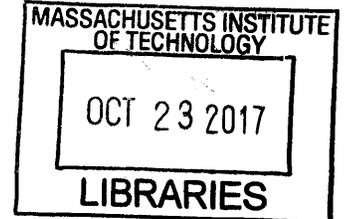# Private and Government Banks: A DSGE Approach

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PRIVATE AND GOVERNMENT BANKS: A DSGE APPROACH

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Abstract

This paper studies the role of public banks in a Dynamic Stochastic General Equilibrium (DSGE) model with heterogeneous financial intermediaries. In accordance with the empirical literature on the subject, this study shows that the presence of public banks alter the reaction of the aggregate variables to negative shocks relative to standard DSGE models. Namely, the economy is able to recover faster following negative shocks due to the less pro cyclical behavior of government banks. The paper shows that ignoring this dimension of heterogeneity may render misleading assessments and conclusions regarding economic variables like GDP, consumption, investment, labor, etc.

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1 Introduction

Governments are major financial institutions. State-owned banks, in particular, are present in most emerging economies and some developed ones. The public nature of state-owned banks has been, however, largely ignored by equilibrium models with financial intermediaries. This raises some questions: Does the presence of public banks matters for modeling an equilibrium model? Do they behave differently than private banks during recessions? And if they do, is this different behavior big enough to justify modeling public banks?

The next table from La Porta et al (2002) shows that those banks are big enough to potentially affect macroeconomic variables like GDP, consumption, investment, labor, etc.

Table 1: Government banks, share of assets of the top 10 banks. La Porta et al (2002).

Country	Share
Argentina	60.5
Belgium	27.6
Bolivia	18.5
Brazil	31.7
Chile	19.7
China	99.5
Colombia	53.9
Costa Rica	90.9
Ecuador	40.6
Egypt	88.6
El Salvador	26.4
France	17.3
Germany	36.4
Guatemala	22.2
Honduras	29.9
Israel	64.6
Italy	36
Nicaragua	63.4
Paraguay	48
Peru	26.5
Poland	84.3
Portugal	25.7
Taiwan	76.5
Thailand	17.1
Turkey	56.5
Uruguay	68.8

On the other hand, the literature shows that government banks seem to be different from private ones. Levy-Yeyati et al (2004) classify four different reasons of why state-owned banks can be different from their private counterparts. Those reasons are the social, the development, the political and the agency view. The first one justify the presence of public banks in order to ameliorate the market imperfections. According to this theory public banks would finance project with high social return

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but low private one (Atkinson and Stiglitz (1980), Stiglitz (1994)). The development view, identified with Gerschenkron (1962) says that public banks are necessary to provide capital in economies with low rates of capital in order to facilitate economic development. The political view establishes that politicians use public banks to achieve their own political goals (La Porta et al (2002)). Finally, the agency view is based in a social welfare-maximizing bank but where it may exists corruption and misallocation (Banerjee, 1997; Hart et al, 1997). This view explains the role of weak managerial incentives. According to this the ultimate efficiency of public banks depends on the trade off between internal an allocative efficiency (Tirole, 1994).

Under a different point of view, which one is not among the presented above, Micco and Panizza (2006) argue that government banks are apparently less pro cyclical than their private counterparts[1]. This would be especially important in a financial model, since this kind of behavior could potentially imply a different reaction of the whole economy after a negative shock. Following these explanations, the assumption of modeling banks as homogeneous might be wrong.

Taking this evidence, this paper develops a DSGE economy composed of privates and governments banks. The latter behave differently during recession in the dimension that they receive money from the government in order to continue making loans to firms. The model is similar in results to that of Aliaga-Diaz and Olivero (2012). However, different from that paper, this study adds to the framework government banks and households without access to the financial market. The government bank plays two roles in the model: The first one is to transfer resources to financially constrained households through money given by the government taken in part from these banks profits, and the second one is to keep lending to firms during recessions, when private banks cut lending down.

This paper does not conduct a welfare analyses and the model results are not normative. Therefore this study does not argue in favor or against the existence of public banks. The paper is focuses on 'finding out the changes on the economy behavior when this new kind of heterogeneity in the financial sector is incorporated.

The paper is organized as follow: The first section is this introduction, the second part is a literature review of the most relevant papers about private and public banks, the third section is the develop of the DSGE model, the fourth part is the presentation of some simulations and results and the final part are some conclusion.

2 Literature Review

The existing literature has focused on whether or not private and public banks are empirically different, and on whether theses differences can have aggregate effects.

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[1]A good example of this behavior are Chilean Government policies after the Subprime crisis in 2009.

Moreover, to the best of my knowledge, a general equilibrium model with a specific role for government banks has yet to be developed. Such a model could be used to determine whether the presence of these intermediaries impacts the transmission of negative shocks.

La porta et al (2002) uses a cross section of different countries in order to evaluate the effect of different variables on government ownership and how this affects measures of development, economic growth and productivity. They show initially that public banks are very relevant in terms of their asset holdings across the world. 59% of the equity of the 10 largest banks was owned by the government in 1970, and 42% was still state-owned in 1995. According to this paper, a government can participate in the financing of firms in a variety of ways: it can provide subsidies directly, it can encourage private banks through regulation and suasion to lend to politically desirable projects or it can own financial institutions, completely or partially. The paper works with two different views about government ownership. One is the development one in which the government provides resources to finance socially desirable projects that cannot get funds from private banks. The other view is the political one in which the government banks give resources to political connected firms in order to achieve political goals.

First of all they run a regression where the dependent variable is the percentage of government ownership of a bank. They find that this percentage is bigger in countries that were poorer in 1960, and more interventionist in the sense of heavier regulation, higher frequency of price controls, heavier banking regulation, and higher black market exchange rate premium (this controls for initial per capita income). There is no relationship between government ownership and the size of this, measured by government consumption or government transfers and subsidies relatives to GDP. The percentage is lower in countries that have wider political rights or are more democratic. This supports the view that in democratic environment the government is less able to use the banks they own to redistribute wealth to political supporters given that they are subject to greater oversight by the electorate. On the other hand countries with greater security of property rights (property rights index, rule of law, and the likelihood of government repudiation of contracts) have lower government ownership. In a second type of regressions, using different dependent variables regarding development, economic growth and productivity and as an independent variable the percentage of government ownership of a bank, they find that higher ownership of banks is associated with slower subsequent development of the financial system, lower economic growth, and lower growth of productivity.

Sapienza (2004) uses information from individual loan contracts in Italy to study the effect of government ownership on bank lending behavior. Lending by these banks is conditional on the information that is available for both public and private banks. The paper finds that state-owned banks charge a lower interest rate than privately owned banks. These results are explained in by political issues. The behavior is even present for banks that are able to get loans from both private and state-owned

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banks. The paper finds as well that companies located in the south of Italy benefit more by borrowing to public banks than do companies in the north. Finally and contrary to a social view state-owned banks favor more large enterprises.

Levy Yeyati et al (2004) ask the question of whether the government should be in the banking business at all. They find that public banks can have both positive and negative consequences for the economy. They might stabilize the business cycle through their less procyclical credit supply and can play a role in the development of some incipient areas in the economy, but they might also be controlled by political groups whose primary interests are not promoting stability and development, but spending resources in order to stay in power. The authors point to the necessity of a theoretical model to address the causal relationship between the presence of public banks and aggregate variables in the economy.

Micco and Panizza (2006) evaluate the cyclicality of lending by private and public banks. They find that credit provided by public banks is less responsive to macroeconomic shocks than that by private banks. They present four possibilities for that. The first one is that macroeconomic stability is itself a objective of the government, and public banks lend to achieve this goal. The second one is that depositors may perceive public banks as safer since they count on a full deposit insurance (implicit or explicit). The third possibility is that state-owned banks are poorly managed, and they don't cut lending down when they should. The final potential explanation is that politicians redirect the lending of public banks in order to achieve their political goals.

Micco et al (2007) address the question of whether there are differences in performance between private and public banks and if these differences are higher in election times. The authors find that public banks are less profitable and have higher cost than private banks only in developing countries. Furthermore the difference is bigger in election times. To measure the dependent variable (Performance) they use ROA, interest margins, overhead costs and employment. Two explanations for the finding that public banks are less profitable and have higher costs than private banks only in developing countries are: Industrial countries are better equipped to deal with the distortions that arise from government ownership of banks (governance issues are less serious in these countries) and that public banks in high income countries have ceased to play a development role so they are just like a private bank, whereas in developing countries this role is still very important so they respond to a social mandate rather than to a profit maximization.

In a recent paper, Christiano A. Coelho, Joao M.P. de Mello and Leonardo Rezende (2013) use a Brazilian database to address the question of whether public banks increase competition in the banking sector of local and concentrated market. They find that public banks do not exert pressure over the competition in the banking sector in comparison to private banks. The authors use an empirical strategy where they identify the effects of public banks in the profit of private banks controlling for

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size, number of public and private banks and demand and supply shifters. Looking for an explanation about what could potentially explain this phenomenon, they find that it could be a differentiation in mandates between public and private banks and a higher cost for public banks. Specifically public banks in Brazil are obligated to issue mortgages and rural credits. On the other hand costs are 46% higher for public banks than for private ones.

3 The Model

The model is a DSGE economy based on Aliaga-Diaz and Olivero (2012) and Galindo (2011). This is characterized by six types of agents: Households with access to the financial market, households without access to financial markets, firms, public bank, private banks, and the government. The novel idea is the incorporation of public and private banks into the same model as different financial intermediaries. This is motivated by the importance as evidenced by the data and in the literature reviewed in the previous section. The behavior of the agent in the economy is described as it follows:

3.1 Households

We have two types of households: Ricardian which make a λ percent of the population and Non-Ricardian. The first kind of households has access to the financial market, through the possibility of making deposits every period. Furthermore they are able to buy stocks from private banks. The second type of family does not have access to the banks or to purchase stocks so they spend all their income on consumption.

3.1.1 Ricardian Households

The Ricardian household faces the following dynamic problem[2]

$$\max_{c_{r,t}, l_{r,t}, D_{t+1}, s_{t+1}} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c_{r,t} - \frac{l_{r,t}^{\omega}}{\omega}\right)^{1-\theta}}{1-\theta} \tag{1}$$

s.t.

$$(1+r_t)D_t + w_t l_{r,t} + \left[\frac{div_t^p}{s_t} + p_t\right] s_t \geq c_{r,t} + D_{t+1} + p_t s_{t+1}. \tag{2}$$

Where $c_{r,t}$ is consumption done by the Ricardian household, $l_{r,t}$ is labor hours, r_t is the deposit rate, D_t are the deposits carried out either in private or government

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[2]This utility function is taking from Greenwood et al (1988) and it is used because this allow us to solve for a labor supply net from wealth effects.

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banks, w_t is the wage rate, div_t^p is the dividend given by private banks to the Ricardian household, s_t is the number of shares from private banks and p_t is the price of the stock, which in this case is one share of a private bank.

Solving the problem, we get the following three optimal conditions for the labor hours, consumption and stock purchases along the optimal path, respectively:

$$l_{r,t}^{\omega-1} = w_t, \tag{3}$$

$$\left(c_{r,t} - \frac{l_{r,t}^{\omega}}{\omega} \right)^{-\theta} = \beta E_t(1 + r_{t+1}) \left(c_{r,t+1} - \frac{l_{r,t+1}^{\omega}}{\omega} \right)^{-\theta}, \tag{4}$$

$$\left(c_{r,t} - \frac{l_{r,t}^{\omega}}{\omega} \right)^{-\theta} = \beta E_t \frac{1}{p_t} \left[\frac{div_{t+1}^p}{s_{t+1}} + p_{t+1} \right] \left(c_{r,t+1} - \frac{l_{r,t+1}^{\omega}}{\omega} \right)^{-\theta}. \tag{5}$$

The first condition is the usual static condition for hours worked. The second condition is the Euler equation for optimal consumption where the important interest rate is the deposit rate and the third condition is the Euler equation for stocks allocation, where the important rate for moving resources from one period to other periods is the return on the asset given by $\frac{1}{p_t} \left[\frac{div_{t+1}^p}{s_{t+1}} + p_{t+1} \right]$.

3.1.2   Non Ricardian Households

As previously mentioned and following Galindo (2011), these households do not have access to the financial market and they do not buy stocks from private banks. Therefore the government will provide transfers, which will be especially important during recessions. These transfers will be financed through taxes and the dividends coming from government banks. Given this, the optimization problem for Non Ricardian households is the following:

$$\max_{l_{nr,t}} E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left(c_{nr,t} - \frac{l_{nr,t}^{\omega}}{\omega} \right)^{1-\theta}}{1 - \theta} \tag{6}$$

s.t.

$$w_t l_{nr,t} + tr_t = c_{nr,t}. \tag{7}$$

Hence these households consume their whole income every period, which is composed by salaries coming from hours worked $l_{nr,t}$ and by the transfers given by the government tr_t. Accordingly the optimal equations for these households are:

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$$l_{nr,t}^{\omega-1} = w_t, \tag{8}$$

$$w_t l_{nr,t} + tr_t = c_{nr,t}. \tag{9}$$

3.2 Firms

Firms produce the final product in this economy. To finance their capital through investment, they have to borrow money from banks. Moreover, these firms are exposed to an aggregate productivity shock. The presence of this shock implies that credit plays an important role in maintaining real activity in the economy, especially during a recession.

For the firms, the optimal plan is obtained by solving:

$$\max_{I_t,l_t,L_{t+1}} E_0 \sum_{t=0}^{\infty} \left[\prod_{j=0}^{t} \frac{1}{1+r_j} \right] [Y_t + L_{t+1} - w_t l_t - (1+i_t)L_t - I_t] \tag{10}$$

s.t.

$$Y_t = A_t K_t^\alpha l_t^{1-\alpha}, \tag{11}$$
$$K_{t+1} = (1-\delta)K_t + I_t, \tag{12}$$
$$L_{t+1} = K_{t+1}, \tag{13}$$
$$log(A_{t+1}) = \rho log(A_t) + \epsilon_{t+1}, \quad \epsilon_{t+1} \sim N(0,\sigma^2). \tag{14}$$

Where A is total factor productivity, K is the level of capital, l is labor, L is the level of loans financed by banks, i is the interest rate on loans, I is the investment level, δ is the depreciation rate, ρ a parameter that measures the persistence of the shocks, and ϵ is the productivity shock.

As we can see, the firm maximizes profits subject to the typical movement equation for capital, the productivity process and, most importantly, a constraint that implies that the firm is not able to finance its investment with own resources. This constraint implies that, after a negative shock, output may be reduced further as banks reduce their supply of credit.

Given the optimal problem for the firm, the optimal equations are given by:

$$(1-\alpha)\frac{Y_t}{l_t} = w_t, \tag{15}$$

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$$E_t \left[\frac{1}{1 + r_{t+1}} \left(\alpha \frac{Y_{t+1}}{K_{t+1}} - (\delta + i_{t+1}) \right) \right] = 0. \tag{16}$$

Where the first equation is the usual marginal productivity of labor equal to the wage rate, and the second shows the optimal decision for capital. As we can see, in the second equation it appears the interest rate for loans given that this is the mechanism the firm uses to finance its investment decisions.

3.3 Banks

There are two kinds of banks: private and government-owned banks. Both issue loans to firms and receive deposits from Ricardian households. Motivated by the empirical literature, the objective function for both kinds of banks is the same. However, public banks differ from private banks in two dimensions. The first one is that one part or their profits goes back to the government and is used in part to fund transfers to the non-Ricardian households. The second one is that the government can capitalize those banks in special periods (e.g. recessions) in order to stabilize the economy.

It is worth noting that those two facts are taken directly from the empirical literature where it is found that government banks can be a big contribution in term of stabilization during recession, Micco and Panizza (2006), Altavilla et al (2016). This because of those banks are non as pro cyclical as the private ones.

Through these two differences, government banks potentially affect the economy in two different ways. The first is through the money they provide to the government that can be converted into transfers, which allows households to smooth consumption in a better way given their constraints. The second is the possible capitalization of public banks during recessions. This allows those banks to keep providing loans to firms after a negative shock, which potentially helps in overcoming the shock faster and without a bigger decrease in the production of final goods.

It is important to notice that there is a trade off in these two decisions. Given that the government has budget constraint, to provide money to the banks implies less money in transfers to consumers and vice versa.

3.3.1 Private Banks

There are a ϕ percent of private banks in this economy. Those banks maximize the expected dividend subject to balance sheet constraints. The problem is as follow:

$$\max_{D^p_{t+1}, L^p_{t+1}, RE^p_t} E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} q_j{}^3 \left[(1 - \tau)(i_t L^p_t + \phi \pi^f_t - r_t D^p_t) - RE^p_t \right] \tag{17}$$

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[3] $q_t = \beta \frac{u_c(c_t, l_t)}{u_c(c_{t-1}, l_{t-1})}$ and $q_0 = 1$.

s.t.

$$
\begin{align}
e_{t+1}^p &= RE_t^p + e_t^p, \tag{18}\\
L_{t+1}^p &= D_{t+1}^p + e_{t+1}^p, \tag{19}\\
e_{t+1}^p &\geq \gamma^p L_{t+1}^p. \tag{20}
\end{align}
$$

Where τ are the taxes to banks profits, L^p are the loans issued by private banks, D^p are the deposits received by private banks, π^f are the profits coming from the firms, RE^p are retain earnings, e^p is equity and γ^p is the minimum capital requirement for private banks.

Therefore private banks maximize dividends (difference between profits and retained earnings) subject to the fact that the next period level of equity is given by the current period equity plus retained earnings, the fact that the total loans that can be provided by private banks must come from either deposits or equity and to the fact that the equity must be at least a γ^p fraction of the total loans.

From the optimization problem we get the following equation:

$$
\gamma^p = E_t q_{t+1} \left(\gamma^p + (1 - \tau)[i_{t+1} - (1 - \gamma^p) r_{t+1}] \right). \tag{21}
$$

Where we observe that if $\gamma^p = 0$ the solution implies that $i = r$, which implies there is not margin between the loan and deposit rate.

3.3.2 Government Banks

There are a $1 - \phi$ faction of government banks. Those are very similar to the private banks in terms of the maximization problem, however those face a different constraint. Therefore public banks solve the following problem:

$$
\max_{D_{t+1}^g, L_{t+1}^g, RE_t^g} E_0 \sum_{t=0}^{\infty} \prod_{j=0}^{t} q_j \left[(1 - \tau)(i_t L_t^g + (1 - \phi)\pi_t^f - r_t D_t^g) - RE_t^g \right] \tag{22}
$$

s.t.

$$
\begin{align}
e_{t+1}^g &= RE_t^g + e_t^g + g_t, \tag{23}\\
L_{t+1}^g &= D_{t+1}^g + e_{t+1}^g, \tag{24}\\
e_{t+1}^g &\geq \gamma^g L_{t+1}^g. \tag{25}
\end{align}
$$

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Where the variables are the same but for the government (superscript g). Government banks as well have an extra term g_t which is a transfer coming directly from the government. This allows the government to capitalize these banks after a negative shock has hit the economy.

Given that we are modeling the counter cyclical behavior of these banks, we are going to assume that, during normal times this component is equal to zero and after negative shocks, the government follows the following rule:

$$g_t = \chi(Y_{ss} - Y_t). \tag{26}$$

Where Y_{ss} is the steady state product. As in negative periods $Y_t < Y_{ss}$, $g_t > 0$. χ is a parameter that allows us to calibrate the magnitude of the government transfer to public banks. This rule is taking directly from the observed behavior of government banks and tries to imitate a less pro cyclical reaction regarding loans.

Given this problem, the optimal equation for government banks is given by:

$$\gamma^g = E_t q_{t+1} \left(\gamma^g + (1 - \tau)[i_{t+1} - (1 - \gamma^g)r_{t+1}] \right). \tag{27}$$

3.4 The Government

The government acts passively in this economy. It provides transfers to non-Ricardian consumers and money to government banks using the funds coming from taxes and from government banks dividends. In for simplicity that, every period, the government keeps a budget balance equal to zero. Therefore the government budget constraint is:

$$g_t + tr_t = \tau(i_t L_t - r_t D_t + \pi_t^f) + div_t^g. \tag{28}$$

Here we can see clearly the trade off that exists between the transfer given to consumers and the money provided to banks. This fact, once solved the DSGE model could be very useful in order to know where the resources coming from the government are more efficient spent.

3.5 Aggregation

Finally to compute the equilibrium for the model, we need the following aggregated equations:

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$$
\begin{aligned}
c_t &= \lambda c_{r,t} + (1 - \lambda) c_{nr,t}, & (29) \\
l_t &= \lambda l_{r,t} + (1 - \lambda) l_{nr,t}, & (30) \\
Y_t &= c_t + I_t + g_t, & (31) \\
L_t &= \phi L_t^p + (1 - \phi) L_t^g, & (32) \\
L_t &= K_t; & (33) \\
D_t &= \phi D_t^p + (1 - \phi) D_t^g. & (34)
\end{aligned}
$$

Where c is the aggregate consumption and l the aggregate amount of labor.

3.6 The Recursive Competitive Equilibrium

Given all the description of the economy, the recursive competitive equilibrium is defined by:

- Taking the w_t, p_t and r_t as given, Ricardian households maximize their utility function by choosing $c_{r,t}$, $l_{r,t}$ D_{t+1} and s_{t+1}.

- Taking w_t and tr_t as given, non-Ricardian households choose labor and spend all their income every period.

- Taking w_t and i_t as given, firms maximize profits by choosing l_t, K_{t+1} and I_t.

- Taking r_t, i_t , γ^p and τ as given private banks maximize profits by choosing D_{t+1}^p, L_{t+1}^p and RE_t^p.

- Taking r_t, i_t , γ^g, g_t and τ as given government banks maximize by profits choosing D_{t+1}^g, L_{t+1}^g and RE_t^g.

- The government keeps its budget balance in every period.

- Markets clear.

4 Model Simulations

In this section it is explained the calibration for the model and it is performed some simulations in order to show what are the implications regarding the macroeconomic variables of incorporating these government banks to the standard DSGE model with banks.

4.1 Calibration

To perform the calibration of the DSGE model the study uses a mixture between very well know values for the parameters in the literature of DSGE models and real data for developing economies. Using this, the parameters to be used in the model are the following:

Table 2: Parameter values.

Parameter	Value
θ	3
β	0.98
ω	2
α	0.33
ρ	0.9
δ	0.1
γ^p	0.1
γ^g	0.1
τ	0.15
χ	0.125
λ	0.7

In the previous table it is presented the values calibrated for the parameters that will be used to solve for the model. The parameters θ, β, ω, α, δ are standard values from the business cycle literature, Aliaga-Diaz and Olivero (2012). The γ^is are close to the coefficient proposed in Basilea II. λ is the coefficient of financial inclusion in the named countries. χ is calibrated to have an injection of 0.5% of the GDP when the product has decreased in 4% respect to its steady state.

4.2 Moments for the Macroeconomic Variables

The following table provides the mean and standard deviations for the principal macroeconomic variables of the model using different parameters for the participation of government banks in the economy. The idea behind this is to show how these variables change when it is increased the amount of state owned banks.

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**Table 3:** Simulation moments for different values for ϕ: Macroeconomic variables.

Variable	$\phi = 1$		$\phi = 0.9$		$\phi = 0.7$	
	Mean	Std.	Mean	Std.	Mean	Std.
$Ricardian\ Consumption(c_r)$	1.3481	0.2161	1.3483	0.1673	1.3467	0.1948
$Non-Ricardian\ Consumption(c_{nr})$	1.2013	0.7335	1.2051	0.3048	1.2073	0.3467
$Consumptino(c)$	1.3040	0.2974	1.3053	0.1925	1.3049	0.2109
$Labor(l)$	1.0960	0.1220	1.0968	0.0852	1.0965	0.0950
$Investment(I)$	0.4889	0.2479	0.4901	0.1011	0.4896	0.1353
$Capital(K)$	4.8873	1.4393	4.9007	0.8663	4.8954	1.0347
$Output(Y)$	1.7930	0.4004	1.7954	0.2794	1.7945	0.3117
$Deposits(D)$	4.3986	1.2954	4.4106	0.7796	4.4059	0.9312
$Transferences(tr)$	0.0000	0.6781	0.0021	0.1951	0.0050	0.2774
$Loans(L)$	4.8873	1.4393	4.9007	0.8663	4.8954	1.0347
$Loans\ Interest\ Rate(i)$	0.0211	0.0126	0.0209	0.0116	0.0210	0.0120
$Deposit\ Interest\ Rate(r)$	0.0207	0.1442	0.0214	0.1924	0.0206	0.0771
$Salary(w)$	1.0960	0.1220	1.0968	0.0852	1.0965	0.0950
$Stock\ Price(p)$	0.4925	0.4650	0.5415	0.1956	0.6348	0.3875
$TFP(A)$	0.9989	0.0629	0.9989	0.0629	0.9989	0.0629

It is possible to observe form the previous table that when we add government banks, through the dimension covered on this paper, the standard deviation of almost all macroeconomic variables decrease. It is interesting as well to notice that this volatility does not continue decreasing as we increase the percentage of government banks. This less volatility of these variable is given by the reaction of the stated owned banks.

4.3   Impulse Response Analysis

Given the selection for the parameter values, we can observe in the following graphs the reaction of the economy after a negative shock of one standard deviation in the total factor productivity,

As we can see in figure 1, there is some differences respect to the standard DSGE model at incorporating this heterogeneity in some percentage of the financial intermediaries. Consumption of non Ricardian families recovers much faster than in a usual situation. This is explained by the transfers that the government is able to do given taxes and the dividends coming from public banks. In terms of the investment level, it takes three quarters to almost completely be again in the steady state level. That fast return to the steady state level can be justified in the less pro cyclical behavior of state owned banks. This in this case, given by the extra resources injected in those institutions that allow them to continue providing loans to firms.
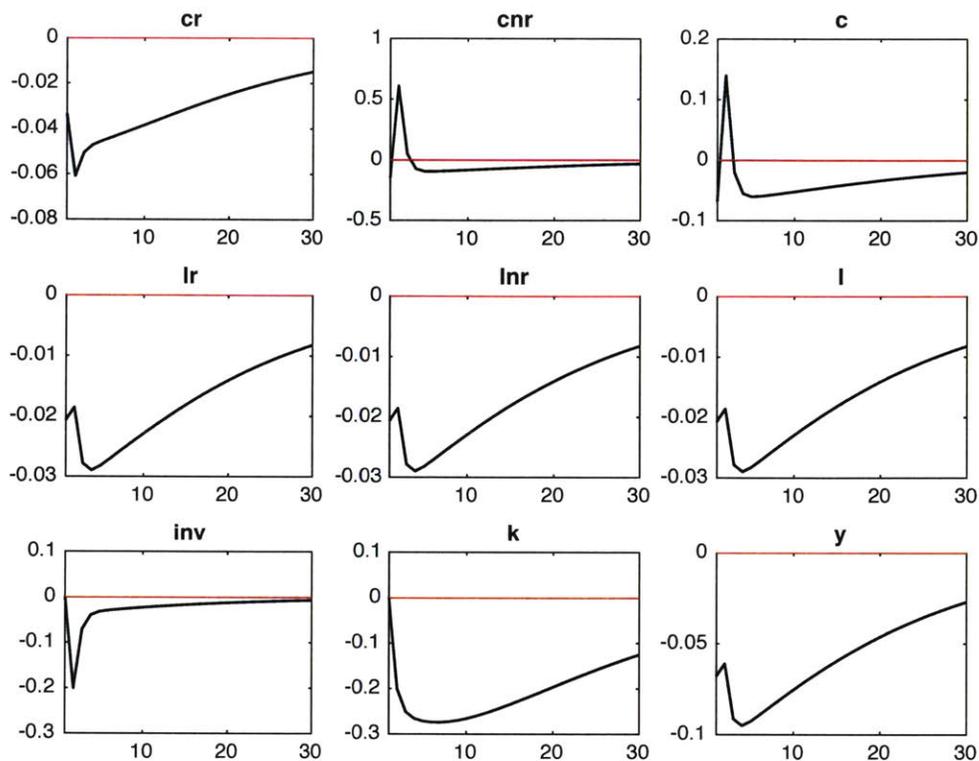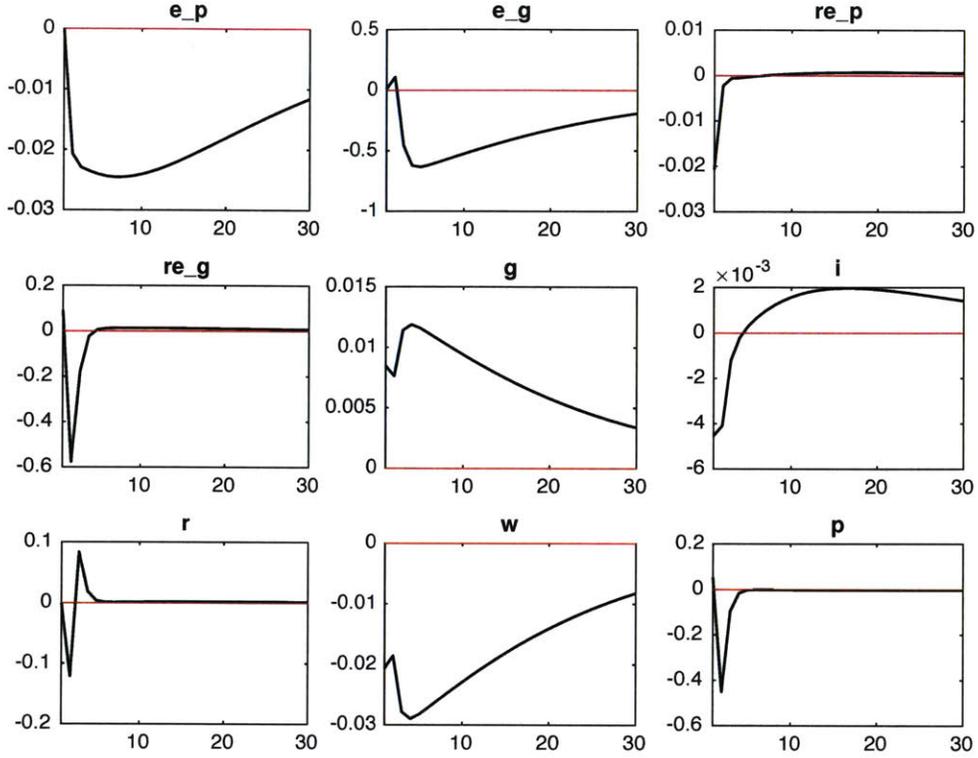
Figure 1: Impulse response to one shock in the productivity for c_r, c_{nr}, c, l_r, l_{nr}, l, I, K and Y, respectively. The variables are in logarithm. The red line indicates the logarithm of the steady state. $\phi = 0.9$.

In figure 2 we can see the effect in the aggregate over the loans issued by private and public banks. Private banks as it was expected strongly constrain the amount of loans provided to firms. Government banks on the other hand try to keep the level of loans for two quarters and after that those fall anyway.
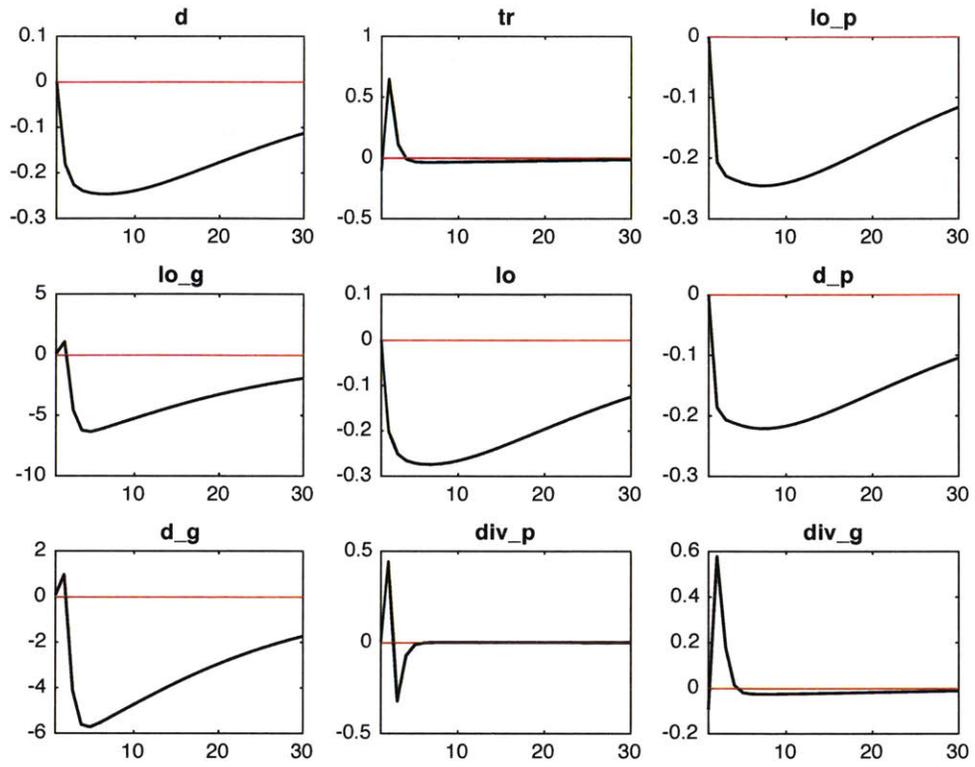
Figure 2: Impulse response to one shock in the productivity for D, tr, L^p, L^g, L, D^p, D^g, div^p and div^g, respectively. The variables are in logarithm. The red line indicates the logarithm of the steady state. $\phi = 0.9$.

Figure 3: Impulse response to one shock in the productivity for e^p, e^g, RE^p, RE^g, g, i, r, w and p, respectively. The variables are in logarithm. The red line indicates the logarithm of the steady state. $\phi = 0.9$.

In figure 3, we observe how g reacts after a negative shock, given the rule used by the government. Together with this we can see as well that the interest rate over loans suffers a big fall after the shock but a very fast recovery given the behavior of public banks.

4.4 Comparison for Different values for ϕ

In this part this study perform a comparison of the different reaction of the macroeconomic variables output, consumption, investment and labor in order to see how they depend on the percentage of government banks in the economy. In doing so the paper evaluates three possible values for ϕ, 1, 0.9 and 0.7 which implies no government banks, only 10% of public banks and 30% of state owned banks.

The idea behind this simulations is to observe whether the responses are altered by the presence of government banks given our rule for capital injection after a negative shock. In figure 4 we can see a big difference in the reaction of the product

with and without public banks. Specifically we the recovery is less severe when the economy is composed by 10% of public banks. Which is interesting is that the recovery is not less severe as we have more government banks. As a matter of fact, with 30% of public banks the recovery is still less severe than with no government banks but is more severe than with 10%.
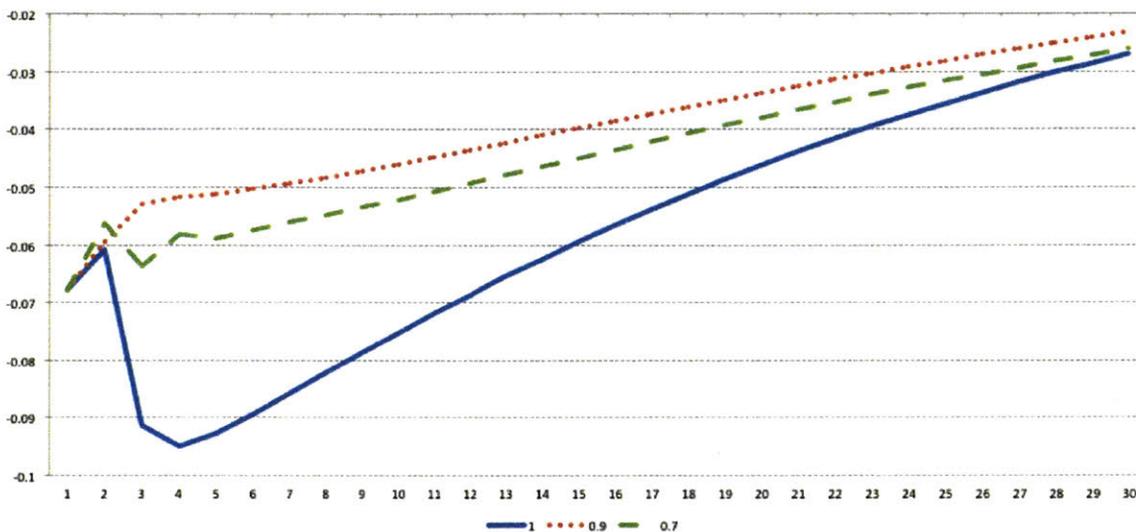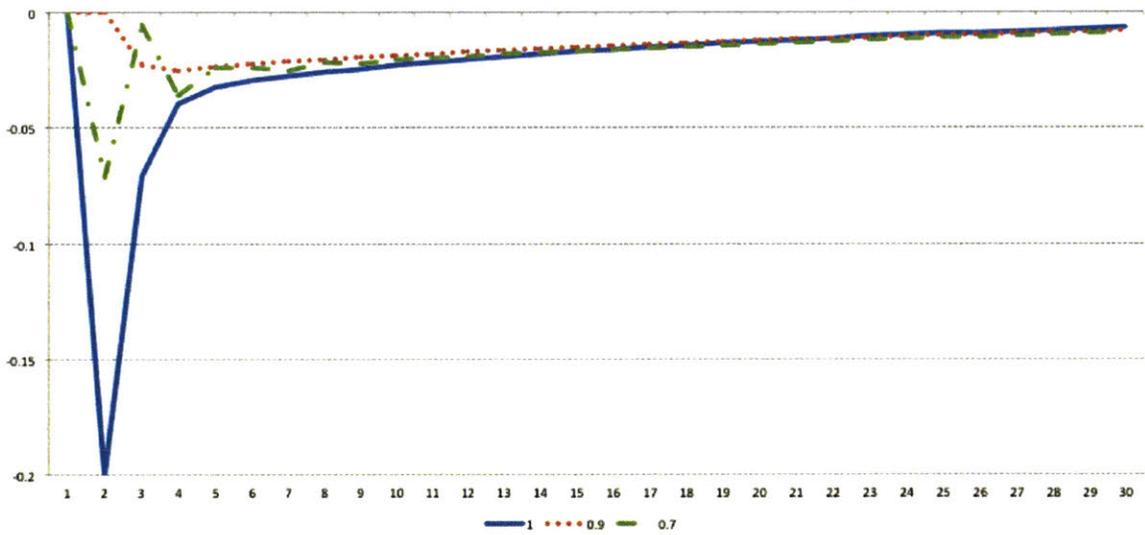

Figure 4: Output reaction to a TFP shock for different values for ϕ

Figures 5, 6 and 7 show the same pattern than figure 4. The recovery is less severe with public banks in the economy.

It is important to notice here that however the previous results, the most important fact is that the response is very different regarding these macroeconomic variables. Given that the goal of this paper was to answer if it made sense to incorporate the heterogeneity of private and public banks, this impulse response functions show that it actually do.

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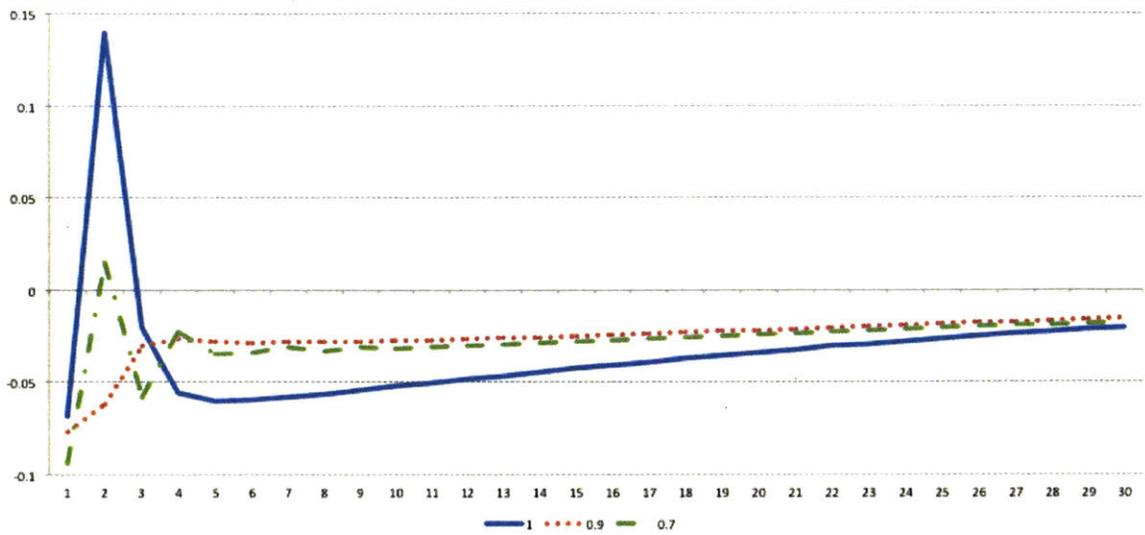
Figure 5: Consumption reaction to a TFP shock for different values for ϕ

Figure 6: Investment reaction to a TFP shock for different values for ϕ
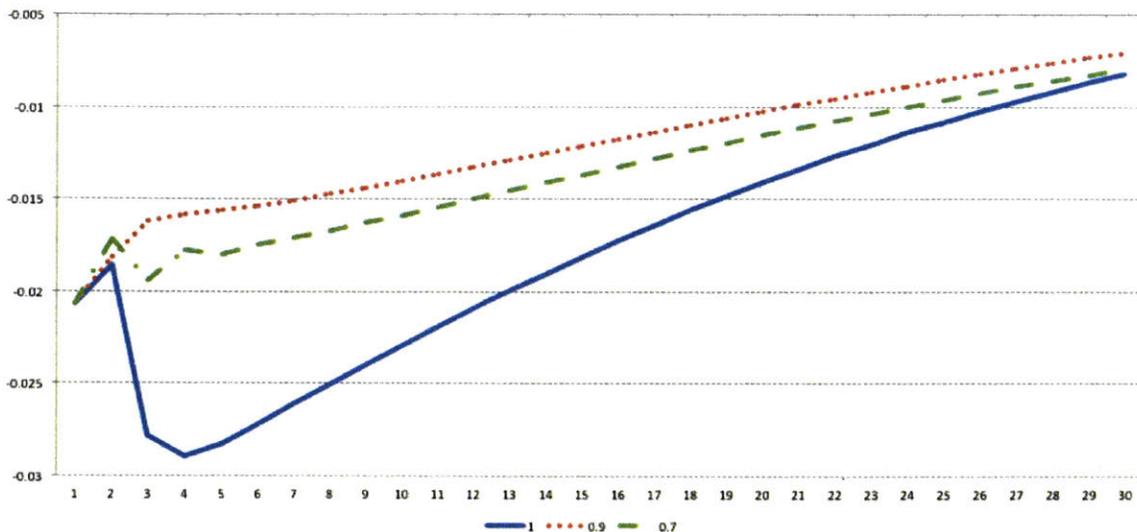
Figure 7: Labor reaction to a TFP shock for different values for ϕ

As we were expecting given our hypothesis it seems that to treat those banks as heterogeneous is important for the understanding of the spreading out of a negative shock in the economy. All these based in the difference the paper took from the literature which was that they react differently during recession.

An important part of this analysis is to highlight that in order to observe very different results in term of magnitude from the standard DSGE we need a small percentage of government banks in the economy.

Notwithstanding the previous analysis It is worth noting that in this case the paper is only modeling one of those big differences that these banks have. Under different assumptions, for example with less efficient government banks or under a bad political control those results could be exactly the opposite.

5 Conclusions

This paper develops a DSGE model with heterogeneous financial intermediaries and studies the role of public banks. The model highlights the different characteristics that state-owned and private banks have. In particular, it explicitly models the lower pro-cyclicality of public banks and shows that given they behave differently during recessions it has implications regarding macroeconomic variables like GDP, consumption, investment and labor.

The results show the importance of incorporating this heterogeneity into the classical DSGE framework. As evidenced by the impulse response functions, state-

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owned banks can make recessions less prolonged and less severe. This result is especially salient the output, consumption, investment and labor.

In order to observe this different responses in macroeconomic variables it is only needed a very small percentage of overnment banks.

The study also highlights the important trade-off between lending to firms and transferring funds to consumers during recessions. A natural extension of this work would be to study this trade-off in detail. That would allow for explicit policy evaluations.

Finally, it is worth noting that it didn't consider political or agency problems. A larger model with these features would be more appropriate for policy guidance, as the empirical literature shows that these are first-order frictions in state-owned banks.

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