: the actual level of fixed investment. It should be mentioned that the closer to the unity is the value of c, the faster is the adjustment of net investment in the present period. Conversely, as c tends to zero the adjustment becomes slower.

The desired level of investment is given by the following equation which constitutes the behavioral equation of investors. The introduction of the interest rate on loans in this equation captures the negative relation between net investments and the aforementioned interest rate.

$$I_t^{*} = b(K_t^{*} - K_{t-1}) + dr_{Lt}, \quad b > 0, d < 0 \quad \textbf{(14)}$$

where K_{t-1}: the actual capital with a time-lag and K_t^{*}: the desired capital. Under the assumption of a finite time path, we presume that the desired level of capital is stable. This allows the notation of the desired level of capital with K^{*} for the rest of our analysis. Finally, the definition of net investment is expressed by equation (15):

$$I_t = K_t - K_{t-1} \quad \textbf{(15).}$$

The combination of relations (13) to (15) yields the reduced form in the product market:

$$K_t + \left[c(b+1)-2\right]K_{t-1} + (1-c)K_{t-2} = cbK^* + cdr_{Lt} \quad \textbf{(16)}.$$

In the absence of the interest rate on loans from the behavioral equation of investors, relation (16) constitutes the typical second order accelerator in discrete time (Dalla & Varelas, 2015) that has as follows:

$$K_t + \left[c(b+1)-2\right]K_{t-1} + (1-c)K_{t-2} = cbK^* \quad \textbf{(17)}.$$

This mechanism provides an explanation of the endogenous origination of investment cycles. Thus, its solution describes the motion of capital over time. The solution of (17) is periodic for $c\left(b+1\right)^2 < 4b$ with capital following a trigonometric path with period equal to $2\pi/\omega$ and decreasing amplitude. The stability of this system can also be ensured by the satisfaction of a set of necessary and sufficient conditions (Gandolfo, 1996). The critical stability condition is then $c(b+2) < 4$. In addition, the equilibrium level of capital is derived equal to its desired level. Therefore:

$$\overline{K} = K^* \quad \textbf{(18).}$$

To conclude, the behavior of capital over time in the case of the trigonometric oscillatory movement is described by the following equation, which is also the general solution of this model:

$$K_t = R^t \left[A_1 \cos \omega t + A_2 \sin \omega t\right] + K^* \quad \textbf{(19)}$$

where *R*: the absolute value/ modulus of the characteristic roots, and A_1, A_2 $\in \mathbb{R}$ are arbitrary constants which can be derived using two initial conditions.

4. Solution of the Model

Firstly, we assume that the production function is described by an "AK" model, that is:

$$Y_t = AK_t \quad \textbf{(20)}$$

where *A*>0 the parameter of technology.

Then, the equilibrium interest rate on loans in the case of (dis)economies of scope (equation (10)) as well as in the case of no economies of scope (equation (12)) can be expressed in terms of capital as follows:

$$r_{Lt}^{*} = \frac{1}{3} A\Omega_1 K_t + \frac{2}{3}\Omega_2, \quad \Omega_1, \Omega_2 \in \Re \quad \textbf{(21)}$$

&

$$r_{Lt}^{*} = \frac{1}{3} A\mu_1 K_t + \frac{2}{3}(r+m) \quad \textbf{(22).}$$

Inserting relations (21) and (22) in the reduced form in the product market (equation (16)), we obtain the second order accelerator for fixed investment in the respective case. Their functional forms are given by the following equations respectively:

$$\left[1 - \frac{Acd\Omega_1}{3}\right] K_t + \left[c(b+1) - 2\right] K_{t-1} + (1-c) K_{t-2} = cbK^{*} + \frac{2cd\Omega_2}{3} \quad \textbf{(23)}$$

&

$$\left[1 - \frac{Acd\mu_1}{3}\right] K_t + \left[c(b+1) - 2\right] K_{t-1} + (1-c) K_{t-2} = cbK^{*} + \frac{2cd}{3}\left(r+m\right) \quad \textbf{(24)}$$

Both relations (23) & (24) are second order difference equations with constant coefficients. Their solution describes the behavior of capital over time. To begin with the deviation of capital from its steady-state in each case, this is given by the general solution of the homogeneous equations corresponding to equations (23) and (24), that is of:

$$\left[1 - \frac{Acd\Omega_1}{3}\right] K_t + \left[c(b+1) - 2\right] K_{t-1} + (1-c) K_{t-2} = 0 \quad \textbf{(25)}$$

&

$$\left[1 - \frac{Acd\mu_1}{3}\right] K_t + \left[c(b+1) - 2\right] K_{t-1} + (1-c) K_{t-2} = 0 \quad \textbf{(26).}$$

The relative characteristic equations are respectively:

$$\left[1 - \frac{Acd\Omega_1}{3}\right] \lambda^2 + \left[c(b+1) - 2\right] \lambda + (1-c) = 0 \quad \textbf{(27)}$$

&

$$\left[1 - \frac{Acd\mu_1}{3}\right] \lambda^2 + \left[c(b+1) - 2\right] \lambda + (1-c) = 0 \quad \textbf{(28).}$$

The discriminant in each case has as follows:

$$\Delta = \left[c(b+1)-2\right]^2 - 4\left[1-\frac{Acd\Omega_1}{3}\right](1-c) \quad \textbf{(29)}$$

&

$$\Delta = \left[c(b+1)-2\right]^2 - 4\left[1-\frac{Acd\mu_1}{3}\right](1-c) \quad \textbf{(30)}$$

In both cases of cost function, the second order accelerator mechanism interprets the existence of investment cycles if the value of the corresponding discriminant is negative. Therefore, under the assumption of a negative discriminant in the case of (dis)economies of scope, capital follows a trigonometric oscillatory path with period equal to $2\pi/\omega_1$. The characteristic roots are conjugate complex numbers with modulus or absolute value equal to $R_1 = \sqrt{\left(3(1-c)\right)/\left(3-Acd\Omega_1\right)} > 0$. If the latter's value is less than unity, the amplitude of the trigonometric oscillations is decreasing leading to the capital's convergence towards the steady-state. The necessary and sufficient conditions for the oscillations to be damped are:

$$\begin{aligned} &\frac{c\left(3b-Ad\Omega_1\right)}{3-Acd\Omega_1} > 0 \\ &\frac{c\left(3-Ad\Omega_1\right)}{3-Acd\Omega_1} > 0 \qquad \textbf{(31)} \\ &\frac{3\left[4-c\left(b+2\right)\right]-Acd\Omega_1}{3-Acd\Omega_1} > 0 \end{aligned}$$

Given the assumption of a negative discriminant when no economies of scope exist, the resulting movement of capital is a trigonometric oscillatory path with period equal to $2\pi/\omega_2$ and decreasing amplitude if and only if the modulus or absolute value of the corresponding characteristic roots is less than unity. The latter is calculated equal to $R_2 = \sqrt{\left(3(1-c)\right)/\left(3-Acd\mu_1\right)} > 0$. In this case, the necessary and sufficient conditions for the oscillations to be damped are given by the following inequalities:

$$\frac{c\left(3b-Ad\mu_1\right)}{3-Acd\mu_1}>0$$

$$\frac{c\left(3-Ad\mu_1\right)}{3-Acd\mu_1}>0 \qquad \textbf{(32)}$$

$$\frac{3\left[4-c\left(b+2\right)\right]-Acd\mu_1}{3-Acd\mu_1}>0$$

Now, we apply the method of undetermined coefficients to obtain the particular solution of equations (23) and (24). These solutions are interpreted as the equilibrium level (steady-state) of capital in each concept of the model. For this reason they should be positive. Their functional form are as follows[2]:

$$\overline{K}=\frac{3bK^*+2d\Omega_2}{3b-Ad\Omega_1},\ 3b-Ad\Omega_1\neq 0 \quad \textbf{(33)}$$

&

$$\overline{K}=\frac{3bK^*+2d\left(r+m\right)}{3b-Ad\mu_1},\ 3b-Ad\mu_1\neq 0 \quad \textbf{(34)}$$

On the whole, the behavior of capital over time for the two types of the cost function is described by the following equations, respectively:

$$K_t=R_1^t\left[A_3\cos\omega_1 t+A_4\sin\omega_1 t\right]+\frac{3bK^*+2d\Omega_2}{3b-Ad\Omega_1},\ 3b-Ad\Omega_1\neq 0 \quad \textbf{(35)}$$

&

$$K_t=R_2^t\left[A_5\cos\omega_2 t+A_6\sin\omega_2 t\right]+\frac{3bK^*+2d\left(r+m\right)}{3b-Ad\mu_1},\ 3b-Ad\mu_1\neq 0 \quad \textbf{(36)}$$

where A_3, A_4, A_5, A_6 $\in\mathbb{R}$ are arbitrary constants which can be derived using two initial conditions.

5. Monetary Policy Implications

The interbank rate $\left(r\right)$ and the reserve requirements $\left(a\right)$ serve as the available instruments of monetary policy to the Central Bank. From the solution of the model, it is inferred that these

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[2] The restrictions $3b-Ad\Omega_1\neq 0$ & and $3b-Ad\mu_1\neq 0$ are satisfied in the case of convergence of capital towards its steady-state due to the satisfaction of the corresponding set of stability conditions (31) & (32).

exogenous variables do not affect the deviation of capital from its equilibrium, i.e. the cycle, in either case of economies of scope in the banking sector. While this is true, monetary policy achieves to influence the equilibrium state of our system, which is expressed by relations (33) and (34) in the cases of (dis)economies of scope and no economies of scope respectively. In particular, both the interbank rate and the fraction of reserve requirements are introduced in the steady-state of capital when (dis)economies of scope exist, while if no economies of scope exist the steady-state depends only on the interbank rate. Therefore, monetary policy via the minimum reserve requirements has no impact on the equilibrium state of capital when $\kappa = 0$ and the loan and deposit markets are separate.

Now, taking into consideration that our model is deterministic which implies full information, no uncertainty and perfect foresight, we consider a change in either the interbank rate or the fraction of reserve requirements as a permanent shock of monetary policy. Under this hypothesis, the implementation of monetary policy results in a new steady-state of capital. In order to examine the effectiveness of monetary policy we apply comparative statics by using the partial total derivative (Chiang, 1984) of the steady state of capital for different values of κ with respect to the respective instrument. Comparative statics allows us to compare the initial equilibrium level of capital to the final one, ignoring the transition path.

To begin with the interbank rate, the effectiveness of monetary policy implies that expansionary (restrictive) monetary policy, that is a decrease (increase) in the interbank rate, should lead to an increase (decrease) in the equilibrium level of capital. So, the following inequality should be hold:

$$\frac{\partial \bar{K}}{\partial r} = -\frac{6b_1 d\left(\left(1-a\right)\kappa + 3\gamma\right)}{4\kappa^2\left(b - Ad\mu_1\right) - 9b_1\left(3b - Ad\mu_1\right)\gamma} < 0 \quad \textbf{(37)}.$$

Given the value intervals of the model's parameters and the second order condition (11)[3], the above condition is satisfied when $0 < b_1 \leq 4\gamma/\left(1-a\right)^2$ & $-\left(3\sqrt{b_1\gamma}/2\right) < \kappa < 3\sqrt{b_1\gamma}/2$ and/or when $b_1 > 4\gamma/\left(1-a\right)^2$ & $-3\gamma/\left(1-a\right) < \kappa < 3\sqrt{b_1\gamma}/2$. Hence, we infer that monetary policy via

[3] The second order condition for profit maximization in the first stage of the Cournot interaction in the banking sector (relation (11)) entails that $-\left(3\sqrt{b_1\gamma}/2\right) < \kappa < 3\sqrt{b_1\gamma}/2$.

the interbank rate can be effective in the case of (dis)economies of scope as well as when no economies of scope exist.

Moving now into the case of monetary policy via the minimum reserve requirements, the effectiveness requires the satisfaction of the following inequality:

$$\frac{\partial \bar{K}}{\partial a} = \frac{6b_1 dr\kappa}{4\kappa^2\left(b - Ad\mu_1\right) - 9b_1\left(3b - Ad\mu_1\right)\gamma} < 0 \quad \textbf{(38).}$$

Given the parameters' value intervals and the second order condition (11), this inequality is satisfied only if $-\left(3\sqrt{b_1\gamma}/2\right) < \kappa < 0$, i.e. in the case of scope economies. Thus, it turns out that the manipulation of the reserve ratio serves only as a means of controlling the increased liquidity implied by the presence of scope economies ceteris paribus.

Finally, to investigate the type of scope economies for which not only the interbank rate but also the reserve requirement ratio is an effective instrument of monetary policy, we have to consider the simultaneous satisfaction of inequalities (37) & (38). It is deduced that this is possible when $0 < b_1 \le 4\gamma/\left(1-a\right)^2$ & $-\left(3\sqrt{b_1\gamma}/2\right) < \kappa < 0$ and/or when $b_1 > 4\gamma/\left(1-a\right)^2$ & $-3\gamma/\left(1-a\right) < \kappa < 0$, that is in the case of economies of scope.

6. Numerical Example

6.1 Calibration

Following the methodology of Karpetis & Varelas (2012), we assign random values within the accepted intervals to our model's parameters. Table 1 summarizes our calibration for both the banking sector and the investment decision:

Banking Sector						
μ_1	b_1	β_1	γ	φ	m	
1.5	0.5	30	1.2	1	9	
Investment Decision & Policy Parameters						
c	b	d	A	K^*	α	r
0.4	1	-0.3	2	15	0.1	0.1

Table 1: Calibration

The crucial parameter of our model is κ, the sign of which determines the type of scope economies. What we know about this parameter is that its value should satisfy the second order condition for banking profit maximization, relation (11). Given our calibration, this is related to the satisfaction of the following inequality $P(\kappa)=\left(16/9\right)\kappa^2-2.4<0$. It can be proved that the value intervals for which the aforementioned inequality holds is the $(-1.162,1.162)$. Therefore, we examine three different cases: $\kappa=-1$ (economies of scope), $\kappa=0$ (no economies of scope) & $\kappa=1$ (diseconomies of scope). It should be mentioned that in all these cases our model interprets the existence of investment cycles with period equal to 9 and decreasing amplitude.

6.2 Monetary Policy

In this section, we consider two different types of expansionary monetary policy: a decrease in the interbank rate (r) from 0.1 to 0.05 and a decrease in the fraction of reserve requirements (a) from 0.1 to 0.05. Both of them are realized as permanent shocks that occur at period t=1 and result in a new steady-state of capital. Figures 1.1, 2.1 & 3.1 show the effect of monetary policy via the interbank rate in the case of economies of scope, no economies of scope and diseconomies of scope respectively. It can be clearly seen that in all the aforementioned cases capital reaches at a new higher equilibrium level after the implementation of monetary policy. Hence, the interbank rate is an effective instrument of monetary policy in this context. On the other hand, figures 1.2, 2.2. & 3.2 present the transition path of capital after expansionary monetary policy via the minimum reserve requirements in the cases of economies of scope, no economies of scope and diseconomies of scope. While this policy is effective in the case of economies of scope, it has the opposite results when diseconomies of scope exist. Finally, in the absence of economies of scope, the change in the minimum reserve requirements has no effect on capital. Therefore, our theoretical findings are confirmed.

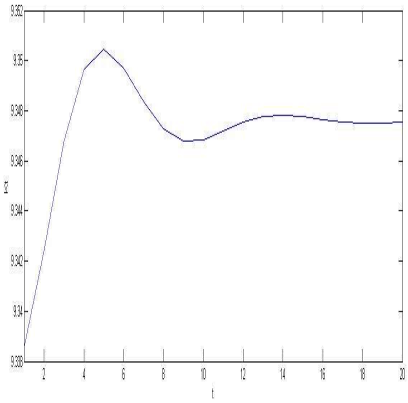

Figure 1.1: Scope Economies $(\kappa = -1)$-Expansionary monetary policy via r

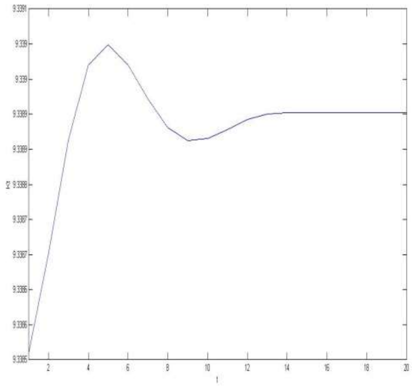

Figure 1.2: Scope Economies $(\kappa = -1)$-Expansionary monetary policy via a

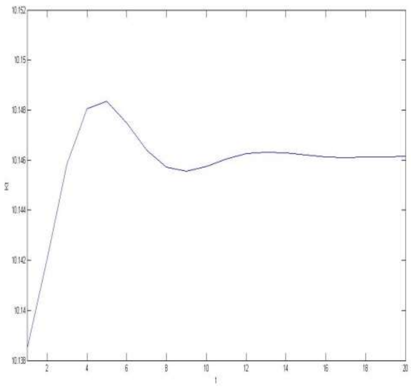

Figure 2.1: No Economies of Scope $(\kappa = 0)$-Expansionary monetary policy via r

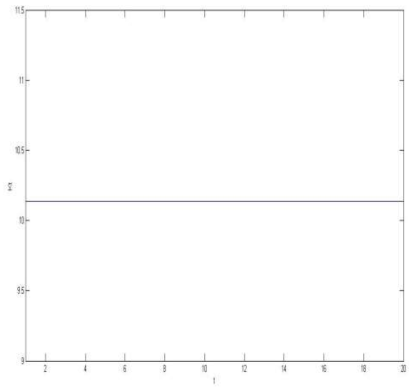

Figure 2.2: No economies of Scope $(\kappa = 0)$-Expansionary monetary policy via a

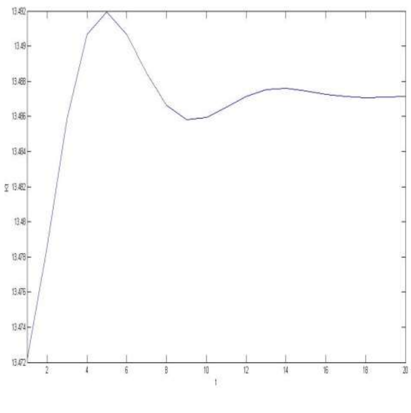

Figure 3.1: Diseconomies of Scope $(\kappa = 1)$-Expansionary monetary policy via r

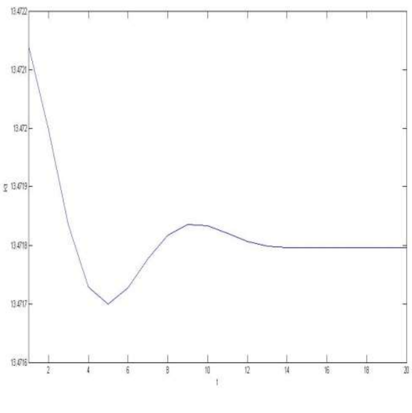

Figure 3.2: Diseconomies of Scope $(\kappa = 1)$-Expansionary monetary policy via α

The effectiveness of monetary policy for the different types of economies of scope in the banking sector can also be examined using the method of comparative statics, as this is explained in section 5. Given our calibration, table 2 presents the sign of the partial total derivatives (37) and (38) for the accepted, according to the second order condition for profit maximization, value interval of κ. It is inferred that the reserve ratio serves as an effective instrument of monetary policy only in the case of economies of scope, i.e. when $\kappa \in (-1.162, 0)$.

	Economies of Scope	**No Economies of Scope**	**Diseconomies of Scope**
κ	$(-1.162, 0)$	0	$(0, 1.162)$
$\frac{\partial \bar{K}}{\partial r}$	(-)	(-)	(-)
$\frac{\partial \bar{K}}{\partial a}$	(-)	0	(+)

Table 2: Effectiveness of monetary policy

7. Conclusions

In this paper, we examined the effects of monetary policy on capital for different kinds of scope economies in the banking sector. For this reason, we established a theoretical model that relates the oligopolistic banking sector with the firms' investment decision. The banking sector was described by a two-stage Cournot game with scope economies. On the other hand, assuming the existence of adjustment costs both in the changes of the capital stock and in the changes of the level of investment, we used the second order accelerator (SOA) as the mechanism to explain the investment cycle. The solution of the model described the motion of capital over time. In addition, we considered the effectiveness of monetary policy in this context. Using comparative statics, we found that both the interbank rate and the minimum reserve requirements are effective instruments of monetary policy in the case of economies of scope in the banking sector. Therefore, the manipulation of the reserve requirements serves only as a means of controlling the increased liquidity implied by the presence of scope economies ceteris paribus.

On the whole, our analysis prompts several important issues as subjects of future research. An interesting extension of our model is to introduce the information asymmetry in the ability of the oligopolistic commercial banks to obtain funds from both the Central Bank and the depositors (Gertler & Kiyotaki, 2010) and examine how our main results change in this case. In fact, this is related to the financial accelerator effect (Gambacorta & Mirstrulli, 2004; Hubbart et al., 2002; Kishan & Opiela, 2002) that can be used as a transmission mechanism of monetary policy. Further, the examination of different perspectives of banking production would provide important insights on the role of banking conduct in the implementation of economic policy and its effect on the investment decision. Finally, the investigation of the monetary policy effects on the investment decision in the case of other market forms of the banking sector with scope economies is left as a question to be answered by future research.

Appendix

In this section we provide the derivation of the equilibrium interest rate on loans based on the industrial organization approach to banking. The profit maximization problem of the individual bank can be stated as:

$$\max \ \Pi_i\left(L_{it}, D_{it}\right) = r_L\left(L_t, Y_t\right) L_{it} + r\ M_{it} - r_D\left(D_t\right) D_{it} - C_i\left(L_{it}, D_{it}\right) \quad \textbf{(A.1)}$$

Substituting relations (1) to (7) into the above one, the maximization problem is transformed into:

$$\begin{aligned} \max \Pi_i\left(L_{it}, D_{it}\right) = & \left[\mu_1 Y_t - b\left(L_{it} + L_{jt}\right) - r - \theta\left(D_{it}\right)\right] L_{it} + \\ & + \left[r(1-a) - \beta_1 - \gamma\left(D_{it} + D_{jt}\right) - \varphi\right] D_{it}, \quad i, j = 1, 2 \,\&\, i \neq j \end{aligned} \quad \textbf{(A.2)}$$

Considering a two-stage Cournot game, in the first stage the banks decide over the level of deposits simultaneously, while in the second stage they choose the volume of loans simultaneously. Assuming that the equilibrium constitutes a subgame perfect equilibrium and that the second stage has a well defined Nash equilibrium, we apply the backward induction method. Thus, the profit maximization problem of the individual bank in the second stage of the Cournot game is:

$$\begin{aligned} \max_{L_{it}} \Pi_i\left(L_{it}, D_{it}\right) = & \left[\mu_1 Y_t - b_1\left(L_{it} + L_{jt}\right) - r - \theta\left(D_{it}\right)\right] L_{it} + \\ & + \left[r(1-a) - \beta_1 - \gamma\left(D_{it} + D_{jt}\right) - \varphi\right] D_{it}, \quad i, j = 1, 2 \,\&\, i \neq j \end{aligned} \quad \textbf{(A.3)}$$

The first order condition for profit maximization is:

$$\frac{\partial \Pi_{it}}{\partial L_{it}} = 0 \Rightarrow \mu_1 Y_t - 2b_1 L_{it} - b_1 L_{jt} - r - \theta\left(D_{it}\right) = 0, \quad i, j = 1, 2 \,\&\, i \neq j \quad \textbf{(A.4)}$$

Solving the above equation with respect to L_{it}, we obtain the reaction function of loans of the individual bank:

$$L_{it} = \frac{\mu_1 Y_t - r - \theta(D_{it}) - b_1 L_{jt}}{2b_1} \quad , \quad i,j = 1,2 \ \& \ i \neq j \quad \textbf{(A.5)}$$

From the solution of the system of the reaction functions of the banks, we get the equilibrium level of loans in the second stage subgame:

$$L_{it} = \frac{\mu_1 Y_t - r - 2\theta(D_{it}) + \theta(D_{jt})}{3b_1} \quad , \quad i,j = 1,2 \ \& \ i \neq j \quad \textbf{(A.6)}$$

Moving mow into the first stage, each bank maximizes its profit function with respect to the individual amount of deposits. The objective function is obtained after the substitution of (A.6) in (A.3):

$$\begin{aligned} \max_{D_{it}} \Pi_i(D_{it}) = \frac{1}{b_1}\left[\frac{\mu_1 Y_t - 2\theta(D_{it}) + \theta(D_{jt}) - r}{3}\right]^2 + \\ + \left[r(1-\alpha) - \beta - \gamma(D_{it} + D_{jt}) - \varphi\right] D_{it}\,, i = 1,2 \,\&\, i \neq j \end{aligned} \quad \textbf{(A.7)}$$

The first order condition of the individual bank, after the substitution of relation (7) into it, has the following functional form:

$$\frac{\partial \Pi_{it}(.)}{\partial D_{it}} = -\frac{4}{9b_1}\left(\mu_1 Y_t - 2\kappa D_{it} + \kappa D_{jt} - m - r\right)\kappa + r(1-\alpha) - \beta_l - \gamma(2D_{it} + D_{jt}) - \varphi = 0 \quad \textbf{(A.8)}$$

where $i = 1,2 \,\&\, i \neq j$

From the solution of the system of the first order conditions of the oligopolistic banks, we obtain the equilibrium level of deposits of each bank which are equal to:

$$D_{1t}^* = D_{2t}^* = \frac{4\kappa(\mu_1 Y_t - m - r) - 9b_1\left(r(1-a) - \beta_1 - \varphi\right)}{4\kappa^2 - 27b_1\gamma} \quad \textbf{(A.9)}$$

At this point, it is necessary to present a critical condition for our analysis, the second order condition for profit maximization in the first stage subgame:

$$\frac{\partial^2 \Pi_i\left(D_{it}\right)}{\partial D_{it}^2} = \frac{8}{9b_1}\kappa^2 - 2\gamma < 0, \quad i = 1,2 \quad \textbf{(A.10)}$$

Regarding the optimal level of loans, substituting relation (A.9) into (A.6), we get:

$$L_{1t}^* = L_{2t}^* = \frac{\mu_1 Y_t - r - \kappa D_{1t}^* - m}{3b_1} \quad \textbf{(A.11)}$$

The equilibrium interest rate on loans is obtained after the substitution of relations (A.11) and (A.9) into the inverse demand function of loans (relation 1):

$$r_{Lt}^* = \frac{1}{3}\Omega_1 Y_t + \frac{2}{3}\Omega_2, \quad \Omega_1, \Omega_2 \in \Re \quad \textbf{(A.12)}$$

where $\Omega_1 = \left[1 + \frac{8\kappa^2}{4\kappa^2 - 27b_1\gamma}\right]\mu_1$ & $\Omega_2 = r + m + \kappa\left[\frac{-4\kappa\left(m+r\right) - 9b_1\left(r\left(1-a\right) - \beta_1 - \varphi\right)}{4\kappa^2 - 27b_1\gamma}\right]$

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