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LETICIA LOANA DA CUNHA

**SAVINGS IN BRAZIL:
A GENERAL EQUILIBRIUM APPROACH**

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2020

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Dissertação de mestrado apresentada ao Programa de Pós-graduação em Economia Regional (PPE) da Universidade Estadual de Londrina, como requisito parcial para a sua conclusão.

Orientador: Prof(a). Dra. Joanna Georgios Alexopoulos

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RESUMO

Esta pesquisa desenvolve um modelo dinâmico de equilíbrio geral com diferentes tipos de rendimentos para dois agentes, funcionários do setor público e do setor privado. O modelo analisa as distribuições de riqueza e consumo entre os agentes, constatando que uma parte majoritária da poupança por motivo precaução é dos funcionários do setor privado. Em simulações utilizando o modelo, os resultados sugerem que uma diminuição na porcentagem de funcionários públicos e na persistência de choques levam a aumentos na taxa de juros e à redução da razão capital-produto.

Palavras-chave: Poupança brasileira. Calibração. Choques idiossincráticos. Motivos para poupar.

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ABSTRACT

This research develops a dynamic general equilibrium model with different types of earnings for two agents, public and private workers. The model analysis wealth distributions and consumption across agents, finding that a majority part of precautionary savings comes from private workers. We make three different simulations and results suggest that both a decrease in percentage of public workers and in persistence of shocks lead to increases in the interest rate and reduction in capital-output ratio.

Keywords: Brazilian savings. Calibration. Idiosyncratic shocks. Savings motives.

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1 INTRODUCTION

Private savings can be defined in two different ways: the difference between current disposable income and current consumption or variation of wealth over time. Economic theory establishes three different motives for agents to save: price, income and precautionary motive.

The price motive is related to the interest rate and is driven by the elasticity of intertemporal substitution in consumption. *Ceteris paribus*, changes in the interest rate change consumption profile and therefore, savings. The income reason explains how consumer reacts to an expected variation in income in order to smooth consumption over time. Finally, the precautionary reason comes from the convexity of marginal utility and shows how savings are used to avoid the worst possible consumption in the presence of income uncertainty.

The start point of this research is the consequences of a change in the politic of wages and careers for public employment, with reduction of expenses and loss of stability in the public career. If public and private sector employees faced greater uncertainty, what would the consequences be, and if the public sector were to match the private sector, what would be the differences in the steady state and the impact on capital accumulation? These reflections were inspired by the current Brazilian debate that questions the wage differences between public and private sector and the size of the state apparatus. They were initiated by the increase in the public deficit in the recent period and by the pension reform approved in 2019 (which means increased uncertainty in the future for poorest workers and mainly the private sector employees). This increase in the level of uncertainty in the economy, according to the theory of real business cycles used here, can lead to changes in the structure of consumption and savings of the agents of the economy.

One of the main researches related to savings was carried out by Aiyagari (1994), in which author develops a model with non-aggregated idiosyncratic shocks, allowing an individual analysis of each agent savings behavior in addition to aggregate analysis. That is, the shocks incorporated into the model occur in worker individual productivity and not in production, as is usually done.

The model built in this paper is based on Aiyagari (1994), but instead of just one agent, our model incorporates two representative agents: public and private workers. These two agents have idiosyncratic shocks distinct in their life time. Incomplete markets with borrowing constraints are another important feature. We assumed one type of assets, which households can borrow, the net savings equal investments in capital market equilibrium. The research goal is analyze the behavior and composition of savings for private and public workers in Brazil. So find out how households affect the allocation of resources in economy. We answer this fundamental issue in three stages. First, developed a model inspire in Aiyagari (1994). Second, develop a calibration strategy, and last of all, estimate the equilibrium results with a recursive

method and check experiments. After the model was developed, we performed the calibration for Brazilian data. When analyzing the applied data, it is possible to infer that Brazilian public workers' savings are mainly driven by the price motive while private workers' savings are driven by precautionary reasons.

This thesis is divided in five chapters. The first is the introductory chapter, the second chapter shows the existing literature and data available for Brazil, the third details the model and calibration strategy, in the fourth chapter, we explore the quantitative results and simulations. The final chapter contains the conclusion of this study.

2 LITERATURE REVIEW

Many authors categorized the reasons for saving in different ways, using different approaches. This study focus on two main literature strands. The first one is related to the substitution of intertemporal consumption due to changes in the real interest rate (Boskin (1978); Campbell e Mankiw (1989); Attanasio e Weber (1993)). The second one is related to precautionary motive to save. There is a vast literature that emphasizes the role of precautionary savings as an important factor in determining fundamental economic variables. This is mainly due to the relationship between risk aversion and uncertainties, which can be considered as the reason for saving as a precaution. Who consolidated the theory of choice under uncertainty was Kimball (1989), with a theoretical article about a reinterpretation and new propositions about precautionary saving, using Arrow-Pratt measure of risk aversion. There is a relationship with precautionary motives and the income variance, when uncertainty increases, current consumption reduces and the families hold more wealth (KENNICKELL; LUSARDI, 2004).

In Lugilde, Bande e Riveiro (2019) presents an empirical literature review about precautionary savings. The question of estimating precautionary savings and its impacts with both micro and macro data was at the center of the discussion. According to the authors, the results are controversial, indicating a variety of different consequences for the economy due to precautionary savings. Despite of this, the relationship between a convex marginal utility function as an indicator and a way of measuring precautionary savings is consolidated in the literature.¹

The precautionary reason for saving is also studied in the model developed by Aiyagari (1994), in which the importance of individual decisions in aggregate savings is analyzed. The author adds individual shocks to worker productivity to the model instead of incorporating these shocks into the aggregate. Other study that approaches the precautionary savings is Bayer et al. (2019) that examines the macroeconomic consequences in uncertainty variations on a business cycle model for US economy. However, they take into account a model with incomplete markets, liquid and illiquid assets, and a nominal rigidity. They find that welfare effects of uncertainty shocks crucially depend on household's asset position and the monetary policy that can effects and redistributes the assets between different classes.

In the recent study of savings in Brazil, Silveira e Moreira (2015) finds the apex savings behavior of Brazilian households it is around the age of 65 to 80 years, that isn't consistent with the life cycle model, but are accordant with a Buffer-stock model. This last model provide more realistic prerequisites for Brazilian economy. Savings in Brazil only increases after 55-60 years of age, between 25-55 years households maintain a low proportion of savings, but data are missing in the form of a time series to add consumption as a variable for another studies

¹ In their seminal articles Leland (1978) and Dreze e Modigliani (1975) laid the foundation for precautionary savings theory. In addition, they gave the necessary justification to estimate savings.

that a buffer stock model can be used.

In this thesis we also explore the precautionary motive to save, but we don't include in this research business owners, only some classes of workers. This is because some studies like Kennickell e Lusardi (2004) shows that could be more fruitful to study business owners in isolation for United States. In the Brazilian case, there are evidence for different behavior for business owners savings and a data limitation for include them.

Facing this fact and the data available at RAIS-ME, we seek to study the difference in savings behavior between public and private workers in Brazil. The Figure 1 shows that, according to RAIS-ME data for the period from 1986 to 2017, the income of public and private sector workers showed a significant increase between 2004 and 2014 (4.87% and 3.20%, respectively, on a logarithmic scale).

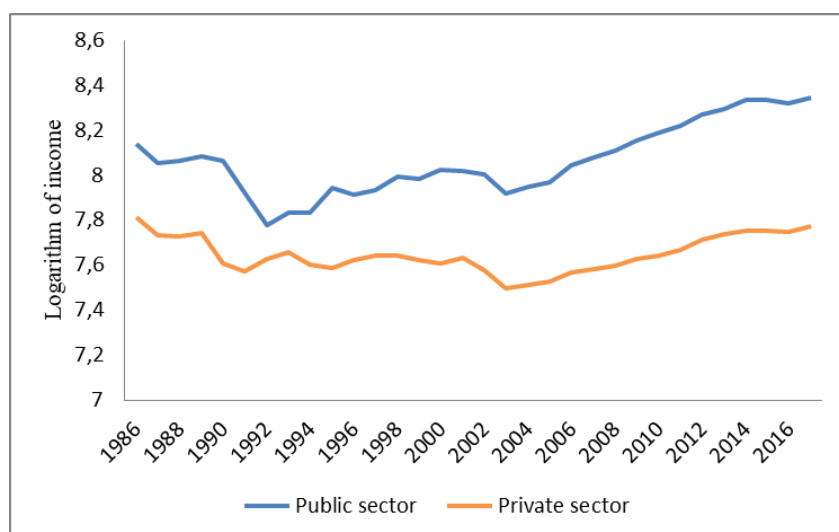


Figura 1 – Logarithm of real income for public and private workers in the period of 1986 to 2017.

However, there has been a deepening of the difference in income between these two sectors that has never been seen before. The income level at the beginning of the sample in 1986 (R\$ 3.419,00 and R\$ 2.473,00) was only reached in 2009 by public workers (R\$ 3.480,00) and only in 2014 for private workers (R\$ 3.330,00). This information is substantial because, despite the widening difference between sectors, the level of income had little variation in the period and almost no substantial increase compared to 1986 for the private sector that makes up the majority of workers.

Another aspect about the data used in this research is that only the earnings of public and private sector employees are taken into account. The income earned in mixed companies and other types of companies that are discriminated in RAIS, for having less participation and presenting different characteristics from the sample set, were not included in the survey. For example, the average remuneration in mixed companies was more than double the average in the public sector throughout the period.

This scenario of increased labor income was accompanied by growth in the GDP and improvement in other economic indicators. About household income inequality Ferreira, Firpo e Messina (2014) show that Gini coefficient for earnings fell by 20% between 1995 and 2012. The decline in earnings inequality "was driven primarily by changes in the structure of remuneration in the Brazilian labour market, rather than directly by changes in the distribution of worker characteristics"(FERREIRA; FIRPO; MESSINA, 2014).

In a study carried out by the Brazilian Central Bank, the evolution of the Family Savings Rate (TPF - "Taxa de Poupança Familiar") was analyzed from 2003 Family Budget Survey (POF - "Pesquisa Orçamentária Familiar") compared to POF 2009. The results go beyond the reduction of TPF from 6.1% to 5.5% in 2009, but also the reduction in percentage of families that save (from 44% to 42%) and the verification that schooling is not correlated with TPF. Another interesting point presented by the study is the estimate of family's average savings rate. While families with monthly per capita income in the ranges of 0.5 to 1.5 minimum wages saved between 3.9% and 6% of their income approximately, for families with income above six minimum wages the average is 10.7% of their income in 2009, in Brasil (2013).

3 MODEL

In this model, the main goal is to analyze the behavior and composition of savings for private and public works in the Brazilian Economy. With shocks only in the individual level, we can analyze the aggregate savings and the behavior of savings for each agent. With this, the average earnings are unchanged and consequently the income motive for saving is shut down.

Hence, we add two types of households: public sector workers and private sector workers in Aiyagari (1994) model. These agents have a set of distinct parameters, such as the average yield and persistence factor (explained in the next subsection). For simplicity, there is a representative firm and no government. Therefore, the difference between public and private workers comes from different idiosyncratic productivity shocks.

The average level of employment here depends of a invariant distribution associated with Q^i , which is a transition matrix. In other words, the level of total employment is different for two reasons, due to the different distributions and also for their participation in total employment.

$$N = \sum_{i=P,G} s^i \Pi^i \quad (3.1)$$

$$N = (1 - \eta)s^P \Pi^P + \eta s^G \Pi^G \quad (3.2)$$

Where η is the percentage of public sector's share of total registered employees in the economy.

Another important hypothesis is define the down limit of the capital, or the borrowing constraints (the φ), as so:

$$k^i \geq -\varphi \quad (3.3)$$

Where k is the level of capital for each household (or agent) and φ is the borrowing constraints.

The households type $i = (P, G)$ solves the problem of consumer, given k, r, w for a Bellman equation:

$$V(k^i, s^i) = \max_{k^{i'}} [u(c) + \beta EV(k^{i'}, s^{i'})] \quad (3.4)$$

with:

$$c + k^i = s^i w + (1 + r + \delta)k^i \quad (3.5)$$

And a restriction of non-negativity of consumption and a borrowing constraints:

$$k^i \geq -\varphi^i, i \in (P, G) \quad (3.6)$$

$$c \geq 0 \quad (3.7)$$

Define

$$k^{i'*} = g^i(k^i, s^i) \quad (3.8)$$

Here, r is the real interest rate, w is the salary or income received by workers, s is the idiosyncratic productivity shock for each type of worker, c is the part of the income that is consumed.

3.1 Definition of equilibrium

A stationary recursive competitive equilibrium is defined as two policy functions $[g^P(k^P, s^P); g^G(k^G, s^G)]$, two probability distributions $[\lambda^P(k^P, s^P); \lambda^G(k^G, s^G)]$ and positive real numbers (r, w) . Such that

i. The price (w,r) satisfy

$$w = \frac{\partial F(K, N)}{\partial N} \quad (3.9)$$

$$r = \frac{\partial F(K, N)}{\partial K} - \delta \quad (3.10)$$

;

ii. The two policy function $g^P(k^P, s^P)$ and $g^G(k^G, s^G)$ solves the household's optimum problem;

iii. The probabilities distributions $\lambda^P(k^P, s^P)$ and $\lambda^G(k^G, s^G)$ are a stationary distribution associated with their policy functions and Markov Chains, if satisfies

$$\lambda^i(k^i, s^i) = \sum_{s^i} \sum_{k^i: k^i e = g^i(k^i, s^i)} \lambda^i(k^i, s^i) Q^i(s^i, s^i e) \quad (3.11)$$

;

iv. The average value of K is implied by the average of household's decisions

$$K = (i - \eta) \sum_{k^P, s^P} \lambda^P(k^P, s^P) g^P(k^P, s^P) + \eta \sum_{k^G, s^G} \lambda^G(k^G, s^G) g^G(k^G, s^G) \quad (3.12)$$

.

3.2 Calibration Strategy

For the computation of equilibrium we have to assume a calibration strategy, in other words, how pin down parameter values. Here we have eleven parameters, divided in three classes: (i) the utility parameters that provide the preference of household; (ii) the technology parameters; and (iii) shocks parameters. They are described in the table 1.

The preference parameter are $\beta, \sigma \in \Phi$. In the work of Cavalcanti (1993) the risk aversion σ estimate for the Brazilian economy is set at 0.49 for the decade of 1980. The $-\Phi = 0.30$ was defined as the borrowing limit required for individuals (here the households) in Brazilian legislation, present in Law No. 10,820 of 2003. There is no limit on loans defined by

Tabela 1 – Calibration

Preference parameters		
σ	1.25	Risk aversion
β	0.95	Subject discount factor
φ	0.30	Borrowing constraints
Technology parameters		
δ	0.17	Depreciation rate
A	1.73	Production technology
α	0.49	Capital share of income
Shocks Parameters		
η	0.18	Percentage of workers in public sector
ρ^P	0.8230	Factor of persistence for private workers wage shock
ρ^G	0.9853	Factor of persistence for public workers wage shock
σ^P	0,0478	Standard deviation of private sector earnings
σ^G	0.0942	Standard deviation of public sector earnings

Tabela 2 – State vector and transition matrix for public and private workers

Sector	State vector	Transition matrix
Private	$s^P = \begin{pmatrix} 0.8451 \\ 1.1833 \end{pmatrix}$	$Q^P = \begin{pmatrix} 0.7368 & 0.2632 \\ 0.2632 & 0.7368 \end{pmatrix}$
Public	$s^G = \begin{pmatrix} 0.4558 \\ 2.1937 \end{pmatrix}$	$Q^G = \begin{pmatrix} 0.9942 & 0.0058 \\ 0.0058 & 0.9942 \end{pmatrix}$

the Central Bank of Brazil, but it is usual a maximum amount paid in each period be restricted as a percentage of earnings.

The technology parameters were extracted from the work of Jr, Gomes e Sachsida (2002), which calculated the $A = 1.73$, the capital share of income as $\alpha = 0.49$ and depreciation $\delta = 0.17$, just as subjective discount factor $\beta = 0.95$. The shock parameters were calculated using the same strategy as Aiyagari (1994).

We use the method of Tauchen for finding a discrete Markov chain and calculated ρ^i e σ^i , $i \in \{P, G\}$, in the first step. Thus, with these results we calculate the state vectors and the transition matrix. The another shock parameter η is the percentage of public works and was calculate with basis in the PNAD - *Contínua* from IBGE for the period of 2012-2017.

We estimate two log-log regression of income with a A(1) process, one for each $i = (P, G)$:

$$\ln(\text{Income}_t^i) = \beta_0^i + \rho^i \ln(\text{Income}_{t-1}^i) + \xi_t^i \quad (3.13)$$

with one lag. The ξ_t^i represents the error that can't be explained for the variable income. The

data covers the period 1986 to 2017.

Finally, we specify the transition matrix and state vector (Table 2). Considering just two possible states for each type, high and low productivity, the wage inequality among public workers is higher while the probability of changing from one state to another is lower than for private workers. In the next chapter we will use the parameters estimate bellow to find the equilibrium results, make simulations and analysis the main results.

4 QUANTITATIVE RESULTS

The stationary equilibrium results for the model show a capital-output ratio of 2.24% and an interest rate of 4.91%, as shown in figure 2. The results are in line with the Brazilian economy. In the paper of Morandi e Reis (2004), the mean of capital-output ratio estimate for the period from 1950 to 2002 was 2.60 %. And according to Filho (2017) the average real interest rate in Brazil from 2005 to 2015 is 5.94%. Level of capital in general equilibrium determines an interest rate very close to that found in complete markets, indicating that the borrowing constraint is not binding for most of households.

Figure 2 – Demand and supply curves of capital for households in steady state

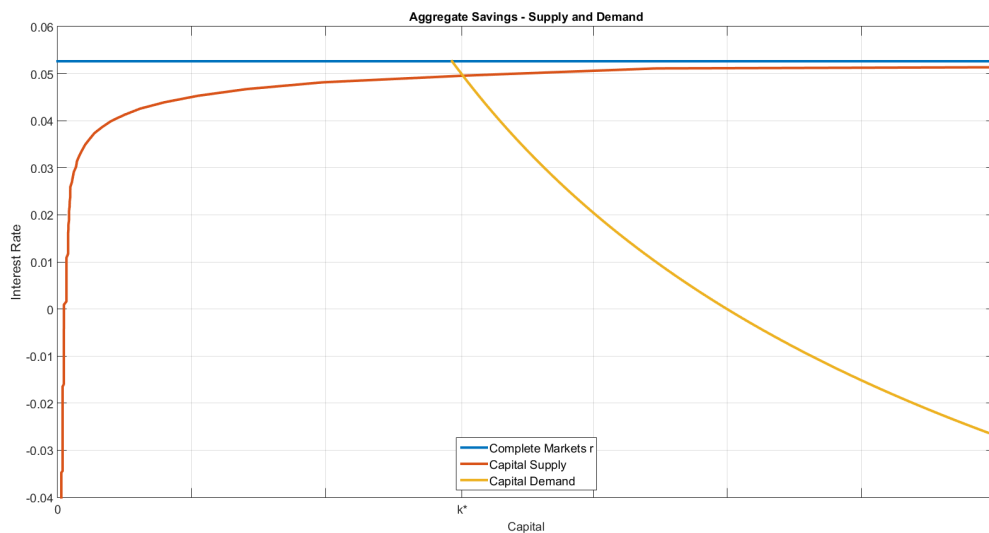


Figure 3 shows the supply aggregate savings, or investment, for the economy and the public and private savings behavior for each level of interest rate. We have that the behavior of public workers are substantially different from private workers. Only with a sufficient high interest rate, public workers begin to save, but, in equilibrium, they are responsible for the majority of aggregate capital supply. With low levels of interest rate, the principal motive to save is precautionary and private workers are almost the solo responsible for savings. In other hand, with an increase in interest rate the price motive becomes more important for public workers, that will save more. In the equilibrium, the majority of savings will be from public workers.

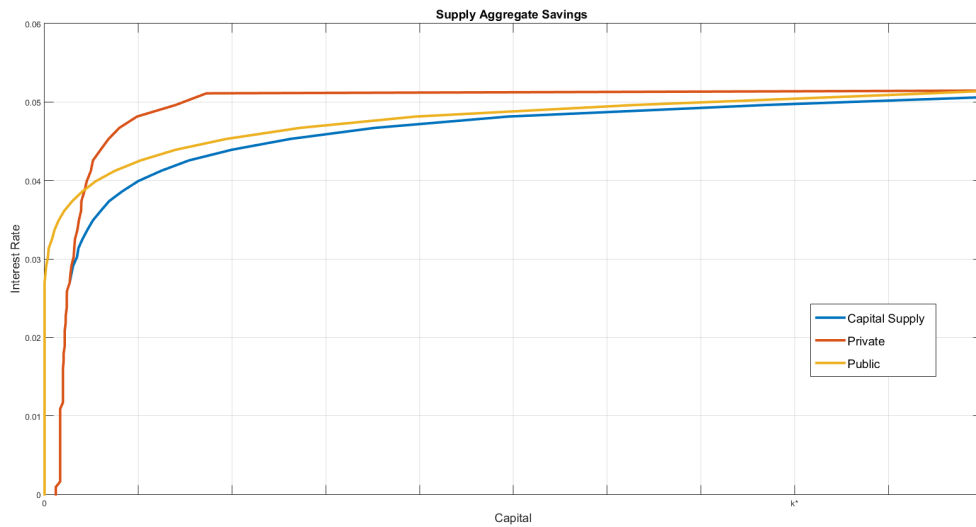
Figura 3 – Supply aggregate savings.

Figure 3 shows the optimal aggregate capital supply for each type of worker for given interest rate. With an interest rate high enough (higher than 4%, approximately), aggregate public savings are higher than aggregate private savings. In other words, public workers savings are driven mainly by the interest rate or price motives. For private workers, there are no difference between an interest rate when it was lower than equilibrium. They save almost the same quantity of capital wherever the interest rate is, hence, they save because precautionary motives.

The average income for these two types of agents is important but what will determine the differences in behavior are two points: the uncertainty regarding the state of the agent, indicated by the transition matrix (which is the probability of the agent being in low productivity state) and how beneficial the agent's state is to him, indicated by the state vector. A public sector worker has 99.42 % chance of continuing the same job in the next period. On the other hand, private workers have 26.32% chances of change his actual status for a bad one in the next period.

4.1 Simulations

What happened if there are changes in the structure of public and private sector workers, reducing the proportion of public employees? What would be the changes in the economy? To assess changes in public policies or differences in the uncertainty of the earnings parameters, it is interesting to use simulations. These can go beyond validating the model, but also assessing the impact of variations in these parameters.

Thus, simulations were performed for three parameters: 1. η - Percentage of works in public sector; 2. ρ^P - Factor of persistence for private sector; and 3. σ - Standard deviation of earnings. For each one, we will vary 15% for more or less the parameter, with equal

distribution and keep the others constant. The simulations results will be present in the next three tables.

Tabela 3 – Experiment 1: variation in η

	% Public workers	Interest rate	Capital-Output ratio
Baseline	0.18	0.0491	2.2369
	0.1530	0.0495	2.2326
	0.2070	0.0487	2.2410

Change the percentage of public workers, we find that an reduction of 15% cause an increase of 0.81% in the interest rate and a decrease of 0,19% in the capital-output ratio.

This movement is due to the change in the proportion of workers employed in the public sector who obtain higher income, and with the reduction of their proportion, the average salary is reduced and the risk in economy increases, consequently increasing the interest rate. In relation to capital, with the reduction in wages, there is a reduction in savings (investment) in the aggregate. Although the qualitative result is interesting, the experiment 1 showed that the equilibrium real interest rate and aggregate savings are robust to variations in size of public sector.

The next experiment is range the factor of persistence for private earning shocks in 15%, in the Table 4. Note that for public employees the persistence factor is 19.7 % higher than for the private sector. However, even though the duration of the shocks has a tendency to extend for a longer period, the probability of presenting a bad shock is less than 1 % (in table 2).

Tabela 4 – Experiment 2: variation in persistence of private sector shocks ρ^P .

Sector	ρ^P	% Interest rate	Capital-Output ratio
Private - Baseline	0.8230	4.91	2.2369
	0.6995	4.94	2.2338
	0.9464	4.68	2.2600

In the private sector, there is a clear improvement in interest rates and the capital-labor factor when the persistence of shocks increases. This is due to a better condition when the employee is in a not good state (0.8451) even though the probability of remaining in a good state is less than in the public sector (table 2). Note that increases in the persistence of shocks for private workers can represent a decrease of 4.68% in interest rate, the most representative difference in the experiment.

Tabela 5 – Experiment 3: variation in σ^i , the standard deviation of earnings for private and public sector.

Sector	σ	% Interest rate	Capital-Output ratio
Baseline		4.91	2.2369
Public	0.2609	4.99	2.2286
	0.3530	4.82	2.2461
Baseline		4.91	2.2369
Private	0.1858	4.92	2.2357
	0.2514	4.89	2.2384

Fonte: Elaborado pelos autores.

When the standard deviation of earnings changes (table 5) in 15% we have the same behavior for the agents, but with different magnitudes. An increase of standard deviation, decreases the interest rate and increases the capital-output ratio.

5 CONCLUSION

Results show that when the interest rate is high enough, the savings are almost from public workers since they are driven mainly for interest rate motive to save. For private workers, there are no difference between an interest rate when it was lower than the steady state. They save almost the same quantity of capital wherever interest rate are, hence, they save because precautionary motives.

Our experiments suggest that both a decrease in percentage of public workers and in persistence of shocks could lead to increases in the interest rate and reduction in capital-output ratio.

The model's result is robust with respect to three parameters: the percentage of formal workers in the public sector in relation to the private sector, persistence of public sector shocks and standard deviations for both shocks. Changes in the shock persistence parameter for private workers showed the highest impact on equilibrium results. An increase of 15% on the persistence, decreases the equilibrium interest rate in 4.68% and increases the capital-output ratio in 1.03%. By increasing the shock persistence, both productivity states increase and the probability of changing from one state to another decreases. These effects decrease the precautionary motive to save from private workers. On the other hand, by increasing both private sector productivity states, it increases average earnings what increases savings. This last effect overcomes the decrease of precautionary savings, decreasing the interest rate. Public workers will decrease supply of capital because of the decrease of interest rate, therefore, capital-output ratio increases in only 1.03%.

REFERÊNCIAS

- AIYAGARI, S. R. Uninsured idiosyncratic risk and aggregate saving. *The Quarterly Journal of Economics*, MIT Press, v. 109, n. 3, p. 659–684, 1994. 8, 10, 13, 15
- ATTANASIO, O. P.; WEBER, G. Consumption growth, the interest rate and aggregation. *The Review of Economic Studies*, Wiley-Blackwell, v. 60, n. 3, p. 631–649, 1993. 10
- BAYER, C. et al. Precautionary savings, illiquid assets, and the aggregate consequences of shocks to household income risk. *Econometrica*, Wiley Online Library, v. 87, n. 1, p. 255–290, 2019. 10
- BOSKIN, M. J. Taxation, saving, and the rate of interest. *Journal of political Economy*, The University of Chicago Press, v. 86, n. 2, Part 2, p. S3–S27, 1978. 10
- BRASIL, D. E. Banco Central do. *Boletim regional do Banco Central do Brasil*. [S.l.]: Banco Central do Brasil, 2013. v. 7. 12
- CAMPBELL, J. Y.; MANKIW, N. G. Consumption, income, and interest rates: Reinterpreting the time series evidence. *NBER macroeconomics annual*, MIT Press, v. 4, p. 185–216, 1989. 10
- CAVALCANTI, C. B. Intertemporal substitution in consumption: an american investigation for brazil. *Brazilian Review of Econometrics*, v. 13, n. 2, p. 203–229, 1993. 14
- DREZE, J. H.; MODIGLIANI, F. Consumption decisions under uncertainty. In: *Stochastic Optimization Models in Finance*. [S.l.]: Elsevier, 1975. p. 459–486. 10
- FERREIRA, F. H.; FIRPO, S.; MESSINA, J. A more level playing field? explaining the decline in earnings inequality in brazil, 1995-2012. IRIBA Working Paper: 12, 2014. 12
- FILHO, A. E. d. C. O que determina a taxa de juros real de longo prazo no brasil? *BBR. Brazilian Business Review*, SciELO Brasil, v. 14, n. 6, p. 624–635, 2017. 17
- JR, R. E.; GOMES, V.; SACHSIDA, A. Business cycle fluctuations in brazil. *Revista Brasileira de Economia*, SciELO Brasil, v. 56, n. 2, p. 269–308, 2002. 15
- KENNICKELL, A.; LUSARDI, A. *Disentangling the importance of the precautionary saving mode*. [S.l.], 2004. 10, 11
- KIMBALL, M. S. *Precautionary Saving in the Small and in the Large*. [S.l.], 1989. 10
- LELAND, H. E. Saving and uncertainty: The precautionary demand for saving. In: *Uncertainty in economics*. [S.l.]: Elsevier, 1978. p. 127–139. 10
- LUGILDE, A.; BANDE, R.; RIVEIRO, D. Precautionary saving: a review of the empirical literature. *Journal of Economic Surveys*, Wiley Online Library, v. 33, n. 2, p. 481–515, 2019. 10
- MORANDI, L.; REIS, E. *Estoque de capital fixo no Brazil, 1950-2002 [Fixed capital stock in Brazil, 1950-2002]*. [S.l.]: Encontro, 2004. 17
- SILVEIRA, M. A. C. da; MOREIRA, A. R. B. *Condicionantes e Previsibilidade da Taxa de Poupança das Famílias Brasileiras: evidência microeconômica com as pesquisas de orçamentos familiares do IBGE*. [S.l.], 2015. 10