Public sector employment and aggregate fluctuations

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Public Sector Employment and Aggregate Fluctuations*

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Abstract

An important stylized fact about public sector employment is that it predominantly hires skilled and more experienced workers. In this paper, we consider a search and matching model with public sector and on-the-job human capital accumulation that incorporates this stylized fact to study how the public sector employment affects the labor market volatility. In the model, public sector employment affects aggregate fluctuations by changing the composition of workers employed in the private sector. Because workers accumulate human capital and become more productive when employed, the flows of benefits from forming a match are spread over time. In this environment, if the flow into the public sector increases with human capital, then the government hiring policy decreases the firm’s benefit of hiring and the matching surplus, increasing the responsiveness of labor market tightness to shocks. We calibrate the model for the Brazilian economy and show that this mechanism amplifies the effects of public employment on vacancy creation and private sector employment volatility.

Keywords: Public sector employment; Aggregate Fluctuations.

JEL Classifications: E24, E32, E62, J21, J45, J64

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1 Introduction

The public sector is the largest employer in the economy, both in advanced and developing economies. Behar and Mok (2019) report that Governments of OECD countries account for 18 percent of total employment. In addition, the hiring process in the public sector is biased towards skilled and more experienced workers. Giordano et al. (2011) report that the average share of workers with a tertiary education is 2.6 times higher in the public than in the private sector in Euro Area countries, ranging from 1.6 times in Belgium to 4.3 times in Portugal. In the case of Latin America, Mizala et al. (2011) report that the average years of education in the public sector are 3 to 6 years higher than in the private sector. Fontaine et al. (2020) show that the public sector represents a larger fraction of employment of older workers, accounting for 25 percent of their employment in France and the UK and 22 in Spain and the US, while it accounts for only a small fraction of total employment for young workers.

These facts indicate that the public sector employment may have important consequences for the overall performance of the labor market as the selection of skilled and more experienced individuals into the public sector affects the vacancy creation of firms and the searching decisions of workers in the private sector. In this paper, we consider a version of the Mortensen-Pissarides search and matching model with public sector that incorporates the stylized facts above to study the effects of hiring policies in the public sector on the private sector employment and labor market volatility.

Figure 1 presents the cross-country relationship between the share of public sector employment in the labor force and the labor market volatility for a large set of developing and advanced economies from 1980 to 2018. In the top panel, we show in the left figure the relationship for private employment, while the right figure shows the relationship for the unemployment rate. In both cases, volatility is measured by the average standard deviation and the solid line is the best linear fit. It can be seen that the higher the share of public sector employment, the bigger the standard deviation of both the private employment and the unemployment rate. In addition, in the bottom panel we show that the relationship is even stronger when one looks at the share of civil servants with tertiary education. We take the correlations in Figure 1 as suggestive evidence of the effect of public employment on labor market volatility.¹

In our model, households have preferences for consumption smoothing and individuals are organized in families that pool idiosyncratic risks as in Merz (1995) and Andolfatto (1996). The economy is closed so changes in aggregate productivity generate changes in aggregate consumption and thus discount rates. Lifespan is uncertain

¹It should be noted that the correlations presented in Figure 1 could be the outcome of reverse causality where government increases public employment in countries with higher unemployment volatility to insure workers in line with Rodrik (2000). However, more recent evidence in Gözgör et al. (2019) finds little support in favor of this channel.
Figure 1: **Public sector employment and labor market volatility** Left graph: Volatility in private sector jobs. Right graph: Unemployment volatility. Volatility is measured as the standard deviation. Source: ILO and IMF. The share of civil servants with tertiary education is from the World Bank’s Worldwide Bureaucracy Indicators.

and agents survive from one period to the next with a given probability. This stochastic OLG environment allows the model to accommodate differences in life-cycle earnings growth between private and public workers in a very tractable way. Individuals labor productivity is determined by two components. First, agents are ex-ante heterogeneous with respect to their ability, which can be described as pre-market skills obtained through education. The second component is interpreted as human capital or experience and accumulates in a learning-by-doing fashion. In particular, we build on the work of Ljungqvist and Sargent (1998) in assuming that worker’s productivity changes over time according to laws of motion that depend on whether the worker is employed or not. Employed agents experience increases in productivity on average, while non-employed agents experience declines in productivity on average. In addition, government hires civil servants to produce a public good that enters in the individuals utility functions. Both private firms and the government can direct their search by posting vacancies for agents of a given level of education and human capital. Job creation is exogenous in the public sector and is calibrated to reproduce the fact the government hires disproportionately more high skilled workers. The process of human capital upgrading and downgrading generates endogenous changes.
in wages and labor market states. For example, a private sector employee who upgrades his human capital may endogenously negotiate a higher wage or quit the job relationship in order to transit to the public sector.

The model economy is calibrated to be consistent with micro and macro evidence for the Brazilian economy. Brazil is an interesting laboratory since the public employment is relatively large and, as shown below, employs mostly skilled and more experienced workers. The model is able to match very closely the separation and job finding probabilities for each sector, as well as the average wage growth of continuously employed workers. In addition, vacancy creation in the public sector is treated as exogenous and is calibrated to match the share of civil servants by income quintile. Consistent with the data, public sector jobs in the benchmark model are concentrated at the right end of the skill distribution in such a way that civil servants correspond to nearly 42% of the top 20% earners.

We then use the calibrated model to study how the government hiring policy affects the job creation in the private sector and labor market volatility. To this end, we consider the following experiment. Starting with the economy at its steady state, we compute the impulse response function for the private sector employment in response to an unanticipated 1% drop in aggregate productivity. Next, we repeat the experiment in a counterfactual economy where job creation in the public sector is less biased towards skilled and more experienced agents, but keeping the size of government constant. We find that the fall in employment is nearly 35% smaller in the counterfactual economy compared to the benchmark economy.

We show that human capital accumulation is the key ingredient driving the differences in employment responses in our model. The channel through which the government hiring policy affects the private sector employment and the aggregate fluctuations is by reducing the expected return of a match for private sector firms. The intuition is that hiring workers is an investment activity in which costs are paid up front and benefits accrue gradually as workers’ productivity increase. This is so because the flows of benefits from forming a match are much longer-lived with on-the-job human capital accumulation. In this environment, if the flow into the public sector increases with the workers’ human capital then the government hiring policies reduce the expected benefits of a match for the firm, increasing the responsiveness of labor market tightness to shocks. This is the same intuition behind the results of Hagedorn and Manovskii (2008), who show that an increase in the flow value of unemployment results in a stronger response of market tightness to shocks due to smaller matching surplus.

Recent evidence in Bobba et al. (2021) suggests that on-the-job human capital accumulation is empirically relevant. In fact, using data for the Mexican economy, they find human capital accumulation is responsible for more than half of the overall value of production.
This paper contributes to a growing literature analyzing the interactions between public sector employment and labor market outcomes. Quadrini and Trigari (2007) add public sector to the basic search and matching model in order to study how wage policy in the public sector affects unemployment volatility. Similarly Hörner et al. (2007) consider a model with a private and a public sector, with risk averse agents and direct search, and find that public sector higher stability increases unemployment by inducing too many unemployed workers to queue for public sector jobs. Gomes (2015) uses a dynamic stochastic general equilibrium model with labor market frictions to study the optimal public sector compensation policy. Boeing-Reicher and Caponi (2016) study how the structure of government consumption determines the impact of the public sector on the private sector employment and its volatility. Albrecht et al. (2018) incorporate heterogeneous human capital and match specific productivity in the model to analyze various distributional questions, such as what types of workers tend to work in the public versus the private sector. Gomes (2018) examines the effects of a public-sector wage reform that eliminates the wage premium for all types of public-sector workers. Chassamboulli and Gomes (2019) set up a search and matching model with a private and a public sector to study the effects of wage policies in the public sector on unemployment and education decisions. Geromichalos and Kospentaris (2020) study how meritocratic government hiring can have unintended negative consequences on macroeconomic aggregates in the long-run. Navarro and Tejada (2020) study the interaction between public-sector employment and the minimum wage.

Taking a different approach, Burdett (2012) builds on the canonical job ladder model of Burdett and Mortensen (1998) and adds a public sector. Burdett’s model predicts that public employment should crowd out private employment. More recently, Bradley et al. (2017) also consider a version of the Burdett and Mortensen (1998) model with public sector employment and evaluate the effects from the adoption of austerity measures, such as reduction in public sector hiring and increase in layoffs; and progressive and proportional cuts to the public sector wage distribution. They show that despite decreasing jobs in the public sector, these policies increases hiring and turnovers in the private sector, with only modest changes in aggregate unemployment. Bettoni and Santos (2021) study how job security in the public sector affects household savings behavior and the aggregate performance of the economy in the long-run. Cavalcanti and Santos (2021) uses an occupational choice model to study how public sector wages affect aggregate productivity.

We contribute to the existing literature by studying the role of on-the-job human capital accumulation as a channel though which public sector employment distorts vacancy creation and affects labor market volatility. In addition, most of the literature has focused on the effects of the public sector wage premium, while the focus of our
paper is on the implications of a government that predominantly hires skilled and more experience workers.

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 Facts

We use data from Continuous National Household Sample Survey conducted by the Brazilian Institute of Geography and Statistics (PNADC-IBGE) for 2014. This household survey consists in a series of repeated cross sections representative at the National level. We include all workers aged 25-55 who reported positive earnings during the survey’s reference week. We do not model schooling decisions, thus we use only individuals that have finished their education. We exclude workers and individuals not economically active.

In the bottom panel of Figure 2, we display the distribution of workers by education (left) and income (right) for the public and the private sector. It can be seen that the public sector in Brazil employs 37 percent of college graduates, but only 17 percent of workers with lower qualifications. As consequence, the mass of civil servants is concentrated at the top of the income distribution. In fact, among the richest 20%, the share of the public employment corresponds to nearly 39%, while this figure is just 1% and 8.5% for the first and second quintile respectively.

![Distribution of schooling by sector](image1)

![Distribution of workers by sector](image2)

Figure 2: Facts about public sector in Brazil. Data is PNADC for 2014. We include all workers aged 25-55 who reported positive earnings during the survey’s reference week. We exclude workers and individuals not economically active.

In order to obtain estimates of worker flows, we use data from Pesquisa Mensal de Emprego (PME), a household rotating panel conducted by IBGE in Brazil’s six largest metropolitan regions. Each individual is interviewed during four consecutive
months, then for another four consecutive months one year after their entry into the sample. To construct the estimates of worker flows, we follow individuals for up to the first four months or until their first transition (if sooner). Using the first move to compute transitions minimizes the effects of attrition. At the first interview we observe worker’s employment status. We then use information on employment status and time in the current job from the subsequent three months to construct the estimates.

In Table 1, we show the flow of workers between private and public sector by age, education and income. It can be seen that transitions from private to public sector jobs are increasing on individuals’ experience and the relationship is much steeper for workers with at least a college degree and for workers with high wages. In contrast, direct transitions from public to private sector are much smaller. In fact, the flow of civil servants with college to the private sector decreases with age going from 0.88% at the ages of 31-35 to 0.69 at the ages of 46-50. The flows are somewhat bigger when we control for civil servants’ wages but the pattern is similar. Overall, these flows indicate that average tenure in the public sector is much higher than in the private sector. This is consistent with the fact that civil servants have job security and very few of them choose to leave their job voluntarily to work in the private sector.

Table 1: Flows between private and public sector (%)

<table>
<thead>
<tr>
<th>Age</th>
<th>31-35</th>
<th>36-40</th>
<th>41-45</th>
<th>46-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow from private to public</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with college or more</td>
<td>5.23</td>
<td>5.91</td>
<td>6.35</td>
<td>7.86</td>
</tr>
<tr>
<td>with less than college</td>
<td>2.09</td>
<td>2.49</td>
<td>3.00</td>
<td>3.65</td>
</tr>
<tr>
<td>with high wage</td>
<td>5.36</td>
<td>6.02</td>
<td>6.49</td>
<td>8.12</td>
</tr>
<tr>
<td>with low wage</td>
<td>1.82</td>
<td>2.23</td>
<td>2.85</td>
<td>3.32</td>
</tr>
<tr>
<td>Flow from public to private</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with college or more</td>
<td>0.88</td>
<td>0.71</td>
<td>0.66</td>
<td>0.69</td>
</tr>
<tr>
<td>with less than college</td>
<td>1.04</td>
<td>0.84</td>
<td>1.24</td>
<td>1.33</td>
</tr>
<tr>
<td>with high wage</td>
<td>0.93</td>
<td>0.74</td>
<td>0.68</td>
<td>0.64</td>
</tr>
<tr>
<td>with low wage</td>
<td>1.21</td>
<td>1.08</td>
<td>1.06</td>
<td>1.13</td>
</tr>
</tbody>
</table>

Notes: PME 2002-2012. Monthly flows between sectors. High wage corresponds to the top 20% of wages, while low wage corresponds to the bottom 20%.

3 Model

We consider a search and matching model with risk-averse agents and two sectors. Public sector variables are denoted by the subscript \( g \), while private sector variables
are denoted by \( p \). Time is denoted by \( t = 0, 1, 2, \ldots \).

The economy is populated by overlapping generations of individuals who face an exogenous probability, \( \nu \), of surviving to the next period. At each period, \( 1 - \nu \) new agents are born and \( 1 - \nu \) die, so that the population remains constant at the normalized unit level. As shown below, this life-cycle structure allows the model to take into account differences in earnings growth between the two sectors in a very tractable way.

Individuals labor productivity is determined by two components. The first one, denoted by \( s \) is realized at birth and retained throughout one’s life. It can be interpreted as innate ability and pre-market skills obtained through education.\(^3\) Let \( \varphi_s \) denote the share of agents with skill \( s \) in the population. The second component, \( z \), evolves over time both because of the on-the-job human capital accumulation, the out-of-the-job human capital depreciation, as well as the idiosyncratic productivity shocks. The law of motion for \( z \) is described below.

Individuals are organized into representative households that can be thought of as consisting of a very large number of members who pool their income and thus provide each other with complete insurance against idiosyncratic risks. This type of risk-sharing arrangement is in line with the work of Merz (1995) and Andolfatto (1996). In addition, it is assumed that the economy is closed, so changes in aggregate productivity affect the family’s discount factor as in Hall (2017) and Kehoe et al. (2019).

The family has preferences over the consumption of its members, \( c_t \), and over a public good provided for free by the government, \( g_t \).

\[
\max_{c_t} \sum_{t=0}^{\infty} \beta^t u(c_t, g_t)
\]

where the instantaneous utility function takes the form:

\[
u(c_t, g_t) = \frac{c_t^{1-\gamma}}{1-\gamma} + \frac{g_t^{1-\gamma}}{1-\gamma}
\]

(1)

Risk sharing within the family implies that at date \( t \), each household member consumes the same amount of consumption goods, \( c_t \), regardless of the idiosyncratic shocks that such a member experiences. The family faces the following budget constraint:

\[
c_t + g_t + q_t a_{t+1} = a_t + \int y_{t, t} dt - T_t + \Pi_t
\]

where \( a_{t+1} \) are the family’s holdings of a one-period-ahead security that trades at a

\(^3\)In the quantitative analysis in section 4, the ex-ante heterogeneity will be fully described by education.
price $q_t$. The term $\int y_{i,t} di$ represents the total income of all the members of the family, which includes wages for those members that are employed and home production for those that are not employed, while $T_t$ accounts for the government taxation. In addition, $\Pi_t$ are the profits net of vacancy posting costs that the family receives from its ownership of firms in the economy. As we show below, since firms are owned by families, they discount future flows using the same discount rate that workers use to discount future wages.

### 3.1 Individual Employment Problem

Let $w_{s,j,t}$ denote the wage in sector $j = g, p$ and skill $s$, and $b$ the home production when non-employed. Thus, we can write the income at time $t$ as follows.

$$y_t = \sum_s \left[ e_{s,g,t} w_{s,g,t} + e_{s,p,t} w_{s,p,t} + (1 - e_{s,g,t} - e_{s,p,t}) b \right]$$

where $e_j \in \{0, 1\}$ with $j = g, p$ is an indicator function describing the worker’s employment status.

An individual member chooses to work either in the public or the private sector or remain unemployed in order to maximize the present value of income using the family’s discount factor. Since all members have a constant survival hazard $\psi$, the objective of the individual member is

$$\max e_{g,t}, e_{p,t} \sum_{t=0}^{\infty} \sum_{\omega^t} \psi^t Q_t \pi(\omega^t) y_t$$

where $\pi(\omega^t)$ denote the probability of a given history up to time $t$ of shocks, $\omega^t$, occurring and

$$Q_t = \beta \frac{u'(c_t)}{u'(c_0)}$$

is the family’s marginal valuation of date $t$ output. The one-period-ahead discount factor is thus equal to

$$\frac{Q_{t+1}}{Q_t} = \beta \frac{u'(c_{t+1})}{u'(c_t)}$$

The maximization problem in 3 is constrained by the search and matching frictions and the government hiring policy as described below.
3.2 Human capital and output

A worker is characterized by a skill \( s \) and a productivity level \( z \) which gives the amount of output, \( sz \), that she produces if matched with a firm. In line with Ljungqvist and Sargent (1998) and Kehoe et al. (2019), we think of \( z \) as representing the individual worker’s human capital or experience, which is accumulated on the job in a leaning-by-doing fashion. The human capital dynamic while in the labor market is characterized by upgrading on the job and downgrading while searching. The processes are characterized by shocks moving agents’ up and down the job ladder. In particular, the human capital of an employed worker evolves according to the following skill and sector-specific law of motion, with \( j = p, g \):

\[
\log z' = (1 - \rho_j)\mu_{s,j} + \rho_j \log z + \sigma_j \epsilon'
\]

where \( \rho_j \) determines the persistence, \( \sigma_j \) the volatility and \( \mu_{s,j} \) the mean of the process, while \( \epsilon \) is a Gaussian disturbance with zero mean and unit variance.

We allow for the volatility of the shock, \( \sigma_j \), the persistence, \( \rho_j \), and the mean, \( \mu_{s,j} \) to be different across sectors. This is to be consistent with the fact that labor legislation regarding, for instance, 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. In addition, allowing for idiosyncratic shocks \( \epsilon \) to human capital accumulation allows the model to reproduce the dispersion in wage growth rates observed in the data.

A non-employed worker’s human capital evolves according to a similar AR(1) process with the same volatility but with a different mean (which we normalize to 0) and persistence \( \rho_u \):

\[
\log z' = \rho_{u,j} \log z + \sigma_j \epsilon'
\]

We represent below the Markov processes in (2) and (3) as \( F_{s,j}(z, z') \) and \( F_{s,u}(z, z') \). Finally, newborn workers enter the economy endowed with a draw of \( z \) from a log-normal distribution with mean zero and variance equal to the unconditional variance of productivity process for the unemployed \( \log(z) \sim N(0, \sigma_j^2/(1 - \rho_{u,j}^2)) \).

These laws of motion imply that a newborn worker’s productivity increases on average over time since its productivity converges to \( \exp(\mu_{s,j}) \) from below. The speed at which productivity and, as a consequence, the wage grow over the employment spell is determined by the persistent parameter \( \rho_j \). Similarly, if \( \rho_u \) is relatively low, non-employed workers experience a reduction in their human capital since their productivity converges to \( \exp(0) \) from above. The model thus produces saw-toothed individual productivity profiles: growth while employed and decline while non-employed.
3.3 Matching Technology

We assume that both private and public sectors are subject to matching frictions and that they share the same pool of unemployed workers. Firms and government can direct their search for individuals submarket by submarket, by posting vacancies for agents of a given of level of skill $s$ and human capital $z$. The search is random within each submarket. Let $u_{s,t}(z)$ be the measure of nonemployed individuals with skill $s$ and human capital $z$ and $v_{s,p,t}(z)$ the corresponding measure of vacancies posted by firms in the private sector for agents in submarket $(s, z)$. The flow of successful matches in the private sector within a period are given by the following matching function

$$M_{s,p,t}(z) = \chi_{s,p}u_{s,t}(z)\zeta v_{s,p,t}(z)^{1-\zeta}$$

Dividing 6 by $u_{s,t}(z)$, we can write the probability that an unemployed agent is successfully matched with a private sector firm as follows.

$$m_{s,p,t}(z) = \chi_{s,p}\theta_{s,p,t}(z)^{1-\zeta}$$

where $\theta_{s,p,t}(z)$ is labor market tightness in the submarket $(s, z)$.

Dividing 6 by $v_{s,p,t}(z)$ gives the private sector firm’s matching probability in the submarket $(s, z)$

$$\lambda_{s,t}(z) = \chi_{s,p}\theta_{s,p,t}(z)^{-\zeta}$$

Vacancies in the public sector are exogenous and denoted by $v_{s,g,t}(z)$. Nonemployed agents search in both the public and private sector. Agents employed in the private sector, $n_{s,p,t}$, can search in the public sector which is consistent with the fact that this type of transition account for a large fraction of the flow into the public sector in the data. For tractability, however, we do not allow for on-the-job search within the private sector. The flow of successful matches in the public sector within a period is given by the following matching function

$$M_{s,g,t}(z) = \chi_{s,g} [u_{s,t}(z) + \iota n_{s,p,t}(z)]\zeta v_{s,g,t}(z)^{1-\zeta}$$

where $\iota$ is the relative search intensity of employed workers vis-a-vis unemployed and $u_{s,t}(z) + \iota n_{p,t}(z)$ is the effective pool of agents searching for a public sector job at time $t$ in the submarket $(s, z)$. Thus, the probability of an unemployed worker meets

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4Thus, we are assuming that both dimensions of heterogeneity are observable and contractable.

5In fact, according to PNADC, it accounts for nearly 42% of the flow into the public sector considering employed and unemployed workers.
a vacancy in the public sector can be written as follows:

\[ m_{s,g,t}(z) = \chi_{s,g} \theta_{s,g}(z)^{1-\zeta} \]  

(10)

where

\[ \theta_{s,g}(z) = \frac{v_{s,g}(z)}{u_{s,t}(z) + m_{s,p,t}(z)} \]

and the probability of an employed worker finds a public sector job is \( \imath m_{s,g,t}(z) \).

Assuming two separate matching processes is meant to capture the idea that (i) private and public jobs are not necessarily found in similar places and that (ii) the efficiency of the two matching processes may differ somewhat because the recruiting process is different.\(^6\)

Finally, at each period matches are exogenously destroyed according to a Poisson rate that depends on skill and sector, \( \delta_{s,j} \) with \( j = \{g,p\} \).

### 3.4 Bellman equations

The consumer’s value in any date depends on whether the consumer is employed or not. The value of a worker employed in the private sector is given by its current wage, \( w_{s,p}(z) \) as well as the discounted sum of future output:

\[
V_{s,p}(z) = w_{s,p}(z) + \mathbb{E}_t \psi \frac{Q_{t+1}}{Q_t} \left[ \imath m_{s,g}(\theta_{s,g}) \sum_{z'} F_{s,p}(z, z') \max\{V_{s,g}(z'), V_{s,p}(z')\} \right] \\
+ \delta_{s,p} \sum_{z'} F_{s,p}(z, z') V_{s,u}(z') + (1 - \delta_{s,p} - \imath m_{s,g}(\theta_{s,g})) \sum_{z'} F_{s,p}(z, z') \max\{V_{s,p}(z'), V_{s,u}(z')\} 
\]

(11)

where \( \mathbb{E}_t \) is the mathematical expectation over aggregate productivity conditioned on the date \( t \) information. Notice that the continuation value reflects the consumer’s survival probability \( \psi \), the family’s discount factor \( \frac{Q_{t+1}}{Q_t} \) with which the workers discount future output, the exogenous separation probability \( \delta_{s,p} \) and the decision of whether to continue a relationship. In addition, private sector workers can receive a job offer from the public sector. If successful, the match with a public sector job occurs at date \( t \), but the agent does not begin to work until date \( t + 1 \), by which time the consumer’s general human capital has evolved to \( z' \) according to the law of motion \( F_{s,p}(z, z') \) for the private sector worker described above.

A worker employed in the public sector can not search for a private sector job.\(^7\)

\(^6\)Our approach is related to Albrecht et al. (2018) who also assume random search. However, they assume one matching function to describe the labor market frictions, implicitly assuming that the hiring process is the same in both sector sectors.

\(^7\)This is consistent with the data. In fact, direct transitions from public to private sector are relatively rare in Brazil. Albrecht et al. (2018) show that this is also the case for Colombia.
The value of a civil servant is given by its current wage, $w_{s,g}(z)$ plus the discounted sum of future output as follows:

$$V_{s,g}(z) = w_{s,g}(z) + \mathbb{E}_t \psi \frac{Q_{t+1}}{Q_t} \left[ (1 - \delta_{s,g}) \sum_{z'} F_{s,g}(z, z') \max \{ V_{s,g}(z'), V_{s,u}(z') \} ight. \\
+ \left. \delta_{s,g} \sum_{z'} F_{s,g}(z, z') V_{s,u}(z') \right]$$ \quad (12)

Similarly, the value of a non-employed worker is given by the amount it produces at home, $b$, as well as the discounted sum of future output:

$$V_{s,u}(z) = b + \mathbb{E}_t \psi \frac{Q_{t+1}}{Q_t} \left[ m_{s,g}(\theta_{s,g}) \sum_{z'} F_{s,u}(z, z') \max \{ V_{s,g}(z'), V_{s,u}(z') \} ight. \\
+ \left. m_{s,p}(\theta_{s,p}) \sum_{z'} F_{s,u}(z, z') \max \{ V_{s,p}(z'), V_{s,u}(z') \} ight. \\
+ \left. (1 - m_{s,g}(\theta_{s,g}) - m_{s,p}(\theta_{s,p})) \sum_{z'} F_{s,u}(z, z') V_{s,u}(z') \right]$$ \quad (13)

Notice that the nonemployed agent searches in both sector and thus the continuation value reflects the probability that an agent with type $(s, z)$ is matched with a firm in the private sector, $m_{s,p}(\theta_{s,p}(z))$, and a public sector job, $m_{s,g}(\theta_{s,g}(z))$. In addition, the unemployed may choose to turn down an offer even in the event it matches with a vacancy.

### 3.5 Firm values in the private sector

Each firm in the private sector pays a vacancy cost to form a match, produces output when matched, and pays dividends to the family. The objective of each firm is to maximize the discounted value of dividends using the discount factor of the family it belongs to. A firm that is matched with a worker with skill $s$ and productivity $z$ produces $A sz$ units of output, where $A$ is common to all firms and evolves over time according to

$$\log A' = \rho_A \log A + \epsilon'$$ \quad (14)

where $\epsilon$ is an i.i.d. $N \sim (0, \sigma^2_\epsilon)$ random variable, the only source of aggregate uncertainty in the model economy.

We assume throughout that the worker’s search decision is private information. Therefore, it is not observable by his employer. Thus, the value of a filled vacancy in the private sector is given by the firm’s current profits, output net of wages, as well
as the present discounted value of future profits as follows.

\[ J_s(z) = A sz - w_{s,p}(z) + \mathbb{E}_t \psi_t \frac{Q_{t+1}}{Q_t} \left[ 1 - \delta_{s,p} - m_{s,p}(\theta_{s,p}(z)) \right] \sum_{z'} F_{s,p}(z, z') \max\{J_s(z'), 0\} \]

(15)

where the continuation value captures the possibility that a match no longer yields a positive value to the firm and is thus destroyed.

There is a large number of potential entrants in the private sector that can create a new vacancy in any submarket \((s, z)\) at a cost \(\kappa_{s,p}\). The free-entry condition in submarket \((s, z)\) is given by

\[ 0 = -\kappa_{s,p} + \mathbb{E}_t \psi_t \frac{Q_{t+1}}{Q_t} \lambda(\theta_{s,p}(z)) \sum_{z'} F_{s,u}(z, z') \max\{J_s(z'), 0\} \]

(16)

A private-sector firm with a vacancy does not know what worker type it will meet next period. The firm does know, however, the distribution of worker types among the unemployed. The free entry condition pins down the vacancy-unemployment ratio in each submarket \((s, z)\) in the private sector, \(\theta_{s,p}(z)\). Clearly, no vacancies are created in submarket \((s, z)\) if the value of expected profits conditional on matching is sufficiently low in that submarket. This occurs for all values of \((s, z)\) such that even if a vacancy leads to a match for a firm with probability 1, expected profits are lower than the vacancy posting cost.

Vacancy creation in the public sector is treated as a policy parameter. In particular, we assume that the public sector posts an exogenous measure of vacancies, \(v_{s,g}(z)\), in each submarket \((s, z)\).

### 3.6 Wage determination

We assume that the private-sector wage for a worker with skill \(s\) and productivity \(z\) is determined via Nash bargaining with exogenous worker share parameter \(\eta\). Wages are renegotiated period by period and thus, long-term contracts are not enforceable, which implies that a firm cannot commit to pay any predetermined wage schedule. Given the free-entry condition for private-sector vacancy creation, wages in the private sector, \(w_{s,p}(z)\), solve the following maximization problem:

\[ \max_{w_{s,p}(z)} \left[ V_{s,p}(z) - V_{s,u}(z) \right]^\eta J_s(z)^{1-\eta} \]

Finally, the wage function in the public sector is exogenous. In particular, we assume that the wage setting rule for the civil servants is given by

\[ w_{s,g}(z) = (1 + \phi(z))w_{s,p}(z) \]

(17)
where \( \phi(z) \) denotes the exogenous public sector wage premium, which may depend on the agent’s human capital \( z \) and vary along the wage distribution.

### 3.7 Government

The government produces its goods using a linear technology on labour. This type of good is different from private consumption goods: it is non-rival and supplied to the representative family for free. The government sets a policy for the sequence of vacancies in each submarket \( \{v_{s,g,t}(z)\}_{t=0}^{\infty} \). As in the private sector, the costs of posting vacancies are deducted from production.

\[
g_t = A_{g,t} n_{g,t} - \sum_s \phi_s \kappa_{s,g} v_{s,g,t} \tag{18}
\]

where \( \phi_s \) is the share of agents with skill \( s \), \( n_{g,t} = \sum_s \phi_s \sum_z n_{s,g,t}(z) \) is the aggregate public sector employment and \( v_{s,g,t} = \sum_z v_{s,g,t}(z) \) is the aggregate number of vacancies for skill \( s \). The government collects lump sum taxes to finance its wage bill:

\[
\tau_t = \sum_s \phi_s \sum_z w_{s,g,t}(z)n_{s,g,t}(z) \tag{19}
\]

The numeraire of this economy is the private consumption good. As a public good is not sold, it has no actual price. However, there is an implicit relative price given by the marginal rate of substitution. The formulation of the production function 18 implies that the cost of recruiting is given in units of the public good. Alternatively, if the cost was included in the budget constraint, it would be expressed in units of private consumption.

### 4 Quantitative Analysis

In order to study quantitatively how the public sector biased selection towards workers with more experience affect job creation in the private sector and labor market volatility we estimate and calibrate the model’ parameters such that the model economy matches key micro and macro statistics of the Brazilian economy.

#### 4.1 Calibration

We separate the parameters into two groups: those in the first group are determined exogenously, and those in the second group are calibrated internally. As is customary, we associate the parameters with the target that provides the most intuition for its
value, but all parameters are determined jointly. The value of the parameters and
their source/target are shown in Table 2.

The model period is a quarter. We divide the labor force into two ex ante ability
types according to levels of education: Less than college \((s = nc)\) and college or
more \((s = c)\). Based on PNADC, the correspond population share of each group is
\(\varphi_{nc} = 0.79\) and \(\varphi_c = 0.21\), respectively.

The discount factor is set at 0.986, which entails an interest rate of nearly 6% in
annual terms. A large literature finds that the elasticity of intertemporal substitution
is low on the order of 0.1 to 0.5 when estimated using data on households.\(^8\) We follow
this literature and set \(1/\gamma\) equal to 0.3. According to the Brazilian Institute of Geogra-
phy and Statistics (IBGE), the ratio of public goods to output is roughly 17% - using
information on production costs. Then, we set \(\xi\) equal to 0.22 in order to match this
ratio. The survival rate \(\psi\) is set so that workers stay in the labor market for 40 years
on average.

We set the matching elasticity, \(\zeta\), equal to 0.5, which falls in the range of the es-
timates obtained by Petrongolo and Pissarides (2001). Following common practice
(see e.g. Rogerson et al. (2005)), we set the bargaining power parameter, \(\eta_s\), to 0.5.
In addition, the value of home production, \(b\), is calibrated so as to ensure that the
employment-population ratio is equal to 0.8. The implied value of \(b\) is equal to nearly
40% of workers’ average wage.

We use information on new hires for each sector as a proxy for the job-finding rate.
For individuals with at least college, the probability of finding a job in the government
sector is only 1.16 percent compared to 49.7 percent in the private sector, while for
agents with less than college these figures are 0.91 and 44.2 percent, respectively. We
then use these moments to calibrate the matching efficiency parameters, \(\chi_{s,g}\) and \(\chi_{s,p}\).
To calibrate the relative search intensity of employed workers, \(\iota\), we use the fact that
employed workers accout for nearly 42% of transitions into the public sector.

We follow Shimer (2005) and choose the fixed cost of posting vacancies in the
private sector, \(\kappa_{s,p}\), so as to ensure that the vacancy-unemployment ratio in the steady
state of the model is equal to 1. This is simply a normalization that reflects a choice of
units and is otherwise inconsequential. The cost of posting vacancies is assumed to
be the same across the two sectors so that \(\kappa_{s,g} = \kappa_{s,p}\).

We set the public wage premium for workers to be equal to \(\phi = 0.19\), which is
consistent with the estimate of the conditional public wage premium provided in re-
gression (5), Table 4 in the appendix. Even though 19% is the lower bound of the
estimates presented in table 8, we believe that the specification (5) is the most con-
vincing since it also controls for occupation. The assumption that \(\phi\) does not depend

\(^8\)See Guvenen (2006) and the references therein.
on $z$ is consistent with the data. In fact, we show in Figure 8 of the appendix that in Brazil the public sector wage premium is quite flat for different quintiles of the conditional wage distribution.

Vacancy creation in the public sector is exogenous and is calibrated to match the share of civil servants by education and income. As shown in section 2, public sector workers are over represented in the right end of the income distribution, representing nearly 40% of the top 20% earners and less than 1% of the bottom 20%. We choose $v_{s,g,t}(z)$ for each sub-market $(s, z)$ so that the model can reproduce those moments. The implied steady state level of public sector employment corresponds to 13.8% percent of total employment under the baseline calibration.

We calibrate $\delta_{s,p}$ and $\delta_{s,g}$ to match the separation rate into unemployment for each sector. This separation rate in the private sector is 5.3% for agents with less than college and 2.42% for the ones with college or more. In the public sector, these figures are 1.86% and 0.84% respectively.\(^9\) For both education groups, we see that the separation rate in the private sector is almost three times higher than in the government, which is consistent with the fact mentioned in section 2 that jobs in the public sector are much more stable. In fact, these numbers imply that the average employment spell is nearly 5 years in the private sector and nearly 13 years for civil servants.

### Table 2: Calibration of model parameters

<table>
<thead>
<tr>
<th>Parameter Description</th>
<th>Values</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\beta) Discount factor</td>
<td>0.9940</td>
<td>Interest rate of 6%</td>
</tr>
<tr>
<td>(\gamma) Risk aversion</td>
<td>3</td>
<td>Guvenen(2006)</td>
</tr>
<tr>
<td>(\psi) Survival rate</td>
<td>1-1/480</td>
<td>40 years in the market</td>
</tr>
<tr>
<td>(\phi) Public sector wage premium</td>
<td>0.19</td>
<td>PNAD survey</td>
</tr>
<tr>
<td>(\eta) Workers’ bargaining weight</td>
<td>0.50</td>
<td>Literature</td>
</tr>
<tr>
<td>(\zeta) matching elasticity</td>
<td>0.50</td>
<td>Literature</td>
</tr>
<tr>
<td>(\kappa_{nc,p}, \kappa_{c,p}) vacancy posting cost</td>
<td>1.33, 1.49</td>
<td>normalization of (\theta_{s,p})</td>
</tr>
<tr>
<td>(\varphi_{nc}, \varphi_c) population share</td>
<td>0.79, 0.21</td>
<td>PNAD survey</td>
</tr>
<tr>
<td>(\xi) Preference for gov. services</td>
<td>0.22</td>
<td>Share of public goods</td>
</tr>
<tr>
<td>(b) Nonemployment income</td>
<td>0.83</td>
<td>priv. sector employment rate</td>
</tr>
<tr>
<td>(\chi_{nc,p}, \chi_{nc,g}) matching efficiency param.</td>
<td>0.45, 0.22</td>
<td>job finding rate</td>
</tr>
<tr>
<td>(\chi_{c,p}, \chi_{c,g}) matching efficiency param.</td>
<td>0.54, 0.26</td>
<td>job finding rate</td>
</tr>
<tr>
<td>(\delta_{nc,p}, \delta_{nc,g}) Job destruction</td>
<td>0.053, 0.018</td>
<td>separation rate into unemployment</td>
</tr>
<tr>
<td>(\delta_{c,p}, \delta_{c,g}) Job destruction</td>
<td>0.024, 0.008</td>
<td>separation rate into unemployment</td>
</tr>
<tr>
<td>(\mu_{nc,p}, \mu_{nc,g}) mean of human capital</td>
<td>0.5, 1.3</td>
<td>earnings growth</td>
</tr>
<tr>
<td>(\mu_{c,p}, \mu_{c,g}) mean of human capital</td>
<td>1.5, 2.3</td>
<td>earnings growth</td>
</tr>
<tr>
<td>(\sigma_p, \sigma_g) Var. of human capital shocks</td>
<td>0.16, 0.08</td>
<td>Residual inequality</td>
</tr>
<tr>
<td>(\rho_p, \rho_g) Persistence of human capital</td>
<td>0.93, 0.96</td>
<td>earnings growth</td>
</tr>
<tr>
<td>(\iota) Employed search intensity</td>
<td>0.36</td>
<td>share of employed transitions</td>
</tr>
</tbody>
</table>

\(^9\)These are the average flows for all quarters in 2014.
The parameters that characterize the human capital dynamic are \((\mu_{s,j}, \rho_j, \sigma_j)\) with \(j = p, g\) for the employed state and \((\rho_u, \sigma_u)\) for the unemployed state. For computational reasons, we use the algorithm described in Tauchen (1986) to approximate these stochastic processes for each sector by a first-order Markov chain with 21 points. We do not have direct information about events that may change human capital on the job, such as training, specific knowledge acquisition, or testing of skills. Thus, we use information on life cycle earnings for each sector to identify these parameters. In particular, we choose \((\mu_{s,j}, \rho_j)\) to approximate the simulated earnings profile with the one computed from the Mincerian regressions presented in Table 4 in the appendix. Then, we use the residual variance to pin down \(\sigma_j\). Finally, we assume that \(\rho_u = \rho_p\) and \(\sigma_u = \sigma_p\). The values that we obtain are presented in Table 2.

Figure 3 shows how human capital (in log) evolves over the employment spell under the baseline calibration. On the left graph, we show the human capital dynamic for a single newborn who enters the private sector with mean human capital and, on the right, we show the average human capital of a sample of newborns who enters the market with mean human capital, both in the public and in the private sector. Even though there is a lot of volatility at individual level, workers’ productive grows on average over time. The growth is very quick with the first few years of experience, and then slows down sharply.

**Figure 3: Human capital over the employment spell:** On the left, we show the human capital dynamic for two private sector workers who entered the market with mean human capital. On the right, we show the average human capital for a sample of newborns who enters the market with mean human capital. Both graphs are in log.

5 Results

In order to study the impact of selection into the public sector on employment volatility, we conduct the following experiment. First, we suppose that the economy is at its steady state. Then, we assume that there is an unanticipated 1% drop in aggre-
gate productivity at period one. This drop is unexpected prior to the first period and individuals have perfect foresight afterwards. We set $\rho_A = 0.9$ so that the model matches average business cycle length in Brazil as documented by Campelo Jr et al. (2013). We run this experiment for the benchmark economy and for two counterfactual economies where vacancy creation in the public sector is less concentrated at right end of the wage distribution. To understand the role of education composition versus experience composition, we proceed as follows. In the first counterfactual, we keep the education composition as in the benchmark and redistribute the vacancies in the public sector towards less productivity individuals - those with lower $z$ - in such a way that the size of the public sector is kept constant.\footnote{By keeping the share of civil servants unchanged, we are able to focus on the effects of the composition of workers in each sector. We study the role of size of public employment in section 5.} Then, in the second counterfactual, we also adjust vacancy creation in the public sector along the $s$ dimension in order to generate an uniform distribution of education in each sector.

Figure 4 presents the share of workers in the public sector by income. Notice that the share of civil servants is still increasing in labor income in the counterfactual economy but the relationship is much less steep. In fact, in the case where we adjust both the education and the experience composition in the public sector — labeled as "Counterfactual, both $(z, s)$" — the share of civil servants among the top 20% wages is nearly 30% as opposed to 42% in the benchmark.
converges to the steady state. Given this guess, we solve for the value functions of workers and firms by backward induction. These value functions allow us to calculate the evolution of the measures of civil servants, private sector workers and unemployment by forward iteration, starting from the steady state in period one. Finally, we use the equilibrium conditions to update our initial guess for market tightness and consumption and repeat until convergence.

Figure 5 displays the resulting paths of productivity, private sector employment, unemployment and average private sector wages for all economies in the quarters following the shock. It can be seen that in all cases the drop in private sector employment is higher around 5 periods after the shock. However, in the benchmark case the drop is much more pronounced, being almost 0.16 percentage point higher than the counterfactual in which we adjust both the education and the experience composition in the public sector. Interestingly, as shown in the impulse response function labeled as "Counterfactual, just $\varepsilon$", most of this difference, nearly 70%, is accounted by the experience composition.

These results indicate that the channel through which the government hiring policy affects the private sector employment and the aggregate fluctuations is by reducing the expected return of a match for private sector firms. The intuition is that hiring workers is an investment activity in which costs are paid up front and benefits accrue gradually. Because workers accumulate human capital and become more productive when employed, the flows of benefits from forming a match are much longer-lived compared to a model without on-the-job human capital accumulation. In this environment, if the flow into the public sector increases with experience, then the public sector reduces the firm’s expected flow of surplus, discouraging vacancy creation in the private sector and increases the responsiveness of labor market tightness to shocks. This is the same intuition behind the results of Hagedorn and Manovskii (2008), who show that an increase in the flow value of unemployment results in a stronger response of market tightness to shocks due to a smaller matching surplus.

It should be noted that the effects of public sector on labor market volatility arise without any active cyclical policy from the government. Since we treat vacancy creation in the public sector as exogenous, we thus abstract from the possibility that the government may respond endogenously to recessions by hiring more workers. It allow us to better focus on the role of human capital accumulation which we explore next.

The role of On-the-Job Human Capital Accumulation

In this section, we study the importance of on-the-job human capital accumulation by comparing the implications of the benchmark model with those of an alternative
model where $\mu_p = \mu_g = 0$. Thus, the exercise consists in shutting down the growth in human capital for employed workers. We leave the other parameters of the human capital process unchanged. We recalibrate the vacancies in the public sector to match the share of civil servants by income. Notice that although this model has no returns to tenure, it still features heterogeneity in $z$ because of the labor productivity shocks. We also adjust the value of home production, $b$, to keep the employment-population ratio at its benchmark value. The implied value of $b$ is equal now to 20% of a worker’s average income, which is smaller compared to the baseline calibration and reflects the lower expected returns to work in this version of the model.

We study the employment response to an unanticipated 1% drop in aggregate productivity at period one for the benchmark economy (where the share of civil servants by income is close to the data), and for the counterfactual economy (where the vacancies in the public sector are more uniformly distributed as explained in Figure 4). We present the results in Figure 6 (dashed line). For the sake of comparison, we also
present in Figure 6 the results when there is on-the-job Human capital accumulation (solid line). As can be seen in the Figure, employment response to a 1% productivity drop is much lower and less persistent in the economy without returns to tenure. In fact, employment falls by less than half of the amount it does in our baseline case, and is essentially at the steady state 40 quarters after the productivity drop. In addition, without human capital accumulation, reforming the public sector does not generate much less volatility in the private sector employment.

Figure 6: Impulse Responses to a productivity shock The IRFs labeled as “Benchmark”, correspond to the baseline calibration. The IRFs labeled as “Counterfactual, both $z$ and $s$”, we redistribute vacancies in the public just over the dimension $z$ to keep the size unchanged and set the share of skilled in each sector equal to 50%. The solid lines correspond to the model with human capital experience, while the dashed lines correspond to the model without human capital accumulation.

In Table 3, we show the aggregate long-run effects of the experiments considered above for the models with and without on-the-job human capital accumulation. Since the government selects more workers with lower skill and experience in the counterfactual economy, the average productivity in the public sector and thus the supply of public goods falls. However, it can be seen that changing the government hiring policy in the model with human capital accumulation increases steady state private sector employment by nearly 1.5 percentage point, while the effect is nearly zero when there is not productivity growth on average on the job. Note that in both cases, the share of civil servants is kept unchanged in the counterfactual economy and thus all the effects are associated with changes in incentives to job creation in the private sector.

These results indicate that when human capital accumulation is an important determinant of the value of production and thus of the expected flow surplus of the match, a government that hires disproportionately more skilled and experienced workers can crowd out private sector employment and increase unemployment in the long run. The is so because of the incentives to vacancy creation are lower as well as the average quality of workers matching with private firms.
Table 3: Long-run effects

<table>
<thead>
<tr>
<th>Variable</th>
<th>with hc accum</th>
<th>without hc accum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benchmark</td>
<td>Counterfactual, both ((z, s))</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>6.5%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Private sector empl. rate</td>
<td>79.7%</td>
<td>81.2%</td>
</tr>
<tr>
<td>Public sector empl. rate</td>
<td>13.8%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Mean wage private sector</td>
<td>1.85</td>
<td>2.03</td>
</tr>
<tr>
<td>Mean wage public sector</td>
<td>2.68</td>
<td>2.49</td>
</tr>
<tr>
<td>Public good-output ratio</td>
<td>18%</td>
<td>16.9%</td>
</tr>
</tbody>
</table>

The role of the size of public employment

In this section, we study how the size of public employment — which was kept unchanged in the counterfactuals studied above — affects the private sector employment. To this end, we run an exercise in which we adjust both the education and experience composition of civil servants as in Figure 5 but without redistributing vacancies towards less productivity agents to keep \(n_g\) constant. As a consequence, the share of civil servants falls from 13.8\% at the benchmark to 10.6\% at the counterfactual economy, nearly a 23\% decrease. We show in the left top panel of Figure 7, the distribution of civil servants by income for the benchmark, for the exercise presented in Figure 5 and for the case where \(n_g\) is allowed to change which is labeled as "Counterfactual, size".

In the right top panel of Figure 7, we show the impulse response functions for the private sector employment after an unanticipated 1\% drop in aggregate productivity. It can be seen that private employment falls by less when we allow the share of civil servants to fall, indicating that \(n_g\) amplifies the impact of the shock. The size effect though is relatively small compared to the effect of the experience composition discussed in Figure 6.

Interestingly, in a economy without human capital accumulation — bottom left panel of Figure 7 — the effects are much less pronounced, which suggest that the interaction between size and the composition is important and crucially depends on the learning-by-doing human capital accumulation.

6 Conclusions

We develop a two sector search and matching model where firms and workers produce output that depends on workers’ human capital, which accumulates on-the-job in a learning-by-doing fashion and depreciates while searching. Government hires civil servants to produce a public good that enters in the workers’ utility function. Job creation is exogenous in the public sector and is directed towards skilled and more experienced. The model economy is calibrated to be consistent with micro and
Figure 7: **Impulse Responses to a productivity shock** Left figure in the top panel shows the distribution of civil servants by income quintile for the benchmark and counterfactual economies. The IRFs labeled as "Benchmark", correspond to the baseline calibration. The IRFs labeled as "Counterfactual, both \( z \) and \( s \)”, correspond to case where we redistribute vacancies in the public just over the dimension \( z \) to keep the size unchanged and set the share of skilled workers in each sector equal to 50%. The IRFs labeled as "Counterfactual, size", correspond to case where we allow the size of public employment to change. Right figure in the top panel presents the results for the model with human, while the figure in the bottom panel corresponds to the model without human capital accumulation.

macro evidence for the Brazilian economy. We use the calibrated model to study the effects of government employment on the private sector employment and labor market volatility.

We find that in an economy in which the government hires a large share of the skilled and more experience workers, the employment response to an unanticipated 1% drop in aggregate productivity is nearly 30% larger compared with an economy in which selection into the public sector is less concentrated at the top. We show that human capital accumulation is the key ingredient driving the differences in employment responses. In addition, we show that the public sector employment crowds out private sector employment in the long-run.

Thus, although a large government can help to improve the performance of the economy if, for example, the provision of public infrastructure is below the optimal
scale, when the selection into the public sector is excessively biased towards skilled and more experienced workers, it might discourage vacancy creation by private sector firms and thus have unintended negative consequences on labor market volatility and on the long-run unemployment rate.

References


A Regression Results

Table 4 presents results for seven Mincerian wage equations in which the dependent variable is the logarithm of income per hour. Columns (1)-(3) use the standard human capital variables, such as schooling and experience (represented by age and age squared) as controls. There are 16 schooling dummies, each representing the number of years of completed schooling of the individual. The dummy goes from no schooling to 15 or more years of completed schooling. In addition to these variables, in column (4) we also add the variable gender and whether or not the worker has a formal job. In column (5) we add control for 13 occupations. Notice that the coefficient of the variable *civil servant* is statistically different from zero in all regressions and it ranges from 19% to 25%. The potential problem of unobservable selectivity implies that our OLS regression might not be capturing the exogenous effects of public sector premium on wages. The standard approach to address this issue is to use instrumental variable (IV) techniques. However, this procedure depends on the presence of valid instruments for the indicator variable *civil servant*. Since we do not have a valid instrument in our sample and it is difficult to address this bias in non-experimental data, we use the procedure developed by Altonji et al. (2005) to investigate the potential size of any bias due to unobservable variables. The main hypothesis in their procedure is that selection of observable variables is the same as that of unobservable variables, such that:

\[
\frac{\text{Cov}(\epsilon, \text{civil servant} (CS))}{\text{Var}(\epsilon)} = \frac{\text{Cov}(\beta X, \text{civil servant} (CS))}{\text{Var}(\beta X)},
\]

where \(X\) is a vector of observable characteristics, and \(\epsilon\) is the error term potentially correlated with *civil servants*. This is a valid procedure when the point estimates for *civil servant* are sensitive to the inclusion of additional control variables, which corresponds to our case, since when we introduce control for occupations and the formal sector dummy the estimated coefficient of the variable *civil servant* decreases in magnitude from 25% to 19%. The biased from OLS is

\[
\frac{\text{Cov}(\epsilon, \tilde{CS})}{\text{Var}(\tilde{CS})},
\]

where \(\tilde{CS}\) denotes the residuals from a regression of the variable *civil servant* on \(X\). Although positive which is an evidence of a positive correlation of unobservable variables in the wage equation and the variable *civil servant*, the estimated bias in the two most complete specifications (columns (4) and (5)) are not statistically different from zero and it does not seem that the estimated public sector wage premium is driven by unobservable variables.
Table 4: Log of income per hour. Source: 2008 PNAD.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All indiv.</td>
<td>All indiv.</td>
<td>Workers and civil servants</td>
<td>Workers and civil servants</td>
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</tr>
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<td>-0.2582**</td>
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<td>(-8.3)</td>
<td>(-5.73)</td>
<td>(0.07)</td>
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<td>0.0411**</td>
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<td>0.0433**</td>
<td>0.0426**</td>
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<td></td>
<td>(57.27)</td>
<td>(25.49)</td>
<td>(24.19)</td>
<td>(26.01)</td>
<td>(25.74)</td>
<td>(23.92)</td>
<td>(7.13)</td>
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<td>(-17.17)</td>
<td>(-18.65)</td>
<td>(-18.46)</td>
<td>(-17.71)</td>
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<td>0.2309**</td>
<td>0.2549**</td>
<td>0.2383**</td>
<td>0.1875**</td>
<td>0.0438**</td>
<td>0.0383**</td>
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<td>(36.91)</td>
<td>(32.82)</td>
<td>(36.11)</td>
<td>(34.39)</td>
<td>(22.89)</td>
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<td>(45.23)</td>
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<td>91,265</td>
<td>91,265</td>
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<td>0.3806</td>
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<td>0.3980</td>
<td>0.3995</td>
<td>0.3674</td>
<td>0.3890</td>
<td>0.4061</td>
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We then consider specification in column (3) of Table 4 but estimate the wage equation using quantile regression. Because quantile regression procedure produces one point estimation for each quantile, for the sake of space, we focus only on the coefficient of the indicator variable civil servant. Figure 8 reports the estimated coefficient of this variable for each quantile of the conditional wage distribution, as well as the 95% confidence intervals. The OLS estimate is also presented by the dotted horizontal line together with its 95% confidence interval. Quantile regression provides the appropriate tool to determine whether or not there is any difference in the wage premium for different quantiles of the conditional wage distribution. Observe that the coefficient of the dummy variable civil servant is positive and statistically different from zero for all quantiles. It is also quite flat for all quantiles. It varies from 31% (low and high quantiles) to 22% (middle quantiles).
Figure 8: Quantile regression Public sector wage premium for different quantile of the conditional wage distribution. Solid line: quantile point coefficient. Grey area: 95% confidence interval of the quantile coefficient. Thick dotted line: OLS point coefficient. Thin dotted line: 95% of the OLS point coefficient.