The Effects of Public Sector Employment on Inequality and the Fiscal Multipliers *

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Very preliminary

Abstract

The heterogeneous response to fiscal consolidation observed across countries following the 2008 Financial Crisis recalled the debate about the determinants of fiscal multipliers. The upsurging literature suggests that the effects of fiscal consolidation depend on country characteristics. In this research project, we propose a new dimension that can help understand these heterogeneous responses: public sector employment. We aim to contribute to the literature, both empirically and theoretically, by presenting empirical evidence and a general equilibrium model that captures the main mechanisms through which public sector employment may affect the size of fiscal multipliers.

Keywords: Public sector employment; Fiscal multipliers.

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1 Introduction

Following the 2008 Financial Crisis, there was a heap in the use of anticyclical fiscal policy around the world, mostly financed through debt. In many European countries, this promptly led to fiscal imbalances and an urge for the adoption of fiscal consolidation policies either through public expenditures reduction or through tax increases. The heterogeneous response to fiscal consolidation observed across countries recalled the debate about the determinants of fiscal multipliers.¹ How do the impacts of these austerity policies depend on country characteristics and on the fiscal policy instrument used? The upsurging literature suggests that the effects of fiscal consolidation depend on country characteristics.² In this paper, we aim to contribute, both empirically and theoretically, by proposing a new variable that varies significantly across countries and might explain such heterogeneity: public sector employment. More specifically, we present evidence and a model that captures the main mechanisms through which this variable affects the size of fiscal multipliers.

Whenever workers are paid according to their marginal productivity, and the public sector produces a non-wasteful good the allocation of production between public and private sector does not affect individuals’ savings and labor supply behavior. In this case, the share of public sector employment would not affect the size of fiscal multipliers. In several countries, however, the public sector provides a different institutional frame compared to the private sector in terms of higher wage and job stability.³ These differences between the public and private sector jobs can affect the amount of insurance in the economy and, if private insurance markets are absent, can affect the way agents respond to changes in fiscal policy. In this environment, the size of the public sector can be important to understand the size of fiscal multipliers.

We begin by presenting empirical evidence on the relationship between the level of public sector employment and the size of fiscal multipliers. First, we

²Ilzetzki, Mendoza, and Vegh (2013) for instance, show that the size of fiscal multiplier seems to depend on economy’s development level, exchange rate regime and openness.
³Santos and Cavalcanti (2015) provides evidence for Brazil and discuss evidence for some other countries, such as the US and some European countries.
extend the methodology proposed by Ilzetzki, Mendoza, and Vegh (2013) and show that the response of the fiscal multiplier to an increase in government consumption is quite different conditional on the level of public sector employment. As additional suggestive evidence we construct a measure of fiscal multiplier for Latin America countries using a new dataset on cyclically adjusted primary balances from Ardanaz, Corbacho, Gonzales, and Tolsa Caballero (2015). Using this data, we document a strong negative correlation between this measure and the share of public sector employment. However, this is just a correlation based on information for a small set of countries. We aim to extend such database by including information on developed countries.

The channel through which public sector employment may affect the size of fiscal multipliers works through the idiosyncratic income risk. Given that the public sector jobs are more stable and pay higher wages, the larger the share of public sector employment, the lower the amount of idiosyncratic risk faced by individuals in the economy. To the extent that agents have to self-insure themselves, this reduction in risk decreases precautionary savings and, as a consequence, increases the share of low wealth and credit constrained individuals. Given that these individuals have a lower marginal propensity to consume goods and leisure out of future income, they have less labor supply responses to increases in taxes or decreases in government expenditures. Thus, the higher the public sector employment, the lower the fiscal multiplier will be.

If the public sector employment indeed reduces the idiosyncratic income risk, we would expect that the higher job stability would also lead to a decrease in the inequality from labor market. In Section 2 we provide some evidence that confirm this relationship and show that it seems to be stronger for developing countries.

To rationalize the mechanism outlined above, we develop a life cycle overlapping generations model with heterogeneous agents and incomplete markets. Our artificial economy is populated by agents who live for a realistic number of periods, have preferences over consumption and leisure and choose at each period whether to work in the public or in the private sector. Individuals are ex ante heterogeneous with respect to their ability and face uncertainty about their labor productivity. Agents can accumulate a single risk-free asset, which takes the form of capital. Savings may be precautionary and allow partial insurance
against the idiosyncratic shocks. We provide more detail about the environment below.

We calibrate and estimate the model for the Brazilian economy and provide some external validation by analyzing the performance of the model in reproducing moments that were not used in the estimation. The choice of Brazil as benchmark economy lies firstly in the significant share of public sector over total employment, which provides civil servants higher stability, wages and pensions compared to the private counterpart. Secondly, the model can easily account for the selection process for most of public jobs in Brazil, which are provided by a public exam. Moreover, the existence of household surveys allows the identification of the differences between private and public sector to be used to calibrate the model. Finally, there is no much literature on fiscal multiplier for developing countries, which might be particularly sensible to the share of public sector employment. Hence, analyzing Brazilian economy we aim to contribute to reduce this gap.

We use the calibrated model to investigate the extent to which the share of public sector employment changes the amount of insurance in the economy and the size of fiscal multiplier. In order to do this, first we conduct counter-factual exercises by analyzing the effects of different levels of public sector employment over households’ labor supply and savings decisions. Next, we analyze the isolated role of job stability and higher wages in the public sector. In particular we evaluate the output that would emerge from turning off those channels (i.e. from equalizing the stability and wages in both sectors). Finally, we account properly for the economy’s response to fiscal shocks, both through taxes increases and reduction in government expenditures.

There has been a surge in the literature studying the determinants of fiscal multipliers. Guajardo, Leigh, and Pescatori (2014) focus on short-term effects of fiscal consolidations on economic activity for a sample of OECD countries, using the narrative approach as in Romer and Romer (2010), finding that a 1 percent fiscal consolidation shock causes GDP to to decline by 0.62 percent. Blanchard and Leigh (2013) find a sizeable negative effect of fiscal consolidation programs in Europe and show that the IMF underestimates this effect. Alesina, Barbiero, Favero, Giavazzi, and Paradisi (2015) analyze 16 OECD countries and show that the size of fiscal multipliers depends on the type of policy adopted,
being much higher (more costly in terms of output) for a tax-based fiscal consolidation than for an expenditure-based one. Dupaigne and Fève (2016) show that a more persistent government spending leads to greater fiscal multipliers. Ilzetzki, Mendoza, and Vegh (2013) shows that fiscal multipliers are higher in industrial countries, economies operating under predetermined exchange rate and economies that are more open. Carroll, Slacalek, Tokuoka, and White (2017) show that the aggregate consumption response to transitory shocks is stronger in economies with large wealth inequality and where a larger proportion of households has little wealth. Brinca, Holter, and Malafry (2016) also provide empirical evidence that higher wealth inequality is associated with stronger impacts of increases in government expenditures. Auerbach and Gorodnichenko (2012) focus on government purchases and show that the fiscal multiplier is larger during recessions.

We also relate to the literature on the effects of public sector employment. Santos and Cavalcanti (2015) show that an overpaid public sector can generate sizeable welfare losses due to misallocation. Gomes (2014) presents the effects of public sector higher wage (compared to the private counterpart) over unemployment. Dos Reis and Zilberman (2014) emphasize the insurance role of public sector employment and show that, despite increasing welfare, a reduction in the public sector reduces the amount of insurance in the economy.4

The remainder of the paper is structured as follows. In order to motivate our study Section 2 presents some empirical evidence. In Section 3 we present the model economy, followed by the calibration and the quantitative analysis in Section 4. Finally, Section 5 contains concluding remarks.

2 Empirical evidence

In this section we provide empirical evidence on the relationship between public sector employment and the size of fiscal multiplier. Our main approach lies on extending some relevant empirical studies. Firstly we use the dataset from Ilzetkzi, Mendoza, and Vegh (2013) and extend their methodology by incorpo-

4Gomes (2018) also shows that a review of the payment in the public sector towards the one adopted in the private sector (labor earnings according to marginal productivity) could lead to a reduction on economy’s unemployment.
rating the share of public sector employment. Secondly, we exploit the recent dataset on cyclically adjusted primary balances for Latin American countries from Ardanaz, Corbacho, Gonzales, and Tolsa Caballero (2015) to construct a measure of fiscal multiplier and relate such measure with the size of public sector employment. Finally, we present supportive evidence on the proposed mechanism by showing the relationship between the share of public sector job and income inequality for a large set of countries.

2.1 Pooled regressions by country characteristics

A main issue in estimating fiscal multipliers lies in data availability. Ilzetzki, Mendoza, and Vegh (2013) overcome this issue using an unique dataset on government consumption in quarterly frequency comprehending a set of 44 countries (both developed and developing). They pooled these countries in two groups according to some characteristics (i.e. development level, exchange rate flexibility and openness to trade) and estimate the fiscal multiplier for each of them relying on the VAR approach as in Blanchard and Perotti (2002). Their objective is to estimate the system of equation:

$$AY_{n,t} = \sum_{k=1}^{K} C_k Y_{n,t-k} + Bu_{n,t}$$

where $Y_{n,t}$ comprise real government consumption and real GDP for country $n$ in the quarter $t$. $A$ is a matrix that captures the simultaneous effects between the endogenous variables $Y_{n,t}$ and $C_k$ is the $k$ lag own and cross effect of the variables on current observations, with $K = 4$. Finally, $B$ is a diagonal matrix, so that $u_t$ are i.i.d. shocks to government consumption and GDP. The matrices $A, B$ and $C$ are assumed to be invariant across time and countries.

In order to estimate the model and fulfill the necessary identification assumptions over $A$, the authors assume that is necessary at least one quarter for the government consumption to respond to innovations in output. Following the estimation, they obtain the cumulative fiscal multiplier, defined as:

5The authors choose to pool countries instead of do estimations country-by-country in order to keep a larger sample size.
CumulativeMultiplier(T) = \frac{\sum_{t=0}^{T} \Delta y_t}{\sum_{t=0}^{T} \Delta g_t}

which measures the cumulative output multiplier from a shock in the government consumption.

We lean on this dataset and methodology, sorting out countries according to the share of public sector employment in 2008 relative to the sample mean. The results are robust to other pooling specifications. Figure 1 plots the impulse response to a 1 percent change in government consumption for each group of countries: at the left, countries with public sector job above the median level of the sample; at the right those bellow.

Figure 1: Cumulative multiplier from a shock to government consumption. Countries are sorted according to their level of PSE relative to the sample median for 2008. Higher (lower) PSE on the left (right) side.

Accordingly, the output response of each group is different both in terms of signal and magnitude. For those countries with higher level of public sector employment, the impact from an increase in government consumption is negative, but is statistically significant only for a quarter. On the other hand, the response is positive and more persistent for those with lower share of public sector job, keeping statistically significant for several quarters following the shock.
2.2 Fiscal Multiplier for Latin America and Caribbean

As additional suggestive evidence we exploit a novel dataset on cyclically adjusted primary balances for Latin America and Caribbean from Ardanaz, Corbacho, Gonzales, and Tolsa Caballero (2015). The authors provide estimations of structural balances for 20 countries between 1990 and 2013 taking particular care for those which most of their fiscal revenue from commodity related activities. Then, they use such estimates to analyze the cyclical behavior of fiscal policy of those countries.

We rely on this dataset to obtain a simplified measure of fiscal multiplier to relate with the share of public sector employment. We obtain such measure by estimating for each country:

\[ \Delta y = \beta_0 \Delta Fiscal \]

where \( \Delta y \) is the output growth and \( Fiscal \) is the change on cyclically adjusted (structural) primary balance from 2009 until 2013, the period following the riot of the Financial Crisis, which was marked by the widely adoption of fiscal policies around the world. Figure 2 presents the estimated measure of fiscal multiplier versus the share of public sector employment in 2008.

We relate the 2009-2013 fiscal multiplier with 2008 share of public employment in order to avoid possible endogeneity concerns between public sector expenditures and GDP, since a recession might affect the share of public sector jobs by worsening government’s budget. Moreover, the way individuals respond to changes in the fiscal policy in a given period depends on their previous decision concerning savings and labor supply, which is determined by the risk they faced and, thus, might be affected by the higher stability from public sector job.

Figure 2 suggests a strong negative correlation between the size of fiscal multipliers and the share of public sector employment. However, this is just a correlation based on information for a small set of countries. It should be emphasized that one of the main goals of this research project is to provide a careful empirical analysis on the effect of public sector employment on the size of fiscal multipliers.
Figure 2: Fiscal multiplier (y axis) versus the share of public sector employment. The fiscal multiplier is estimated using $\Delta y = \beta_0 \Delta \text{Fiscal}$ for each country, where $\Delta y$ is the output growth and $\Delta \text{Fiscal}$ is the change on the cyclically adjusted (structural) primary balance for the period between 2009 and 2013. We relate this measure with the share of public sector employment in 2008.

2.3 Inequality

As a third empirical evidence, we show that the reduction in idiosyncratic risk might indeed be the channel through which public sector employment affects the size of fiscal multiplier. We provide such evidence relating the size of public sector employment and income inequality for several countries. The idea is that if the higher stability from public sector job indeed reduces the idiosyncratic risk individuals face, it should also reduce the inequality originated from labor market.\(^6\) As a suggestive evidence, figure 3 presents the share of public sector employment versus the income inequality measured by the Gini Index in 2015.\(^7\) The left panel plots the results for a large set of countries, while in the right panel we show data just for developing countries.

The figure suggests that countries with higher share of public sector employment presents, on average, lower income inequality. Moreover, the results

\(^6\)It should be stressed that this negative relationship could also be due to a higher public sector wage premium for low skilled (Santos and Cavalcanti (2015)).

\(^7\)Figure 3 shows the relationship between the share of public sector employment (over total employment) and inequality for a group of countries in 2015. The data for the public sector and for the Gini comes from ILO and Gini databases respectively.
seems stronger for developing countries. In this way, the results suggest that public sector job reduces the idiosyncratic risk, verifying our mechanism.

Jointly the three previous exercises suggest that the share of public sector employment matters to understand the size of fiscal multiplier. In particular, they provide empirical evidence on a negative relationship between those variables, suggesting lower fiscal multipliers for countries with higher public sector jobs. In the next section we characterize the structural model to conduct our analysis.

3 Model

In this section, we outline the model that will guide our quantitative assessment of the effect of public sector employment on inequality and the size of fiscal multipliers. Our artificial economy is populated by agents who live for a realistic number of periods, have preferences over consumption and leisure and choose at each period whether to work in the public or in the private sector. Individuals are ex ante heterogeneous with respect to their ability and face uncertainty about their labor productivity. Agents can accumulate a single risk-free asset, which takes the form of capital. Savings may be precautionary and allow partial insurance against the idiosyncratic shocks. We provide more detail about
the environment below.

3.1 Demography

Time is discrete and at each period $t$ a new generation is born. Individuals may live for at most $T$ periods. Uncertainty regarding the time of death is captured by the fact that each individual faces a probability $\psi_{t+1}$ of surviving to the age $t+1$ conditional on being alive at age $t$. The lifespan uncertainty entails that a fraction of the population leaves accidental bequests, which, for simplicity, are assumed to be distributed to all surviving individuals in a lump-sum basis.

We may map the survival probability into the time invariant age profile of the population denoted $\{\mu_t\}_{t=1}^T$. Letting $g_n$ denote the population growth rate, the fraction of agents $t$ years old in the population is found using the following law of motion

$$\mu_t = \frac{\psi_t}{1 + g_n} \mu_{t-1},$$

with $\mu_t \geq 0$, $\sum_{t=1}^T \mu_t = 1$.

For most of our analysis we will focus on the steady-state allocations. Since it greatly simplifies the presentation, we shall drop all time indices, $j$, from aggregate variables and use $t$ to represent age.

3.2 Private sector technology

Firms in the corporate sector produce the consumption good through a standard constant returns to scale production function:

$$Y_c = G^\infty K_c^\alpha N_c^{1-\alpha}, \ \alpha \in (0, 1).$$

They take prices as given and choose factors of production to maximize profits. The first-order conditions of a representative corporate firm are given by:

$$11$$
\[ r = \alpha G^x \left( \frac{K_c}{N_c} \right)^{\alpha-1} - \delta, \]  
(2) 
\[ w = (1 - \alpha)G^x \left( \frac{K_c}{N_c} \right)^\alpha. \]  
(3)

### 3.3 Government sector

We assume that the public good is produced by the government. The public good, \( G \), is produced using efficient labor units \( N_g \) and capital \( K_g \) according to the following technology:

\[ G = A_g K_g^\alpha N_g^{1-\alpha}, \quad A_g > 0. \]  
(4)

This is an aggregation of labor and capital to produce public goods and services such as paved roads and the rule of law. It is important to highlight that \( K_g \) in our model is capital, such as machines and equipments, employed in the public sector to produce public infrastructure. Capital employed in the public sector evolves according to the following law of motion:

\[ K_{g,t+1} = I_g + (1 - \delta_g)K_{g,t}, \]  
(5)

where \( I_g \) is financed through taxes.

There are two different social security regimes: A scheme for private workers and entrepreneurs and a scheme for public workers. The replacement rate for civil servants is different from the one faced by private sector workers. Consequently, in the model we have two types of retirees: individuals who retired from the public sector and individuals who retired from the private sector.

In addition, we assume that the government carries out an exogenous flow of expenditure, \( C_g \), which includes other parts of government consumption such as military expenditure that is deemed to be unproductive in our model. \( C_g \) is just useful to allow the model to match the actual aggregate share of government spending in the economy and it is kept constant in the quantitative exercises. In order to finance its expenditures, the government levies proportional taxes on consumption, \( \tau_c \) and on capital income, \( \tau_k \). Labor income taxes are al-
allowed to be non-linear. In particular, we use the specification $T(y) = y - \xi y^{1-\varepsilon}$.

### 3.4 Households

**Preferences** Agents derive utility from random paths for consumption, $c$, and leisure, $1-h$, according to

$$U = \max \{c, h\} \sum_{t=0}^{T} \beta^t \prod_{j=1}^{t} \pi_j [u(c, h)]$$

with

$$u(c, h) = \frac{c^{1-\sigma}}{1-\sigma} - \rho_0 \frac{(h + I_A \phi)^{1+\frac{1}{\eta}}}{1 + \frac{1}{\eta}} - I_P \rho_1$$

where $\beta, \sigma, \eta$ are respectively the discount factor, the risk aversion parameter and the Frisch labor supply elasticity. $I_P$ is an indicator function equal to one if individuals participate in the labor force and zero otherwise. The parameter $\phi$ is a fixed utility cost of participating in the labor force. The fixed cost generates an extensive margin decision through a nonconvexity in the utility function. This parameter is important for the model to match the labor force participation profile over the lifecycle.

In each period, agents decide how much of their time endowment to supply to the labor market and whether to work in the private sector or as a civil servant. The indicator function $I_A$ when private sector worker applies for public sector job. At the age $T_r$, agents retire and start to collect social security payments. The social security regime in the public sector is different from the one in the private sector and will be described bellow.

Agents in the private sector who want to work in the public sector must apply for a public job. There is a time cost $\theta > 0$ of searching for a public job and once individuals incur this cost, there is a probability $\bar{q}$ of getting a public sector job in the next period.\(^8\) $I_{A,t}$ is an indicator function that takes value 1 if they choose to apply for a public job and 0 otherwise. Therefore, related

\(^8\)An interpretation for this competition for public jobs is that individuals who would like to work in the public sector must take open exams and only those who obtain the best marks in these exams become eligible to fill a pre-determined number of job positions.
to the matching model literature (e.g., Mortensen and Pissarides, 1994), \( \theta \) is a
search cost and \( \bar{q} \) is the probability of finding a job offer, which depends on the
number of vacancies. We could condition the entry to a public sector job by the
individual human capital level and ability shock. We use the above approach
to simplify the analysis. Also, we view the public sector as a continuum of
different jobs which would require different levels of human capital. The fixed
lump-sum cost to apply for a public job implies that in equilibrium the decision
to apply for a public job will be correlated with an individual’s productivity and
assets.

**Labor Supply and earnings** In each period of life, and conditional on the
career choice, individuals make decisions about asset accumulation and labor
supply.

Each person has a unit time endowment which can be directly consumed in
the form of leisure, \( l \), or used in market related activities. An agent’s period-by-
period time constraint is \( l_t + h_t = 1 \). An individual of age \( t \) who works for \( h \)
hours in the private sector earns \( y_p = wh_t e^{(u+S_{p,t}+\kappa_{p,t})} \), where \( w \) is the rental rate. The variable \( u \sim \mathcal{N}(0, \sigma_u^2) \) is a permanent component of an individual’s skills. It is realized at birth and retained throughout one’s life. On the other hand, \( S_{p,t} \) evolves stochastically according to an AR(1) process, \( S_{p,t} = \varphi_p S_{p,t-1} + \varepsilon_{p,t} \), with innovations \( \varepsilon_{p,t} \sim \mathcal{N}(0, \sigma_{\varepsilon_p}^2) \). Analogously, an individual of age \( t \) who works for \( h \) hours in the public sector earns \( y_{cs} = (1 + \zeta) wh_t e^{(u+S_{g,t}+\kappa_{p,t})} \), where \( S_{g,t} \) follows an AR(1) process given by \( S_{g,t} = \varphi_g S_{g,t-1} + \varepsilon_{g,t} \), with innovations \( \varepsilon_{g,t} \sim \mathcal{N}(0, \sigma_{\varepsilon_g}^2) \).

Whereas \( u \) aims at capturing the heterogeneity at birth, everyone’s most rele-
vant lottery, \( S \) is the main source of uncertainty that affects one’s choices. The
parameter \( \varphi_s \) accommodates the empirically observed persistence of productiv-
ity shocks. \( \kappa_t \) is what we call the age-efficiency profile and it aims to capture the
evolution of individuals wages through working life.

This is to be consistent with the fact that labor legislation regarding, for in-
stance, firing might be different for civil servants when compared to private
workers. This might also be consistent with differences in job characteristics of
the two sectors.\(^9\)

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\(^9\)We do not model unemployment explicitly. In fact, better job security and low risk of un-
employment should be one of the main reasons that agents search for a job in the public sector.
**Asset Accumulation**  Besides choosing how much leisure to consume individuals trade a risk free asset which holdings we denoted by $a_t$.

Asset holdings are subject to an exogenous lower bound. More precisely, for our main exercise, we assume that agents are not allowed to contract debt at any age, so that the amount of assets carried over from age $t$ to $t+1$ is such that $a_{t+1} \geq 0$. Because no agent can hold a negative position in assets at any time, we assume without loss that asset takes the form of capital, $a_t = k_t$, as in 7.

Asset accumulation is, of course, an important aspect of life-cycle choices which we aim at capturing here. As we shall make clear, there is exogenous variation in productivity along the life-cycle. Consumption smoothing thus provides a reason for one to accumulate assets. Another aspect of choices is that individuals may resort to self-insurance to protect themselves against the uncertainty on labor income. Savings will be, to some extent, motivated by precautionary reasons.

**Budget Constraints**  The flow budget constraint that individuals in working age face in our model is

$$(1 + \tau_c)c + a' = [1 + (1 - \tau_k)r]a + \hat{y} - T(\hat{y})$$

(6)

At age $T_r$, agents retire and start collecting social security payments at an exogenously specified replacement rate of the last period earnings. In line with Fact 2 above, there are two main differences in the calculation of retirement benefits in each sector. First, the replacement rate, $\theta_m$, in the public sector is higher than in the private sector. Second, benefits in the private sector are capped by a limit denoted by $\bar{b}$, while there is no benefit cap in the public sector. Thus, the budget constraint for retirees can be written as follows:

$$(1 + \tau_r)c + a' = [1 + (1 - \tau_k)r]a + b_m$$

(7)

**Recursive formulation of individuals’ problems.**  Let $V_{m,t}(\omega_t)$ denote the value function of an individual aged $t$ in the occupation $m = cs, p$, where $\omega_t = (a_t, u, z_{m,t})$

However, we believe that this is captured by differences in the labor income processes between workers in the private sector and in the public sector.
is the individual state space. In addition, considering that agents die at age $T$ and that there is no altruistic link across generations, we have $V_{m,T+1}(\omega_{T+1}) = 0$. Thus, the choice problem of individuals aged $t$ who work in the private sector can be recursively represented as follows:\(^{10}\)

$$
V_{p,t}(\omega) = \max_{c,a'} u(c, h, 0) + \beta \pi_{t+1} E_s \left[ \max \left\{ V_{p,t+1}(\omega'), V_{cs,t+1}(\omega') \right\} \right]
$$

subject to (6),

**Recursive competitive equilibrium.** At each point in time, agents differ from one another with respect to age $t$ and to state $\omega_t = (a_t, u, z_{m,t}) \in \Omega$. Agents of age $t$ identified by their individual states $\omega$, are distributed according to a probability measure $\lambda_t$ defined on $\Omega$, as follows. Let $(\Omega, \mathcal{F}(\Omega), \lambda_t)$ be a space of probability, where $\mathcal{F}(\Omega)$ is the Borel $\sigma$-algebra on $\Omega$: for each $\eta \subset \mathcal{F}(\Omega)$, $\lambda_t(\eta)$ denotes the fraction of agents aged $t$ that are in $\eta$.

Given the asset $t$ distribution, $\lambda_t, Q_t(\omega, \eta)$ induces the asset $t + 1$ distribution $\lambda_{t+1}$ as follows. The function $Q_t(\omega, \eta)$ determines the probability of an agent at age $t$ and state $\omega$ transiting to the set $\eta$ at age $t + 1$. $Q_t(\omega, \eta)$, in turn, depends on the agents’ policy functions and on the exogenous stochastic process for $z$. Now, we have all the tools to characterize the stationary recursive competitive equilibrium. Households’ optimal behavior was previously described in detail above as well as the problem in the corporate sector, non-corporate sector and the government sector. It remains, therefore, to characterize the market equilibrium conditions, the aggregate law of motion, and the government budget constraint. In each period, there are two prices in this economy $(w, r)$. The

\(^{10}\)In order to simplify the notation, we have suppressed the subscript for age from both the state and control variables.
equilibrium in the labor and capital markets are defined by:

\[ K_p = \sum_{t=1}^{T} \mu_t \int_{\Omega} d_{a,t}(\omega) d\lambda_t \]

\[ N_p = \sum_{t=1}^{T} \mu_t \int_{\Omega} d_{pa,t}d_{h,t}(\omega)d\lambda_t + \sum_{t=1}^{T} \mu_t \int_{\Omega} d_{p,t}d_{h,t}(\omega)d\lambda_t \]

\[ N_g = \sum_{t=1}^{T} \mu_t \int_{\Omega} d_{cs,t}d_{h,t}(\omega)d\lambda_t \]

The consumption tax rate, \( \tau_c \), is such that it balances the government’s budget,

\[ C_g + I_g + (1 + \zeta)wN_g + B = \tau (wN_p + (1 + \zeta)N_g) + \tau K_p + \tau C, \]

where \( C \) denotes aggregate consumption and \( B \) denotes total benefits. The distribution of accidental bequests is given by:

\[ \epsilon = \sum_{t=1}^{T} \mu_t \int_{\Omega} (1 - \pi_{t+1})d_{a,t}(\omega)d\lambda_t. \]

Finally, given the decision rules of households, \( \lambda_t(\omega) \) satisfies the following law of motion:

\[ \lambda_{t+1}(\eta) = \int_{\Omega} Q_t(\omega, \eta)d\lambda_t \quad \forall \eta \subset F(\Omega). \]

4 Quantitative Analysis

In order to study quantitatively the extent to which changes in the labor of public sector employment changes the amount of insurance in the economy and the size of fiscal multiplies, we must assign values for the model parameters. We proceed by calibrating and estimating parameters such that the model economy matches key micro and macro statistics of the Brazilian economy. Brazil is an interesting case since it has a large public sector where jobs are more much stable than in the private sector. The model, however, is suffi-
ciently general to be applied to other countries, such as Spain, Portugal, India, among others. In fact, we also provide a cross-country analysis by calibrating the model using data from others economies and investigate the extent to which it can replicate the empirical relationship between public sector employment and the size of fiscal multiplies.

4.1 Calibration

Table 1 lists the value of each parameter for the Brazilian economy and includes a comment on how each was selected.

Model period and age distribution The model period is one year. We assume that individuals start their lives at the age of 25 and live until the age of 80. Therefore, the extension of their lifetimes in the model is 56 periods (T=56). The age population distribution, \( \{ \mu_t \}_{t=1}^{T} \), and the mortality risk are obtained from the Life Tables for the Brazilian population constructed by IBGE (National Central Statistical Agency) based on the 2010 census data.

Preference parameters We choose the intertemporal discount factor, \( \beta \), to match the capital-to-output ratio of 2.90, which is the value observed in the data.\(^{11}\) The coefficient of relative risk aversion, \( \gamma \), is set at 4.0, in line with the bulk of the literature on consumption surveyed by Attanasio (1999).

Production technologies We set the capital share \( \alpha \) at 0.36. This number is consistent with the one reported by Gomes, Bugarin, and Ellery-Jr. (2005), when the correction suggested by Gollin (2002) and Young (1995) about the self-employed income is taken into account. In addition, we assume that the capital stock depreciates at a rate of 6% per year, which is consistent to the figures used in the growth and development literature (cf., Parente and Prescott, 2000). We also set \( \delta_g = 0.06 \). According to the Brazilian Institute of Geography and Statistics (IBGE), the ratio of public goods to output is roughly 16% - using information

\(^{11}\)Using the Heston, Summers, and Aten (2012) Penn World Tables 7.1 and the inventory method, we find a value of 2.87 for the capital-to-output ratio in the Brazilian economy.
Table 1: External Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Values</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_t$</td>
<td>Age population distribution</td>
<td>-</td>
<td>IBGE 2010 Census</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Risk aversion</td>
<td>4</td>
<td>Attanasio (1999)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>Frisch elasticity</td>
<td>0.5</td>
<td>Kaplan (2012)</td>
</tr>
<tr>
<td>$\chi$</td>
<td>Importance of infrastructure</td>
<td>0.1</td>
<td>Hulten (1996)</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital share</td>
<td>0.36</td>
<td>Gomes et al. (2005)</td>
</tr>
<tr>
<td>$\delta = \delta_g$</td>
<td>Depreciation rate</td>
<td>0.06</td>
<td>Growth literature</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>Public-sector wage premium</td>
<td>0.25</td>
<td>PNAD survey</td>
</tr>
<tr>
<td>$\tau$</td>
<td>Income tax rate</td>
<td>18%</td>
<td>Paes and Bugarin (2006)</td>
</tr>
<tr>
<td>$\tau_k$</td>
<td>Capital income tax rate</td>
<td>15%</td>
<td>Paes and Bugarin (2006)</td>
</tr>
<tr>
<td>$\theta_g$</td>
<td>Replacement rate, pub. sector</td>
<td>1</td>
<td>Afonso (2016)</td>
</tr>
<tr>
<td>$\theta_p$</td>
<td>Replacement rate, priv. sector</td>
<td>0.82</td>
<td>Afonso (2016)</td>
</tr>
</tbody>
</table>

Table 2: Internal Calibration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Values</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
<td>1.03</td>
<td>Capital/Output, 2.90</td>
</tr>
<tr>
<td>$\rho_0$</td>
<td>Labor disutility</td>
<td>56.2</td>
<td>Average hours = 1/3</td>
</tr>
<tr>
<td>$\rho_1$</td>
<td>Utility cost of labor</td>
<td>1.048</td>
<td>Average retirement age</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Cost to apply for PSE</td>
<td>1.69</td>
<td>Flow of individuals aged 30-34 from private to public jobs</td>
</tr>
<tr>
<td>$\rho_p$</td>
<td>Persistence, priv. sector</td>
<td>0.88</td>
<td>Average tenure</td>
</tr>
<tr>
<td>$\sigma_{e_p}$</td>
<td>Var. of innov., priv. sector</td>
<td>0.0965</td>
<td>Match residual inequality</td>
</tr>
<tr>
<td>$\rho_g$</td>
<td>Persistence, pub. sector</td>
<td>0.98</td>
<td>Average Tenure</td>
</tr>
<tr>
<td>$\sigma_{e_g}$</td>
<td>Var. of innov., pub. sector</td>
<td>0.017</td>
<td>Match residual inequality</td>
</tr>
<tr>
<td>$1 - \bar{q}$</td>
<td>Selection criteria</td>
<td>0.85</td>
<td>Share of public servants</td>
</tr>
<tr>
<td>$\tau_c$</td>
<td>Consumption tax</td>
<td>0.30</td>
<td>Balance gov. budget constraint</td>
</tr>
<tr>
<td>$A_g$</td>
<td>TFP - Government sector</td>
<td>0.80</td>
<td>Share of public goods</td>
</tr>
<tr>
<td>$C_g$</td>
<td>Unproduct. gov. spending</td>
<td>2% of $Y$</td>
<td>Aggregate government spending</td>
</tr>
</tbody>
</table>

on production costs. Then, in order to match this ratio we set $A_g = 0.80$. To calibrate parameter $\chi$, we rely on estimates provided by Hulten (1996) who uses a cross-section of low income countries including Latin American countries and obtains a point estimate of 0.1 for $\chi$, which is the value we use.

4.2 Main Results
To be done...

5 Conclusions
References


BLANCHARD, O. J., AND D. LEIGH (2013): “Growth forecast errors and scalar multipliers,”


ILZETZKI, E., E. MENDOZA, AND C. VEGH (2013): “How big (small?) are fiscal multipliers?”


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