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Macroprudential policy in a DSGE model: anchoring the countercyclical capital buffer

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Abstract

This paper focuses on the choice of the variable to which the macroprudential instrument must respond - the anchor variable. We input different macroprudential rules into the DSGE with a banking sector proposed by Gerali et al. (2010), and estimate its key parameters using Bayesian techniques applied to Brazilian data. We then rank the results using the unconditional expectation of lifetime utility as of time zero.

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1. Introduction

Many papers have assessed the introduction of macroprudential policy in a dynamic stochastic general equilibrium (DSGE) model. Nevertheless, most of them focus on the interaction of macroprudential and monetary policies without delving into the macroprudential policy itself (e.g., Angelini et al. (2012), Suh (2012)).

On the other hand, Drehmann et al. (2011) use a Signal Extraction Method to investigate the performance of different variables as anchors for setting the level of the countercyclical regulatory capital buffer requirements for banks. They conclude that the best leading indicator is the credit-to-GDP gap, whereas the best coincident indicator is banking spread. Still, the Basel Committee suggests the use of credit-to-GDP gap as an anchor variable for both periods. However, Repullo and Saurina (2011) argue that the use of such variable may exacerbate procyclicality inherent in the financial system and recommend the use of output growth.

To our knowledge, there are no papers that utilize a DSGE model to inquire into the effects of different anchors in the countercyclical capital requirement rule (henceforth just macroprudential rule) on some important macroeconomic variables. The available studies simply take a given rule for granted and then proceed to the step where they evaluate its effects and relationship to monetary policy.

In order to fulfil this gap and to bring together the two strands of literature, we input different macroprudential rules into the DSGE proposed by Gerali et al. (2010). Since DSGE models can be used to analyse and understand the mechanisms through which exogenous shocks (e.g., destruction of bank capital) are transmitted to the real economy, how macro variables react to aggregate shocks and the transmission channels of different economic policies, we believe that it is important to complement the analysis made by Drehmann et al. (2011) addressing the choice of the anchor variable in a DSGE.

The model is estimated for the Brazilian economy. Brazil is an important emerging market and it is an interesting case study for the issues raised in this paper. Brazil has been an early adopter of macroprudential tools and has been widely recognized by its prompt reaction to the 2007-8 financial turmoil (International Monetary Fund, 2013).

The rest of the paper is organized as follows. Section 2 describes the model. Section 3 describes the data and presents the results of the estimation. Section 4 presents the application and the welfare analysis. Section 5 concludes.

2. Model

We take the DSGE model developed in Gerali et al. (2010) as the reference for our analysis. Angelini et al. (2012) have already introduced a macroprudential rule in this model, but they do not focus on the choice of the anchor variable.

Gerali et al. (2010) add monopolistically competitive banks to a model with credit frictions and borrowing constraints as in Iacoviello (2005) and a set of real and nominal frictions as in Christiano et al. (2005) and Smets and Wouters (2003). It fits well to Brazil because there is evidence that Brazilian banks are positioned somewhere between perfect competition and cartel arrangement showing some market power (Nakane, 2002).

We briefly describe the model highlighting those elements related to the way macroprudential policy operates in our setting. For a detailed description of the model see Gerali et al. (2010) and the extended working paper version of this paper Ferreira and Nakane (2015).

The economy is populated by patient and impatient households, and by entrepreneurs. The heterogeneity in agents' discount factors generates positive financial flows in equilibrium. Patient households have larger discount factors and will be net savers in equilibrium whereas impatient households will be net borrowers in equilibrium. Patient households deposit their savings in banks. Impatient households and entrepreneurs borrow, subject to a binding collateral constraint. All households consume, work and accumulate housing, while entrepreneurs produce consumer and investment goods using capital and labor as inputs. Housing services yield utility to the households. Impatient households and entrepreneurs face additional budget constraints relating their assets to their debt.

Banks set interest rates on deposits and on loans to maximize profits. Their assets include loans to firms and to households, and their liabilities are deposits and capital. Banks also face a balance-sheet constraint: there is a target for capital-to-assets ratio they have to observe. This target (set at a fixed level in Gerali et al. (2010)) is precisely our macroprudential instrument.

The interest rate on loans to credit-constrained households and entrepreneurs is as follows:

$$r_t^{bs} = \frac{\varepsilon_t^{bs}}{\varepsilon_t^{bs}-1}\left[r_t - \kappa\left(\frac{K_t^b}{B_t} - v_t\right)\left(\frac{K_t^b}{B_t}\right)^2\right] + Adj_t^{bs} \tag{1}$$

where $\varepsilon_t^{bs} > 1$ is the elasticity of loan demand and s indexes the agent, r_t is the policy interest rate, K_t^b is the bank capital[1], B_t is the sum of risk-weighted loans to entrepreneurs and to households, v_t is the target for the bank capital-to-assets ratio, κ parameterizes the quadratic cost paid by the banks when they deviate from the target v_t, and Adj_t^{bs} captures the cost of adjusting loan rates.

It is assumed, as in Carvalho et al. (2013), that there is no markdown over the policy rate:

$$r_t^d = r_t \tag{2}$$

Loan demand elasticities are crucial in determining the spreads between the policy rate and the lending rates. The bank's trade-off can be seen in the equation that shows overall bank profits (in real terms). The greater the distance between $\frac{K_t^b}{B_t}$ and v_t, the lower the bank profits. However, the larger b_t^H and b_t^E, the higher the profits.

As the business cycle affects bank profits and, therefore, capital (accumulated out of retained earnings), there is room for active policies aiming to mitigate its effects on the real economy.

Equations (1) and (2) show that monetary and macroprudential policies have potentially different roles. Policy rate affects the deposit rate and the loan rate; macroprudential policy only affects the loan rate giving greater freedom to the policymaker. If there is a need to affect differently savers and borrowers, the authority in question can change only v_t.

3. Estimation

We apply standard Bayesian Methods to estimate model parameters without macroprudential policy[2]. Since there is not much literature regarding the parameters driving the banking

[1] Bank capital establishes a link, crucial to the model, between credit supply and the economic cycle. In "good" times, retained earnings increase bank capital stock allowing the soaring of loans, while in "bad" times, when profits are smaller, bank capital shrinks leading to a contraction of loan supply further fuelling the crisis.

[2] We only add macroprudential policy to the model after the estimation is complete. In the sample period, there was no countercyclical capital buffer in Brazil. Thus it is possible to properly recover some unknown parameters from the banking sector.

dynamics in Brazil, we decided to focus our estimation on these parameters, while we calibrate the others. We present more details in the longer working paper version of this paper (Ferreira and Nakane, 2015).

3.1. Data

The model is estimated for the Brazilian economy. We use 9 observables: real consumption, real investment, inflation, deposits, loans to households and to firms, interest rates on loans to households and firms, and the overnight rate. The sample period is 2000q3-2012q4. Data with a trend are made stationary using one-sided HP filter[3], while the inflation rate is demeaned and interest rates are demeaned using the mean overnight growth rate (Pfeifer, 2014).

3.2. Calibrated Parameters

As in Castro et al. (2011) we set the discount factor of patient households at 0.989. We assume that the discount factors are the same for impatient households and entrepreneurs and we set them at 0.95 as in Iacoviello (2005). The target capital-to-loans ratio is set at (16%). The interest rate elasticities were calibrated so as to match the interest spread found in the Brazilian economy. Furthermore, LTV ratios were calibrated in order to generate the credit-to-GDP ratio found in the data. All other parameters follow studies for the Brazilian economy[4].

3.3. Prior and Posterior Distributions

The prior distributions follow mainly Gerali et al. (2010). The posterior mean and median, and the standard deviations of the estimated parameters are reported in the working paper version of this paper (Ferreira and Nakane, 2015). The habit coefficient and the investment adjustment cost values are close to the values found in Castro et al. (2011). The shocks are rather persistent. In the following section, parameter values are set at the posterior median.

4. Applications

This section discusses optimal macroprudential policy after an unexpected destruction of 5% of bank capital. Such shock is introduced in the bank capital accumulation equation:

$$\pi_t K_t^b = (1-\delta^b)\frac{K_{t-1}^b}{\varepsilon_t^k} + j_{t-1}^b \quad (3)$$

in which ε_t^k is the financial shock[5].

First, the anchor variables are ordered using a measure of welfare. Then the impulse response functions of the model that displays the best results will be presented. Thus, it is possible to better understand the propagation mechanism of bank capital destruction and the best way to mitigate its effects.

[3]Smoothing parameter equal to 1,600.

[4]Risk responses to output were set to zero in the estimation.

[5]For this exercise, we set $\bar{\nu}$ at 13%, the required level when the countercyclical capital buffer is on.

4.1. Welfare

Welfare analyses have recently been increasingly used to measure the benefits of macroprudential policy (e.g., Rubio and Carrasco-Gallego (2014) and Laseen et al. (2015)). The optimal combination of monetary and macroprudential policies is here obtained by a second order approximation of the equilibrium.

The welfare measure is the unconditional expectation of average household utility given initial values. Aggregated welfare is given by:

$$E_0 V = E_0 \{V_P + V_I + V_E\} \tag{4}$$

in which V_P is the expectation of patient households' lifetime utility, V_I is the expectation of impatient households' lifetime utility and V_E is the expectation of entrepreneurs' lifetime utility.

As in Schmitt-Grohe and Uribe (2007) and Suh (2012), policy rules are easily implementable because they are functions of observable macroeconomic indicators. The Taylor rule is standard:

$$r_t = (1-\rho_R)\bar{r} + (1-\rho_R)[\chi_\pi(\pi_t - \bar{\pi}) + \chi_y(y_t - y_{t-1})] + \rho_R r_{t-1} \tag{5}$$

Macroprudential rule has a very similar format, being a function of the anchor variable:

$$v_t = (1-\rho_v)\bar{v} + (1-\rho_v)\chi_v X_t + \rho_v v_{t-1} \tag{6}$$

X_t is what we call anchor variable. Anchor variables can be seen as proxies for the cyclicality that the instrument is designed to mitigate. Since there is more information in the literature about monetary policy parameters (χ_y and χ_π), they are restricted to a small range: χ_y between 0 and 3 and χ_π between 1 and 3. The macroprudential policy parameter, about which there is greater uncertainty, is restricted to a broader range: (χ_v) between 0 and 10.

The range for χ_v is partitioned with grids of size 2 and the ranges for all the other parameters are partitioned with grids of size 0.2. Macroprudential policies are assumed to have inertia ($\rho_v = 0.9$) (Suh, 2012). For each combination of parameters, the welfare $E_0 V$ is calculated. The optimal policy is the one that presents the greatest welfare subject to the ranges mentioned.

The anchor variables used in the exercise are some of the variables classified as macroeconomic by the Basel Guide: GDP growth, credit growth, credit-to-GDP growth, risk-weighted credit growth, GDP gap, credit gap, credit-to-GDP gap and risk-weighted credit gap. Then we have nine possible cases: "the monetary policy" (benchmark) and eight models with different anchor variables.

Table I suggests that the introduction of macroprudential policy (MaP) generates welfare gains. The variables are ranked according to the welfare: (1) is the variable that produces the highest welfare and (5) the lowest. The "gap variables" have no benefit in terms of welfare compared to the case with only monetary policy[6].

On the other hand, the most effective macroprudential policy in terms of welfare is the one which uses credit growth as an anchor variable. It is as if target and objective coincide: in order to avoid a drop in credit that would be detrimental to the economy, the relevant authority must be attentive to the behaviour of credit itself.

[6] We also run a model in which we set monetary policy parameters at the calibrated values ($\chi_y = 0.16$ and $\chi_\pi = 2.43$), allowing only χ_v to vary. The optimal choice for χ_v in this scenario is zero, but, as expected, the agents are worse off (they could have chosen these values, but they have not).

Table I. Welfare for different combinations

	Optimal Parameters				
	Taylor		MP		
	χ_π	χ_y	χ_v	Welfare	
Taylor only	1.1	0.5	-	-143.2689	(5)
Taylor + MaP GDP growth	1.1	0	10	-143.2448	(4)
Taylor + MaP Credit growth	1.1	0	10	-142.9508	(1)
Taylor + MaP Risk-weighted Credit growth	1.1	0	10	-142.9527	(3)
Taylor + MaP Credit-to-GDP growth	1.1	0	10	-142.9523	(2)
Taylor + MaP GDP gap	1.1	0.5	0	-143.2688	(5)
Taylor + MaP Credit gap	1.1	0.5	0	-143.2688	(5)
Taylor + MaP Risk-weighted Credit gap	1.1	0.5	0	-143.2688	(5)
Taylor + MaP Credit-to-GDP gap	1.1	0.5	0	-143.2689	(5)

Using an alternative approach (Bayesian Structural Time Series Models in 34 countries), Gonzalez et al. (2015) also find that the credit-to-GDP gap is dominated by the credit-to-GDP growth. According to them, the credit-to-GDP growth exhibits results as accurate as those of the BCBS indicator and lower noise-to-signal ratios.

The result is similar to the one proposed by Akerlof and Shiller (2009), who defended a credit target as a means of mitigating the effects of the recent international financial crisis on the economy. According to them, while the credit crunch lasts, multipliers are much smaller than in normal conditions. Thus, avoiding credit contractions (and consequently multipliers reduction), the need for too large fiscal and monetary stimulus is reduced.

However, the effects of the new policy differ among agents. If given a choice, patient consumers would prefer the regime in which only monetary policy operates, as it ensures greater welfare. On the other hand, entrepreneurs and impatient consumers would choose the regime that combines monetary and macroprudential policies. Thus, the ordering of welfare is sensitive to changes in the weights.

Figure 1 displays the welfare when the anchor variable is credit growth. The axis on the right side displays the range for χ_v and the axis on the left side displays the range for χ_y[7]. The larger χ_v and the lower χ_y, the larger the welfare, implying that when the response of the

[7]From 0 to 10 with grids of 2 results in 6 elements for the range of χ_v. The same reasoning applies for χ_y

countercyclical capital buffer to the anchor variable is strong, there is no need for monetary policy to react.

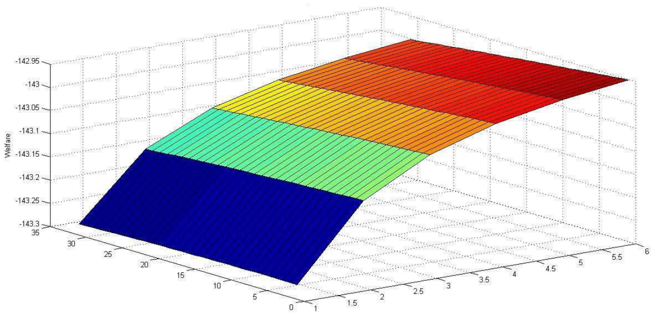

Figure 1: *Anchor: credit growth*

The following subsection presents the impulse response functions of the model with credit growth as an anchor variable. The parameters of monetary and macroprudential policies were set at the associated optimal policy values ($\chi_y = 0$, $\chi_\pi = 1.1$ and $\chi_v = 10$)[8]. It will be compared to the model with only monetary policy that has the parameter values set at $\chi_\pi = 1.1$ and $\chi_y = 0.5$.

4.2. The Effects of a Bank Capital Loss

Figure 2 displays the impact of a bank capital loss on some important macroeconomic variables.

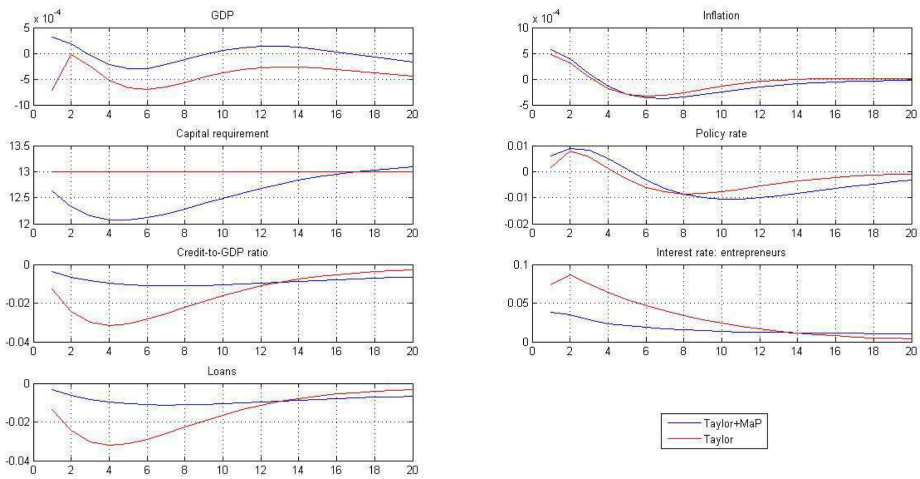

Figure 2: *Anchor: credit growth versus Taylor only*

After the shock, banks face higher costs linked to its capital position and pass it to the interest rates on loans, weakening the demand for credit. The contraction of loans leads to a reduction in the level of investments and product. However, the interest rate charged on loans

[8]Taking into account the inertia parameter, this implies a response 4 times more reactive than the intended: according to Basel Committee on Banking Supervision (2010), when the gap is 10% or larger, the buffer add-on is at its maximum (2.5%).

to entrepreneurs increases less in the case with macroprudential policy because the capital requirement also decreases, reducing costs related to the bank's capital position. This, in turn, results in a lower decrease of loans when macroprudential policy operates.

Thus, the performance of monetary and macroprudential policies reduces the impact that the original destruction of bank capital has on the economy, mitigating the feedback process. As Gerali et al. (2010), the magnitude of the change in the trajectory of variables is greatly reduced. This occurs for two reasons. First, because the shock was calibrated to generate a relatively small bank capital loss. Second, because the shock is unique and disregards other shocks potentially generated by it.

5. Conclusion

We have examined the process of choosing the best anchor variable in a DSGE model. Unlike studies that focus on the regulatory issue, our analysis was focused on the behavior of macroeconomic variables and welfare. We believe that both aspects should be complementary.

In order to fulfil this gap, we input different macroprudential rules into the DSGE proposed by Gerali et al. (2010). We estimate the model for the Brazilian economy, and then we sort the results using a measure of welfare given by the unconditional expectation of lifetime utility as of time zero: the larger the welfare, the better the anchor variable. Credit growth is the variable that performs best.

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