Banks' internalization effect and equilibrium

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Abstract

This paper extends the standard New Keynesian model to allow for the presence of large banks, when the cost channel of monetary policy matters. It is shown that once the presence of large banks is taken into account the severity of the firms' credit constraints, the aggressiveness of the central bank in stabilizing inflation and the degree of loan setting centralization jointly affect the steady state output. Moreover, it turns out that the indeterminacy region is not only shrunk due to the presence of a finite number of large banks but also dependent – among others - on the way in which the central bank and the macroprudential authority systematically behave.

Keywords: Large banks; Cost channel; Indeterminacy; Countercyclical capital buffer

JEL classification: E32, E44, E52

Introduction

There is a well-documented existence of imperfect competition in banking (Claessens and Laeven, 2004; Bikker and Haaf, 2002; De Bandt and Davis 2000)**.** Moreover, Kim, Kristiansen, and Vale (2005), Northcott (2004), and Cohen and Mazzeo (2007), among others, provide evidence on product differentiation as one source of market power in banking. However, hinging on atomistic banks the New Keynesian model disregard the fact that banking interest rates are decided by few *large* banks whose decisions affect the aggregate banking interest rate at the national level. These large banks *internalize* the aggregate effects of their interest rate setting decisions by taking into account - among others- the macroeconomic authorities' decisions. This paper attempts to fill in this gap.

A second branch of literature focuses on macroprudential policy. The objective of this policy is to curtail macroeconomic costs associated with financial instability. A set of new macroprudential policies attempt to both strengthen regulatory constraints on bank leverage and balance sheets and also make such regulation more responsive to cyclical developments. The implications of these regulatory developments both for the banking sector and the whole economy are of great importance and large banks are expected to have a significant role to play.

Third, the cost channel of monetary policy assigns banks a pivotal role in the transmission of monetary policy (Barth and Ramey, 2001; Ravenna and Walsh, 2006). According to this channel marginal production costs – apart from real wage - are also directly affected by interest rates, relating firms' price decisions to credit conditions.

Barth and Ramey (2001) maintain that this supply effect of monetary policy dominates the traditional demand effect, i.e. the interest rate channel. Moreover, for its empirical relevance, see for the U.S., Barth and Ramey (2001), for Europe Dedola and Lippi (2005), and for the euro area, Fabiani et al. (2006). It's worth noticing that under a cost channel, the New Keynesian model is more prone to interdeterminacy issues. Bruckner and Schabert (2003), Surico (2008) and Christiano, Trabandt, and Walentin (2010) postulate that the cost channel introduces an additional upper bound to the inflation reaction in the Taylor rule. Hence, the question arises as to whether the concentrated bank sector - through large banks' internalization effect - impacts on the conditions that guarantee equilibrium determinacy in a standard sticky price model augmented with a cost channel.

Earlier contributions on monetary policymaking do not investigate these three branches simultaneously. The main novelty of the present paper is to embed all of them within a single microfounded framework. Hence, taking the aforementioned considerations into account, I extent the basic New Keynesian model to include three features:

First, I introduce *large* (or non-atomistic) banks in the spirit of the large union literature (Lippi, 2003; Bratsiotis and Martin, 1999; Soskice and Iversen, 2000; Gnocchi, 2009; Cuciniello, 2011; and Coricelli et al., 2006) into a New Keynesian DSGE model[1]. Large banks are a key assumption. These banks by providing differentiated loan services to firms they internalize the aggregate effects of their loan-setting decisions. This feature—which I refer to as *banks' internalization effect*—is meant to capture the documented existence of loan mark-ups in credit markets.

Second, regulatory capital requirements enter through a quadratic adjustment cost on bank leverage, which includes a time-variant capital adequacy rule. This allowance for bank capital requirements to be countercyclical (Angelini et al. , 2011; Brzoza-Brzezina et al., 2013; and Hollander, 2017) reflects Basel III requirements. Combining this modeling choice with the hypothesis of large banks, gives us the opportunity to incorporate macroprudential concerns of an independent macroprudential authority that in our model large banks take into account. With the global financial crisis spreading to the real economy, I believe that this is an interesting area for further research.

Third, I assume that firms need to pay wages in advance of production, which generates a need for external finance. In this way, financial market conditions matter for macroeconomic outcomes because they affect firms' marginal costs. This is the cost channel of monetary policy, first introduced by Walsh and Ravenna (2006) and enriched by Airaudo and Pia Olivero (2019), Hülsewig et al. (2009) and others. The choice of the cost channel of monetary policy not only best serves the purpose of revealing the significance of large banks but also is a necessary assumption that is dictated by its empirical relevance.

[1] To our best knowledge, there is only one article that incorporate large banks into DSGE models of monetary policy, i.e., Cuciniello and Signioretti (2015). Yet, it does not examine the implications of the interactions of large banks with the macroprudential authority, whereas it focuses on the traditional demand channel of monetary policy. Furthermore, it does not examine the stability properties of the rational expectations' equilibrium.

Hinging on these three extensions, this paper adds to the literature, by revealing the importance of interactions between *large* banks, the monetary authority and the macroprudential authority - when the cost channel of monetary policy matters - for the analysis of monetary policy, in terms of the steady state of the economy and the stability properties of simple interest rate rules. It is shown that a banking sector featuring aggressive large banks reduce the indeterminacy region and impacts on the steady state of the economy. Hence, the paper reveals the role of the bank lending channel – when large banks internalize the consequences of their actions (interest rate setting) for the economic variables - in business cycle stabilization.

The remainder of the paper is organized as follows. Section 1 describes the model giving emphasis on the banking sector of the economy. Then the baseline parameterization is presented in Section 2. Section 3 studies the steady state implications of the interactions between large banks, monetary policy and macroprudential authority, while Section 4 discusses the impact on the determinacy of the rational expectations equilibrium. Section 5 concludes.

1. The model

I closely follow Airaudo and Pia Olivero's DSGE model (2019) with a cost channel of monetary policy but without the borrowers' bank-specific deep habits hypothesis. The closed economy consists of four different sectors: a household sector, a production sector composed of manufacturing and retail firms, a banking sector, a monetary authority and a macroprudential authority. Households take consumption-saving and labor-leisure decisions to maximize their expected lifetime utility. Monopolistically competitive retail firms subject to Calvo-type nominal rigidities produce final consumption goods using intermediate goods. Banks use households' savings to provide loans in a monopolistically competitive market. Manufacturing firms produce intermediate goods with labor as the only input. These firms use a composite of imperfectly substitutable heterogeneous loans provided by a mass one continuum of banks, $B_t(j)$, to finance working capital needs (a fraction of the wage bill has to be paid at the beginning of the period before sales revenues are realized). So, each firm borrows from all banks. The working capital requirement is given by

$$B_t(j) = aW_t^r H_t \tag{1}$$

where a denotes the credit distortion (or the share of the wage bill to be paid in advance). Households, retail and manufacturing firms' optimizing problems are identical to those of Airaudo and Pia Olivero's model (2019), so there are not reproduced here. The main differences with respect to the standard framework are in the structure of the banking sector.

Macroprudential and Monetary Authority

The macroprudential authority seeks to counter the build-up of risks during upswings and attenuate credit contraction and excessive risk-aversion in downturns in order to limit the accumulation of financial risks. In doing so, the macroprudential authority adjust its policy instruments dynamically. I follow the Basel III reform and I introduce a countercyclical capital buffer; capital requirements increase in good times (banks must hold more capital for a given amount of loans) and decrease in recessions. Hence, for capital requirements the rule is (Angelini et al., 2011; Brzoza-Brzezina et al., 2013; and Hollander, 2017).

$$V_t = V\left(\frac{Y_t}{Y}\right)^{\chi_v} \tag{2}$$

where χ_v denotes the degree of countercyclicality of the capital buffer. On the other hand, the central bank sets the nominal interest rate, reacting to endogenous variations in inflation according to the following policy rule. The parameter φ_π indicates the aggressiveness of the central bank in stabilizing inflation.

$$R_t = R\left(\frac{\Pi_t}{\Pi}\right)^{\varphi_\pi} \tag{3}$$

1.2 Banking sector with large banks

The economy is populated by a finite number of banks indexed by x where $x\epsilon(1 \dots z)$, $z \geq 2$. Thus, z^{-1} represents the degree of central interest rate setting or bank's ability to internalize the general equilibrium consequences of its interest rate decision to the aggregate variables. Note that $1 < z < \infty$ corresponds to the case of large banks, while $z \to \infty$ to atomistic banks (where there is no internalization effect). Because of $1 < z < \infty$ the representative bank anticipates that

$$\frac{dR_t^b}{dR_t^b(x)} = \frac{1}{z} \tag{4}$$

Following Benes and Lees (2007) and Gerali et al. (2010) I model market power in the banking industry assuming a Dixit-Stiglitz framework for the loan market, whereas the deposit market is perfectly competitive (i.e., the interest rate on deposits equals the policy rate R_t). Accordingly, the loan demand schedule is given by

$$B_t(j) = \left[\frac{R_t^b(j)}{R_t^b}\right]^{-\varepsilon^b} B_t \tag{5}$$

where $R_t^b(j)$ denotes the nominal loan rate of type $j \in x$, R_t^b is the nominal loan rate index defined as $R_t^b = \left[\int_0^1 R_t^b(x)^{1-\varepsilon^b} dx\right]^{1/(1-\varepsilon^b)}$ and ε^b is the elasticity of substitution among varieties of loans (market power in banking).

Banks also have to obey a balance sheet identity equating loans $B_t(j)$ to deposits $D_t(j)$ and bank's capital $K_t^b(j)$ (there is no reserve requirement). As in Gerali et al. (2010) bank's capital is accumulated out of retained earnings.

$$B_t(j){=}D_t(j) + K_t^b(\mathrm{j}) \tag{6}$$

In our setting, large banks maximize the discounted sum of their profits consist of the net interest margin (loan minus deposit interest payments) minus the quadratic cost that the bank is assumed to pay for deviating from its target leverage. The introduction of a time varying target of leverage V_t set by the Macroprudential Authority is in line with Angelini et al. (2011) and Paries et al. (2010).

$$\max \quad E_0\left\{\sum_{t=0}^{\infty}\Lambda_{0,t}^{P}\left[R_t^b(j)B_t(j) - R_tD_t(j) - \frac{\kappa_{Kb}}{2}\left(\frac{K_t^b(j)}{B_t(j)} - V_t\right)^2 K_t^b\right]\right\} \tag{7}$$

where κ_{Kb} is the first-order derivative of a decreasing and convex function measuring the costs incurred by the bank when the ratio $K_t^b(j)/B_t(j)$ deviates from V_t.

The assumption that banks have positive mass is key. Since banks are large (or non-atomistic), they take into account the impact of their loan rate policy on the aggregate variables. Therefore, the maximization takes place subject to the loan demand schedule, the bank's balance sheet constraint, the working capital constraint, the interest rate rule and the macroprudential rule for the capital requirements.

The solution to the union's problem yields the optimal loan interest rate setting equation. Hence, in a symmetric equilibrium and in log-linearized form (around the efficient steady state) [2] I obtain the expression[3]

$$\hat{r}_t^b = \hat{r}_t + \Xi\widehat{lev}_t + X\hat{v}_t \tag{8}$$

where $\widehat{lev}_t \equiv \hat{b}_t - \hat{k}_t^b$ is bank's leverage. Note also the following elasticities

$$\Xi \equiv \frac{d\hat{r}_t^b}{d\widehat{lev}_t} = \frac{e^b k_{kb}(lev)^2 r^{-1} - \Sigma r + (lev)^2 k_{kb}\Sigma v}{e^b - \Sigma r(1 - lev)} lev \tag{9}$$

$$X \equiv \frac{d\hat{r}_t^b}{d\hat{v}_t} = \frac{lev^3 k_{kb}\Sigma v}{e^b - \Sigma r(1 - lev)} \tag{10}$$

Equation (8) can be interpreted as a positively sloped loan supply schedule. It shifts with changes in the policy rate, banks' leverage and *endogenous* loan-to-capital ratio. Banks target an endogenous given leverage ratio and actively manage supply

[2] Variables in levels are denoted with capital letters, logged variables with small letters. Percentage deviations are denoted with small letters with a hat.

[3] This mechanism aims at replicating the stylized fact that banks adjust lending standards in response to their balance sheet conditions, tightening when capital constraints are binding and easing when, instead, there are no concerns about the level of their capitalization.

conditions (i.e. loan rates) in order to bring this ratio back to the desired level whenever it deviates from it.

The elasticity of policy rate to loan rate set by the z-bank is given by the following equation, with $k = (1-\theta)(1-\theta\beta)/\theta$.

$$\Sigma r \equiv \frac{dr_t}{d\pi_t}\frac{d\pi_t}{dr_t^b(j)} = \varphi_\Pi k n z^{-1} > 0 \tag{11}$$

Large banks take into account the positive impact of their loan rate to marginal cost and the subsequent reaction of the monetary authority (increase of policy rate) to the inflationary pressure. The positive sign of Σr is attributed to the presence of the cost channel. By relying to the traditional aggregate demand channel, Cuciniello and Signoretti (2015) find this elasticity to be negative. Note also that the real marginal cost is defined as

$$\widehat{mc}_t^r = \hat{w}_t^r + n\hat{r}_t^b \tag{12}$$

where the elasticity of marginal cost to loan rate variations is equal to $n \equiv d\widehat{mc}_t^r/d\hat{r}_t^b = a\mu^R/[a\mu^R + \beta(1-a)]$ and the real wage is $\hat{w}_t^r = (\sigma+\varphi)\hat{y}_t$. In our setting, the endogenous target leverage ratio is the reason d'être ofthe elasticity of the macroprudential instrument to z-bank's loan rate Σv and the parameter σ^{-1} represents the slope of the IS curve.

$$\Sigma v \equiv -\frac{r_t^b(j)}{v_t}\frac{dv_t}{dr_t^b(j)} = -\chi_v\sigma^{-1}\Sigma r < 0 \tag{13}$$

Large banks internalize not only the reaction of the monetary but also those of the macroprudential authority. Thus, because of the countercyclical capital requirements, they anticipate that their loan interest rate increase trigger the reaction of the macroprudential authority by provoking recession into the economy (see equation 2).

Another elasticity of interest is the elasticity of aggregate loan demand to the loan rate set by the representative bank Σb. Banks perceive loan pressure being driven by the economic slowdown as reducing the loan demand due to the working capital constraint.

$$\Sigma b \equiv -\frac{r_t^b(j)}{b_t}\frac{db_t}{dr_t^b(j)} = -[(\sigma+\varphi)-1]\sigma^{-1}\Sigma r < 0 \tag{14}$$

Finally, e^b represents the elasticity of loan demand to loan rate set by the z-bank

$$e^b \equiv -\frac{db_t(j)}{dr_t^b(j)}\cdot\frac{r_t^b(j)}{b_t(j)} = \varepsilon^b\left(1-\frac{1}{z}\right) + \Sigma b < 0 \tag{15}$$

The first-order condition for banks has the same form as in the standard case with atomistic banks, i.e., $\hat{r}_{t\ ATOMISTIC}^b = \hat{r}_t + k_{kb}r^{-1}(lev)^3\widehat{lev}_t + k_{kb}r^{-1}(lev)^3\hat{v}_t$ as the loan rate is set at a markup over bank's leverage and leverage ratio. However, there is one significant difference. The non-atomistic (large) banks case is characterized by the fact that these time-varying markups depend, through the aforementioned interactions between banks, monetary authority and macroprudential authority, on the degree of centralization of loan setting z^{-1}, on the central bank's aggressiveness in stabilizing inflation φ_{Π}, on the degree of credit distortion a, and on the degree of cyclicality of the macroprudential instrument χ_v. It's worth noticing that the dependences of the loan rate policy decisions on various characteristics of institutions are of vital importance to the model and drive our results; because of these, institutions will have an effect on the aggregate dynamics (New-Keynesian Phillips curve).

2. Parameterization

In order to gain insights into the effects of large banks on the steady state, the determinacy conditions, and the dynamic properties, the results are illustrated by using a calibrated case. For the baseline case the number of firms is set at $z = 3$. Table 1 summarizes this baseline parameterization.

TABLE 1
BAZELINE PARAMETERIZATION

θ	Probability of not adjusting prices	0.75	Gali and Monacelli (2005)
φ	Inverse of the elasticity of labor supply	0.25	Rotemberg and Woodford (1998)
σ	Coefficient of risk aversion	2	Chari, Kehoe, and McGrattan (2002)
β	Discount factor	0.99	Gali and Monacelli (2005)
μ^R	Steady state mark-up in loan market	0.03	Airaudo and Pia Olivero (2019)
α	Credit distortion	1	$a \in (0, 1]$
lev	Bank's leverage	0.1	Brzoza-Brzezina et al. (2013)
k_{kb}	Bank capital adjustment cost curvature.	10	Gerali et al. (2010).
$\varepsilon^b, \varepsilon$	Elasticity of substitution across loan and goods varieties	6	Airaudo and Pia Olivero (2019)
χ_v	Reaction of macroprudential instrument to output	0.9	Angelini et al. (2011)
φ_{Π}	Degree of anti-inflationary policy	1.5	Rotemberg and Woodford (1998)

3. Steady state

I focus on a zero inflation ($\Pi = 1$) non-stochastic steady-state equilibrium. Without loss of generality, I follow Brzoza-Brzezina et al. (2013) and I assume that in steady state $lev = v$. Also, from the households Euler equation, I obtain the steady-state interest rate $r = \beta^{-1}$.

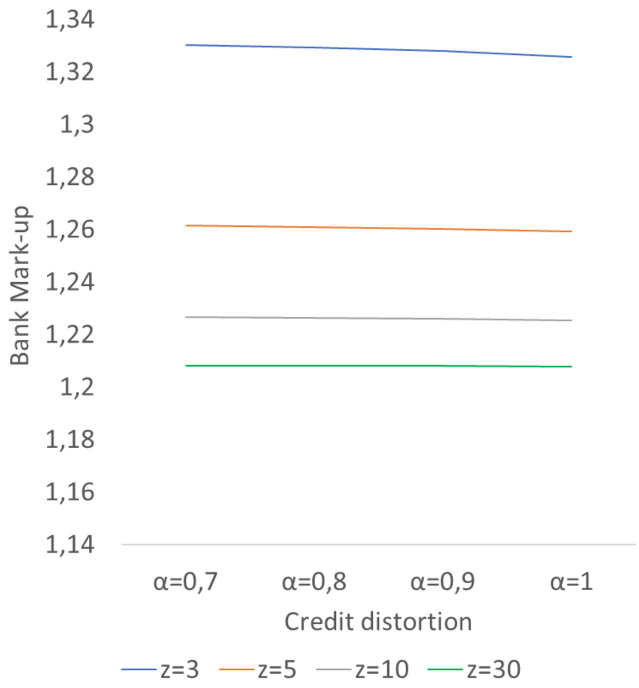
3.1 The steady- state credit mark-up

Regarding the steady state credit mark-up in the presence of large banks, $\mu^R \equiv R^b R^{-1}$, it is true that $\mu^R > 1$, that is a positive steady state credit spread, when $\Sigma r(1-lev) < 1$. The latter is confirmed for plausible parameters values.

Moreover, comparing the steady-state credit mark-up $\mu^R = [e^b - \Sigma r(1-lev)](e^b-1)^{-1}$ with the one under monopolistic competition with atomistic banks, $\mu^R_{ATOMISTIC} = \varepsilon^b(\varepsilon^b-1)^{-1}$, it is found that the former is always bigger. Moreover, this difference appears to be more significant, the larger the e^bor the lower the Σr .

Figure 1 depicts graphically the relation between the steady-state level of the bank mark-up and the level of credit distortion (a), under different assumptions regarding the number of banks, letting $z \in (3,5,10,30)$

FIGURE 1
Relation between bank mark-up and credit distortion, for different numbers of banks



It is evident that the mark-up is negatively related to the level of credit distortion, a; As the credit constraint on firms is lessened (a is increased), Σr is increased too and hence the financing costs. In addition, increased loan market concentration (low number of banks) is associated with high bank mark-up, for any given value of credit distortion.

3.2 The steady- state output level

It turns out that the strategic behavior of banks has an impact on the steady-state. Using the short-run aggregate supply, the marginal cost and the loan rate is straightforward to prove that the steady state level of output, employment, and consumption is equal to

$$Y = C = H = \left[1 + a\frac{1 - \Sigma r(1 - lev)}{e^b - 1}\right]^{-\frac{1}{\varphi+\sigma}} \tag{16}$$

Looking at the steady state level of employment - equation (4)- I would like to stress some points. First, the steady state of the model is not Pareto efficient as the output efficient level is equal to $Y^* = H^* = C^* = 1$. The working capital needs create the need for financial intermediation which takes place under monopolistic competition (credit distortion a). Imperfect substitutability of loan types and intermediate goods as well as the presence of banks drive a wedge between the marginal productivity of labor and the marginal rate of substitution, determining a suboptimal employment and output equilibrium level.

Second, as in Cuciniello and Signoretti (2015) under the presence of large banks the steady state depends on the monetary policy rule φ_Π. But, the novelty of our model is that this dependence is now a negative one. This is due to the cost channel of monetary policy. Large banks are aware of the fact that an increase on their loan rate directly affects firms' marginal cost and hence their price decisions. As a consequence, a more inflation-averse monetary authority provokes a bigger recession. In addition, in our setting, a low credit constraint on firms (high value of α) leads to high value of the elasticity of marginal cost to loan rate variations $n \equiv a\mu^R/[a\mu^R + \beta(1-a)]$; thereby reducing Σr and steady-state employment and output. This is in contrast to the standard case, where steady-state employment is positively related to credit constraint on firms (see equation 17). These considerations are summarized by the Proposition 1.

PROPOSITION 1

With large banks, Pareto inefficiency depends on the aggressiveness of the central bank in stabilizing inflation φ_Π, the degree of loan setting centralization z^{-1}, the steady state level of bank's leverage lev , and the steady state mark-up μ^R.

The model, also, nests the cases of monopolistically and perfectly competitive banking sector. Letting the number of banks tend to infinity, employment, consumption, and output are back to monopolistic competition levels.

$$\lim_{z\to\infty} H = \lim_{z\to\infty}\left\{\left[1 + a\frac{1 - \Sigma r(1 - lev)}{e^b - 1}\right]^{-\frac{1}{\varphi+\sigma}}\right\} = \left(1 + \frac{a}{e^b - 1}\right)^{-\frac{1}{\varphi+\sigma}} \tag{5}$$

When indeed there are infinitely many banks, their mass tends to zero. As a consequence, the internalization effect channel is shut down and the degree of Pareto inefficiency depends on the degree of substitutability among loan types e^b and the credit distortion a. The perfect competition result arises instead when perfect substitutability among loan types is assumed, that is

$$\lim_{e^b \to \infty} H = \lim_{e^b \to \infty} \left\{ \left[1 + a \left(\frac{e^b - \Sigma r(1 - lev)}{e^b - 1} - 1 \right) \right]^{-\frac{1}{\varphi + \sigma}} \right\} = 1 \quad (18)$$

4. Determinacy analysis

In the standard New Keynesian model, under an interest rate rule the monetary authority adjusts the nominal interest rate in response to changes in inflation. However, an interest rate rule can potentially lead to multiple equilibria, since inflation is endogenous. Furthermore, it is well known that in the presence of supply-side effects of monetary policy through the cost channel, the New Keynesian model is more prone to interdeterminacy issues. In this section, I investigate the properties of the equilibrium of the augmented with *large* banks New Keynesian model of the cost channel presented above. I derive the analytical conditions that prevent indeterminacy when the structure of the economy is purely forward-looking and the interest rate responds to current inflation[4]**.** In doing so, I highlight the significance of the internalization effect of large banks for the determinacy of the REE.

The log-linearized (around the steady state), microfounded New Keynesian sticky price model of the business cycle augmented with a cost channel, large banks, monetary and macroprudential authority, consists of the following aggregate relationships:

$$\hat{\pi}_t = \beta E_t \hat{\pi}_{t+1} + k(\sigma + \varphi)\hat{y}_t + kn\hat{r}_t^b \quad (6)$$

$$\hat{y}_t = E_t \hat{y}_{t+1} - \frac{1}{\sigma}\left(\hat{r}_t - E_t \hat{\pi}_{t+1}\right) \quad (20)$$

$$\hat{r}_t^b = \hat{r}_t + \Xi \widehat{lev}_t + X\hat{v}_t \quad (21)$$

$$\hat{r}_t = \varphi_\Pi \hat{\pi}_t \quad (22)$$

$$\hat{v}_t = \chi_v \hat{y}_t \quad (23)$$

$$\widehat{lev}_t\left(\equiv \hat{b}_t - \hat{k}_t^b\right) = -N\hat{y}_t, \text{ where } N \equiv \varphi + \sigma \quad (24)$$

Inflation dynamics are regulated by a Phillips curve (equation 19) augmented with a cost channel and the presence of large banks. With firms borrowing to pay for working capital, the interest rate of loans enters the Philips curve, revealing the role of the internalization effect on inflation. Hence, it turns out that in the context of the cost channel of monetary policy and under the presence of large banks, new factors drive

[4]For determinacy, the number of eigenvalues of Γ1 (matrix of endogenous variables which are non-predetermined) outside the unit circle must equal the number of non-predetermined endogenous variables (Blanchard and Kahn; 1980).

marginal cost and hence inflation. The dynamic IS curve is standard and given by equation (20). Also, an auxiliary equation for $\widehat{lev}_t$ is defined[5].

By using Woodford's (2011) methodology for determination of necessary and sufficient condition of equilibrium, determinacy under a current-looking interest rate rule and in the presence of large banks, the necessary and sufficient condition for the existence of a unique rational expectation equilibrium path converging to the steady state of the economy is

$$1 < \varphi_{\Pi} < \frac{2\sigma(1+\beta) + k[(\sigma+\varphi) - \Xi N + X\chi_V]}{k(\sigma - \varphi + \Xi N - X\chi_V)} \tag{25}$$

The case of a current inflation-targeting rule, when only the demand channel of monetary policy matters, has been previously analyzed by Bullard and Mitra (2002), Carlstrom and Fuerst (2000) amongst others. In particular, for $n = 0$ (there is no cost channel of monetary policy), monetary policy should be active and follow the standard Taylor Principle with no lower bound $\varphi_{\Pi} \in (1,\ \infty)$. On the other hand, due to the borrowing constraint faced by firms, the Central Bank should be active and follow the standard Taylor Principle, with an upper bound on its responsiveness to inflation in the Taylor rule[6]. The reason for this is that increasing rates do not guarantee lower marginal costs. When the cost channel also matters an increasement in the policy rate not only impacts negatively on aggregate demand, but also has a positive impact on aggregate supply (Llosa and Tuesta 2009; Bruckner and Schabert; 2003).

$$1 < \varphi_{\Pi,\ ATOMISTIC} < \frac{2\sigma(1+\beta) + k(\sigma+\varphi)}{k(\sigma-\varphi)} \tag{26}$$

Comparing condition (25) with (26) provide us with interesting insights. In particular, in my model this upper bound is a negative function of the banks' incentive for aggressive loan setting, parameter Ξ. The latter observation leads us to Proposition 2.

PROPOSITION 2

A banking sector featuring aggressive large banks reduce the indeterminacy region, i.e., the less aggressive should be active monetary policy to guarantee that REE is unique.

5. Conclusions

This study suggests the stabilization role of the banking institutions and reveals the implications of interactions among large banks, the monetary authority and the

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[5] Using $\widehat{w}_t^r = (\varphi + \sigma)\hat{y}_t$ into the log-linearized liquidity-in-advance-constraint yields $\hat{b}_t = (1 + \varphi + \sigma)\hat{y}_t$. Moreover, the cash-in-advance-constraint can be written as $\hat{d}_t = (\varphi + \sigma)\hat{y}_t$. Replacing the last two equations into the log-linearized balance sheet constraint, equation (6) yields equation (24).

[6] As long as $\sigma > \varphi$ the cost channel dominates the demand channel of monetary generating an upper bound on interest rate.

macroprudential authority in business cycle stabilization. Earlier contributions on monetary policymaking in the presence of cost channel do not investigate these interactions.

In particular, it is shown that under the presence of large banks, the way in which the central bank and the macroprudential authority systematically behaves, the severity of the firms' credit constraints, the degree of loan rate setting centralization, have an impact on the long-run equilibrium of the model and on the determinacy of the rational expectations equilibrium.

Furthermore, the recent experience implies that negative policy rates have become part of the central banker's toolbox, and calls into question the relevance of the zero-lower bound (ZLB). Following the crisis of 2008, several central banks engaged in a new experiment by setting negative policy rates**.** Understanding how the introduction of these interactions between (large) banks and the macroeconomic authorities alter the optimal implementation of monetary policy in such a low interest rate environment is worth of further efforts in the literature.

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