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On the cost of opportunistic behavior in the public sector: A General-Equilibrium approach

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Abstract

This paper studies the wasteful effect of bureaucracy on the economy by addressing the link between opportunistic behavior of government bureaucrats and the public sector wage bill. In particular, public officials are modeled as individuals competing for a larger share of those public funds. A simple extraction technology in the government administration is introduced in a standard Real-Business-Cycle (RBC) setup augmented with detailed public sector. The model is calibrated to German data for the period 1970-2007. The main findings are: (i) the model performs well *vis-a-vis* the data; (ii) Due to the existence of a significant public sector wage premium and the high public sector employment, a substantial amount of working time is spent in opportunistic activities, which in turn leads to significant losses in terms of output; (iii) The model-based loss measures obtained for the EU-12 countries are highly-correlated to indices of bureaucratic inefficiency.

JEL Classification: E69, E62, E32, J45

Keywords: Rent-seeking, opportunism, bureaucracy, public employment, government wages

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1 Introduction

This paper studies the wasteful effect of bureaucracy on the economy by addressing the link between opportunistic behavior of government bureaucrats and the public sector wage bill. The main focus is on the non-productive activities that occur inside public administration and models them in a dynamic general-equilibrium setting. In line with Goel and Nelson (1998), and Persson and Tabellini (2000, p.8.), the focus in this paper will be on particular types of government expenditure, namely spending on wages, and its potential to produce rent-seeking behavior even in developed Western nations. This is achieved by augmenting an otherwise standard RBC model with a government sector, public employment and allowing those who work in the public sector ("government officials") to engage in opportunistic behavior. The framework in this paper is then used to generate a theory-based measure for the cost of the waste imposed on the economy, and proceeds to evaluate it against empirical indices of institutional quality and government sector efficiency.

In part, the motivation behind this study is based on the sharp increase in public sector employment observed in selected EU member states in the post-WWII era, together with the existence of a significant public wage premium, as documented in Table 1 on the next page, which in turn leads to an increase in the share of the public sector wage bill in output. One possible interpretation of the numbers in Table 1 is the tendency for bureaucracy to

Table 1: Labor market facts 1970-2007

Country	Average public/private sector wage ratio	Average public/private employment ratio	Public wage bill to output ratio
Euro Area	1.22	0.22	0.11
Austria	1.28	0.21	0.16
Belgium	1.28	0.29	0.26
Denmark	1.06	0.45	0.30
Finland	1.03	0.35	0.27
France	1.00	0.32	0.12
Germany	1.20	0.17	0.09
Greece	1.41	0.26	0.35
Ireland	1.22	0.24	0.31
Italy	1.30	0.26	0.11
Netherlands	1.69	0.17	0.18
Norway	0.87	0.44	0.27
Portugal	1.31	0.22	0.31
Spain	1.60	0.16	0.10
Sweden	0.86	0.51	0.40
United Kingdom	1.08	0.27	0.12
United States	1.08	0.16	0.10

Sources: Vasilev (2015b), OECD (2011)

self-breed and expand independently. After all, the state is the largest employer in the EU member states. Importantly, this expansion in the size of the government administration and the subsequent expansion of the public sector wage bill should raise concerns in policy makers, as labor productivity in the public sector is difficult to measure, and a quantity corresponding to government production is also hard to define, since public services are to a great extent non-market production.

To shed some light on some of the processes taking place within public administration, the model setup in this paper incorporates a repeated symmetric non-cooperative game that is played among government bureaucrats themselves to increase individual income at the expense of the other public officials earnings.¹ The symmetric rent-seeking process is modeled as in Murphy *et al.* (1991)²: each individual allocates time optimally on both productive and opportunistic activities. As in Burnside and Eichenbaum (1993), the extraction technology increases one's own capacity and at the same time decreases others' capacity level. This modelling choice is consistent with McKenzie and Tullock (1978), who describe public professionals as maximizers who pursue career advancement, financial security, and try to use the organization where they work to serve their personal interests. As a result of the opportunistic behavior in the model, public investment is lower, and government consumption (wage bill) is too high. Thus, using tools of modern dynamic economics, the study in this paper contributes to the understanding of the wasteful effect of bureaucracy for the economy.

The value-added of this paper is the focus on the link between the opportunistic behavior in bureaucracy and the government wage bill, and the resulting cost imposed on the economy as a result of the non-productive activities taking place in the public sector. Another novelty here is that the opportunistic behavior occurs in a non-competitive labor market, the public sector one, where wage rate is above private sector pay, unrelated to marginal productivity of labor, and determined mostly by budget considerations. Thus wages are inefficiently high, and there is lack of accountability when it comes to government spending on wages: since there is no demand for public services, bureaucrats have an incentive to claim their divisions/ministries are understaffed and that government employees are overworked, and that there is need for more subordinates to be hired. Alternatively, the model can be interpreted as different ministries trying to expand at the expense of others given the size of the budget. This is what the extraction mechanism in paper tries to capture, despite all the structural weaknesses and limitations of the modelling framework.

The excessive wage bill represents the "rent" that can be extracted through expansion of public employment, which in turn stimulates entry of labor in the sector, and as a result, public employment eventually becomes too high. In particular, both the high public wage and employment stimulate opportunism by generating a positive benefit of engaging in wasteful

¹In the literature on bureaucracy, the studies by von Mises (1944), Parkinson (1957), Niskanen (1971), and Tinbergen (1985) all focus on the strong competition for advancement within bureaus and the inter-unit conflicts. In an important study, Rose-Akerman (1999) also argues that corruption, or rent-seeking behavior, is embedded in the hierarchical structure of public administration.

²For surveys of the literature of rent-seeking, see Mueller (2003), and the references therein.

activities. To preserve the budget balance, a higher wage bill in turn requires higher tax rates to finance government spending. In the private sector, high taxes reduce incentives to supply labor and accumulate capital, and decrease consumption and output. Thus rent-seeking has a negative impact on the economy, and this paper attempts to quantify the loss for the economy in a general-equilibrium framework. The study in this paper is also complementary to Park *et. al* (2005), and Angelopoulos *et al.* (2009, 2011), who all address similar issues using RBC models. Their focus, however, falls on problems of tax collection and/or protection of property rights, while this study concentrates on the inefficiencies on the government spending side, and the wage bill in particular, which lead to opportunistic behavior exhibited by government bureaucrats. Even though the rent-seeking mechanism works in a similar way to the other papers in the literature, the interpretation here is quite different, as it tries to capture the effect of excessive public employment and the inter-department competition that leads to the bloating of government administration.

Next, the model is used to generate loss measures for the EU-12 countries, and then those theoretical estimates are compared to empirical indices of institutional quality in the government sector. Angelopoulos *et al.* (2009, 2011) use the ICRG index as a proxy for rent-seeking, while this paper considers a wider set of indicators that specifically focus on public administration quality. In general, the waste resulting from the opportunistic behavior in the public sector is expected to be associated with excessive size, low quality of government, and heavy bureaucratization. The ranking is preserved when public/private sector wage, or public/private employment ratios are used instead of the model-based loss measure. The main findings of the study are that: (i) the model performs well *vis-a-vis* the data; (ii) Due to the existence of a significant public sector wage premium and the high public sector employment, a substantial amount of working time is spent on opportunistic activities, which in turn leads to significant losses measured in terms of output; (iii) The model-generates estimates of the waste computed for the major EU countries are highly-correlated to indices of bureaucratic inefficiency.

The paper is organized as follows: Section 2 presents the model setup. Section 3 explains the calibration strategy. Section 4 discusses the steady-state of the model, and section 5 computes the size of the cost imposed on the economy; Section 6 presents the simulates second moments of the model and compares them to their empirical counterparts, and discusses the effect of unexpected technological innovation on the short-run dynamics of the major variables in the model. Section 7 concludes.

2 Model Setup

2.1 Description of the model

There are N_t households, as well as a representative firm. Each household owns physical capital and labor, which it supplies to the firm. Time can be spent working in the private and/or public sector, spent on opportunistic activities, or dedicated to leisure. Working in

the government sector imposes an additional real rigidity, approximated by a convex cost that is incurred every period when hours are supplied in the public sector. The perfectly-competitive firm produces output using labor and capital. The government produces utility-enhancing public services and uses tax revenues from labor and capital income to finance: (1) government transfers, (2) government investment, and (3) public sector wage bill.

In line with the evidence on EU countries, presented in Table 1 earlier, the public sector wage in this model will be generally higher than the private sector wage. Next, individual hours supplied in the public sector can be augmented by an extraction technology, where the efficiency depends positively on one's own time spent on opportunistic activities and negatively on the time spent by other households on unproductive activities.

2.2 Households

There are N_t representative households in the model economy, who are infinitely-lived.³ There is no population growth. As in Baxter and King (1993), household h maximizes the following expected utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t^{ph}, S_t^g, L_t^h), \quad (2.2.1)$$

where E_0 is the expectation operator as of period 0; C_t^{ph} , S_t^g and L_t^h are household's private consumption, per household consumption of government services, and leisure enjoyed by household h at time t , respectively. The parameter β is the discount factor, $0 < \beta < 1$. The instantaneous utility function $U(., ., .)$ is increasing in each argument and satisfies the Inada conditions. The particular functional form for instantaneous utility used is as follows:

$$U(C_t^{ph}, S_t^g, L_t^h) = \psi_1 \ln C_t^{ph} + \psi_2 \ln L_t^h + \psi_3 F(S_t^g) \quad (2.2.2)$$

where, as in Baxter and King (1993), the function $F(.)$ is concave in government services (i.e, $F'(>) > 0, F''(>) < 0$). Parameters ψ_1, ψ_2, ψ_3 represent the weight attached to private consumption, leisure and public services components in utility, respectively, where $0 < \psi_1, \psi_2, \psi_3 < 1$, and $\psi_1 + \psi_2 + \psi_3 = 1$.

Total time available to each household is split between work, N_t^h , rent-seeking in the public sector, RS_t^h , and leisure, L_t^h . Households can supply hours of work in the public sector, N_t^{gh} , in the private one, N_t^{ph} , with $N_t^h = N_t^{ph} + N_t^{gh}$. In addition, each household incurs a quadratic cost from government work, $\varphi(N_t^{gh})^2$, where $\varphi > 0$, that effectively decreases the time endowment (or equivalently, the time off work). This modeling choice tries to capture some of the market imperfections and real rigidities existing in the public sector labor markets, and at the same time helps the model accommodate different wage rates in the two sectors, and allows for a public hours labor choice in the framework.⁴

³This number is countably infinite, and the households could be thought of being uniformly distributed on the $[0, 1]$ interval.

⁴For a detailed explanation, the interested reader should refer to Vasilev (2013, 2015a).

Labor efficiency differs across sectors. In the private sector, labor efficiency level is constant(normalized to unity), while utilization rate in the public sector is allowed to vary because of the endogenous efficiency of the extraction technology. Therefore, as in Cho and Cooley (1994), and Hayashi and Prescott (2007), in this framework contracted and effective public hours enter the household's utility function through different functional forms. The wage rates per efficiency unit of labor in the private and the public sector are denoted by w_t^p and w_t^g , respectively. In addition, public wage rate will generally feature an endogenously-generated, time-varying premium over the private wage rate, where the latter was in line with the documented evidence on the EU countries.

Next, after joining the public sector, households may decide to engage in opportunistic behavior, as there is a positive benefit from doing so. Given a positive public sector wage, in equilibrium every household will choose to supply a positive amount of hours in the public sector. Thus, the model allows everyone to engage in public sector rent-seeking. The extraction technology in the setup can be interpreted as an abuse of power for personal advantage, or putting one's own interests first in the performance of a public duty. In particular, by using one's own rent-seeking time, an individual's public sector labor income can be augmented by increasing the effective public sector hours worked: By supplying N_t^{gh} contract hours in the public sector, and spending RS_t^h hours on rent-seeking, each household generates $\frac{RS_t^h}{RS_t} N_t^{gh}$ of "efficiency units of labor," as in Burnside and Eichenbaum (1993), hence total public sector labor income then becomes $w_t^g \frac{RS_t^h}{RS_t} N_t^{gh}$. At the same time, predatory behavior decreases the capacity utilization of labor of the other workers in the public sector.⁵

As in Burnside and Eichenbaum (1993), it is assumed that each household cares about effective hours of work only.⁶ Thus, the time constraint that each household faces in each period (expressed in efficiency terms) is as follows:

$$N_t^{ph} + \frac{RS_t^h}{RS_t} N_t^{gh} + \varphi(N_t^{gh})^2 + RS_t^h + L_t^h = 1. \quad (2.2.3)$$

The extraction technology described is a special case of a standard symmetric contestable prize function used in the literature. This approach models opportunistic behavior as an optimal choice made by each government bureaucrat. In addition, the size of the rent ("pie") available to government workers will be endogenously determined, as each bureaucrat chooses individual public hours optimally, and thus chooses the optimal size of their "slice."⁷ This

⁵Note that each household is atomistic, so it takes the aggregate quantity of rent-seeking RS_t as given. (In equilibrium, $RS_t = \sum_h RS_t^h$.) Thus, even though total public employment is exogenous, the individual public hours are endogenous.

⁶As seen below, this is also how household's utility of leisure is specified.

⁷The only modeling difference in this paper from the earlier general-equilibrium studies on rent-seeking, e.g. Angelopoulos *et al.* (2009, 2011), is that the cost of resources spent on influencing the probability of winning, $\frac{RS_t^h}{RS_t}$, is measured in terms of time and thus in utility of leisure terms instead of output/income directly.

specification can also be interpreted as an auction in which competing bureaus lobby for a larger share of the contestable transfer, and the endogenous sharing rule defines the rent-seeking technology. Moreover, a larger share of the rent means higher effective public hours, which can be associated with promotion in the hierarchical structure, higher prestige, more subordinates, more power by entrenchment in an organization and thus the achievement of security and convenience.

In addition to the labor income received, each household saves by investing in private capital I_t^h . As an owner of capital, the household receives interest income $r_t K_t^{ph}$ from renting the capital to the firms; r_t is the return to physical capital and K_t^{ph} denotes physical capital stock in the beginning of period t .

The household's physical capital evolves according to the following law of motion

$$K_{t+1}^{ph} = I_t^h + (1 - \delta^p) K_t^{ph}, \quad (2.2.4)$$

where $0 < \delta^p < 1$ is the depreciation rate of private physical capital.

Finally, consumers are owners of the firms in the economy, and receive equal share of the profit (Π_t^h) in the form of dividends. The budget constraint for each household is

$$C_t^{ph} + I_t^h \leq (1 - \tau_t^l) \left[w_t^p N_t^{ph} + w_t^g \frac{RS_t^h}{RS_t} N_t^{gh} \right] + (1 - \tau_t^k) r_t K_t^{ph} + \Pi_t^h + G_t^{th}, \quad (2.2.5)$$

where τ_t^l, τ_t^k are the proportional tax rates on labor and capital income, respectively, and G_t^{th} denotes the level of per household lump-sum government transfer.

Each household h acts competitively by taking prices $\{w_t^p, w_t^g, r_t\}_{t=0}^\infty$, tax rates $\{\tau_t^l, \tau_t^k\}$ and policy variables $\{G_t^i, S_t^g, G_t^t, K_{t+1}^g\}_{t=0}^\infty$ as given, and chooses allocations $\{C_t^{ph}, N_t^{ph}, N_t^{gh}, RS_t^h, I_t^h, K_{t+1}^h\}_{t=0}^\infty$ to maximize (2.2.1) subject to (2.2.2)-(2.2.5), and the initial conditions for the private and public physical capital stocks $\{K_0^{ph}, K_0^g\}$.

The optimality conditions from the household's problem, together with the transversality condition (TVC) for the private physical capital stock, are as follows:

$$C_t^{ph} : \frac{\psi_1}{C_t^{ph}} = \Lambda_t \quad (2.2.6)$$

$$K_{t+1}^{ph} : \Lambda_t = \beta E_t \Lambda_{t+1} \left[(1 - \tau_{t+1}^k) r_{t+1} + (1 - \delta^p) \right] \quad (2.2.7)$$

$$N_t^{ph} : \frac{\psi_2}{L_t} = \Lambda_t (1 - \tau_t^l) w_t^p \quad (2.2.8)$$

$$N_t^{gh} : \frac{\psi_2}{L_t} \left[\frac{RS_t^h}{RS_t} + 2\varphi N_t^{gh} \right] = \Lambda_t (1 - \tau_t^l) w_t^g \frac{RS_t^h}{RS_t} \quad (2.2.9)$$

$$RS_t^h : \frac{\psi_2}{L_t} \left[1 + \frac{N_t^{gh}}{RS_t} \right] = \Lambda_t (1 - \tau_t^l) w_t^g \frac{N_t^{gh}}{RS_t} \quad (2.2.10)$$

$$\lim_{t \rightarrow \infty} \beta^t \Lambda_t K_{t+1}^{ph} = 0, \quad (2.2.11)$$

where Λ_t is the Lagrange multiplier on the household's budget constraint. The household equates marginal utility from consumption with the marginal cost imposed on its budget. Next, the Euler equation describes the optimal capital accumulation rule, and implicitly characterizes the optimal consumption allocations chosen in any two neighboring periods. Private hours are chosen so that the disutility of an hour work in the private sector at the margin equals the after-tax return to labor. The disutility of an hour of rent-seeking time equals the marginal increase in after-tax public sector labor income. At the margin, the benefit of engaging in rent-seeking equals the utility cost of doing so. The last expressions, (2.1.11), is the so-called "transversality condition" (TVC), imposed to ensure that the value of the private physical capital that remains after the optimization horizon is zero. This boundary conditions guarantees that the model equilibrium is well-defined by ruling out explosive solution paths.

Divide (2.2.9) by (2.2.8), and impose symmetry (hence $RS_t^h = RS_t$, $N_t^{gh} = N_t^g$, $\forall h$) to obtain

$$1 + 2\varphi N_t^g = \frac{w_t^g}{w_t^p}. \quad (2.2.12)$$

Eq. (2.2.12) is a typical labor supply relationship, and characterized in this framework by a positive relationship between total public hours and the public/private wage ratio. Next, divide (2.2.10) by (2.2.8) to obtain

$$\frac{w_t^g N_t^{gh}}{w_t^p RS_t} = 1 + \frac{N_t^{gh}}{RS_t}. \quad (2.2.13)$$

After some rearrangement, and by imposing symmetry once again, it can be shown that

$$RS_t = \left[\frac{w_t^g}{w_t^p} - 1 \right] N_t^g. \quad (2.2.14)$$

Optimality condition (2.2.14) is new in the literature on rent-seeking. As seen from above, rent-seeking time is a product of public employment, N_t^g , and the net public sector wage premium, $\frac{w_t^g}{w_t^p} - 1$, where the first term in (2.2.14) could be interpreted as the "extensive margin," while second is the "intensive margin." Therefore, Eq. (2.2.14) suggests that the source of the inefficiency in the government sector is the suboptimally high public sector wage and that government wages, instead of being driven by the marginal productivity of labor, are determined by budgetary considerations.⁸

⁸As we will see, public sector hours generate utility as an input in the production of valuable government services, but have zero productivity, as those services are provided for free.

2.3 Firms

There is also a representative private firm. It produces a homogeneous final product using a production function that requires physical capital, K_t and labor hours N_t^p . The production function is as follows:

$$Y_t = A_t(N_t^p)^\alpha(K_t^p)^{1-\alpha}, \quad (2.3.1)$$

where A_t measures the total factor productivity in period t ; $0 < \alpha, (1 - \alpha) < 1$ are the productivity of labor and private physical capital, respectively.

The representative firm acts competitively by taking prices $\{w_t^p, w_t^g, r_t\}_{t=0}^\infty$ and policy variables $\{\tau_t^k, \tau_t^l, G_t^i, G_t^t, K_t^g\}_{t=0}^\infty$ as given. Accordingly, K_t^p , and N_t^p are chosen every period to maximize static aggregate profit,

$$\Pi_t = A_t(N_t^p)^\alpha(K_t^p)^{1-\alpha} - r_t K_t^p - w_t^p N_t^p. \quad (2.3.2)$$

In equilibrium, capital and labor receive their marginal products, *i.e.*

$$r_t = (1 - \alpha) \frac{Y_t}{K_t^p}, \quad (2.3.3)$$

$$w_t^p = \alpha \frac{Y_t}{N_t^p}. \quad (2.3.4)$$

Hence, equilibrium per-period profits are zero.

2.4 Government

Government invests in capital, G_t^i , which is used in the provision of the utility-enhancing government services. In addition, government hires labor hours N_t^g at a wage level w_t^g to produce public consumption goods, and distributes transfers $G_t^t (\equiv \sum_h G_t^{th})$.⁹ The production function for public consumption is as in Linnemann (2009) and Economides *et al.* (2011):

$$S_t^g = (N_t^g)^\gamma (K_t^g)^{(1-\gamma)}, \quad (2.4.1)$$

where $0 < \gamma < 1$ is the share of public employment. More hours in the public sector generate more government services (a higher level of the public good available for public consumption), which directly increase utility. In addition, holding all else equal, an increase in public employment raises welfare indirectly by increasing the after-tax public sector labor income, and hence consumption. Lastly, more hours spent in the public sector decrease the amount of leisure the household can enjoy in a certain period, which lowers welfare.

Total government expenditure, $G_t^t + G_t^i + w_t^g N_t^g$, is financed by levying proportional taxes on capital and labor income. Thus, the government budget constraint is as follows:

$$G_t^t + G_t^i + w_t^g N_t^g = \tau_t^k r_t K_t^p + \tau_t^l \left[w_t^p N_t^p + w_t^g N_t^g \right]. \quad (2.4.2)$$

⁹Ex post, in the symmetric equilibrium, government transfers will be equal for each household.

Next, the law for government capital accumulation is as follows:

$$K_{t+1}^g = G_t^i + (1 - \delta^g)K_t^g, \quad (2.4.3)$$

where $0 < \delta^g < 1$ is the depreciation rate of public capital.

Government takes market prices $\{w_t^p, r_t\}_{t=0}^\infty$ and allocations $\{N_t^p, N_t^g, K_t^p\}_{t=0}^\infty$ as given. Finally, only four of the five policy instruments, $\{\tau_t^l, \tau_t^k, w_t^g, G_t^i, G_t^t\}_{t=0}^\infty$, can be exogenously set. Government investment share in output, $G_t^{iy} = \frac{G_t^i}{Y_t}$, as well as the two tax rates $\{\tau_t^l, \tau_t^k\}$ will be fixed to their corresponding data average in all time periods; Thus, the level of government investment will react to private output. Note that public capital stock series will be constructed from a given initial stock $\{K_0^g\}$, and the endogenously-determined public investment sequence (which is a function of output). Next, steady-state government transfers-to-output ratio will be used as a free variable to match the average employment ratio in data. Lastly, the public wage rate will be determined residually to ensure that the government budget constraint is satisfied in every period.

2.5 Stochastic processes for the policy variables

Total factor productivity, A_t , will be assumed to follow AR(1) processes in logs, in particular

$$\ln A_{t+1} = (1 - \rho^a) \ln A_0 + \rho^a \ln A_t + \epsilon_{t+1}^a, \quad (2.5.1)$$

where $A_0 = A > 0$ is steady-state level value of the total factor productivity process, $0 < \rho^a < 1$ is the first-order autoregressive persistence parameter and $\epsilon_t^a \sim iidN(0, \sigma_a^2)$ are random shocks to the total factor productivity progress. Hence, the innovations ϵ_t^a represent unexpected changes in total factor productivity process.

2.6 Symmetric Decentralized Competitive Equilibrium

Given the paths of the policy instruments $\{G_t^i, G_t^t\}_{t=0}^\infty$, the exogenous process followed by total factor productivity, $\{A_t\}_{t=0}^\infty$, and initial conditions for the state variables $\{A_0, K_0^{ph}, K_0^g\}$, a symmetric decentralized competitive equilibrium (DCE) is defined to be a sequence of allocations $\{C_t^{ph}, N_t^{ph}, N_t^{gh}, RS_t^h, I_t^h, K_{t+1}^{ph}, K_{t+1}^g\}_{t=0}^\infty$, $\forall h$, prices $\{r_t, w_t^p, w_t^g\}_{t=0}^\infty$ and the tax rates $\{\tau_t^k, \tau_t^l\}$ so that (i) all households maximize utility; (ii) firms maximize profits; (iii) the government budget constraint is satisfied in each time period, and (iv) all markets clear.

3 Data and model calibration

The model in this paper is calibrated to German data at annual frequency. Since there is no EU-wide fiscal authority, an individual country was chosen, instead of calibrating the model for the EU Area as a whole, Germany was chosen as a benchmark calibration case. The paper follows a well-established methodology in the quantitative macroeconomics literature.

In the German data, the average public/private employment ratio over the period 1970-2007 is $n^g/n^p = 0.17$, and the average public/private wage ratio is $w^g/w^p = 1.20$. Next, the average effective tax rates on labor and physical capital, obtained from McDaniel's (2009) dataset are $\tau^l = 0.409$ and $\tau^k = 0.16$, respectively. The labor share, $\alpha = 0.71$, was computed as the average ratio of compensation of employees in total output from the EU Klems Database (2009). Using the same database, the private capital depreciation rate was found to be $\delta^p = 0.082$, while public capital depreciation rate was on average $\delta^g = 0.037$ over the period.

The discount rate $\beta = 0.979$ was calibrated from the steady-state consumption Euler equation (2.2.7) to match the average private capital-to-output ratio in data. Next, parameter $\gamma = 0.62$, which measures the weight on public sector hours in the public good production was obtained as the average ratio of the public sector wage bill to total government expenditure less transfers and subsidies, as in Linnemann (2009). Next, as in Baxter and King (1993), utility derived out of public services is represented as $F(.) = \frac{1}{1-\sigma}(.)^{1-\sigma}$. Following Falvey (1996), the curvature parameter was set to $\sigma = 0.95$. Alternatively, $1/\sigma$ measures the intertemporal elasticity of substitution of government services, or how responsive the median household (voter) is to growth in public services with respect to the changes in the median household's income.¹⁰

The average steady-state total hours of work in data as a share of total hours available is $n = 0.296$, hence total employment in the model is consistent with the estimates in Ghez and Becker (1975). Together with the public/private employment ratio, this yields the model-consistent steady-state values for private and public hours, $n^p = 0.253$ and $n^g = 0.043$, respectively. The weight on utility from government services was set to $\psi_3 = 0.15$, which is consistent with the value used in Klein *et al.* (2008). Next, the weights attached to private consumption $\psi_1 = 0.35$ and $\psi_2 = 0.50$ are set to match exactly both types of hours in data. On the other hand, the model is roughly consistent with Conesa *et al.* (2009), who argues that private consumption good is on average twice as valuable as government services ($\psi_1/\psi_3 = 2.33$), and leisure - twice as valuable as private consumption ($\psi_1/\psi_2 = 1.43$). The scale parameter of the transaction cost associated with government work, $\varphi = 2.318$, is calibrated to match the average public/private wage ratio in the data. The steady-state level of technology, $A = 1$, will be normalized to unity. Lastly, total factor productivity persistence, $\rho^a = 0.943$, was obtained from an AR(1) regression using the linearly detrended Solow residual, while $\sigma^a = 0.014$, was set to match output volatility. Table 2 below summarizes all model parameters used in the calibration.

4 Steady state results

Once model parameters were obtained, the unique steady-state of the system, as defined in 2.6, was computed for the Germany-calibrated model. Results are reported in Table 3

¹⁰In other words, agents are elastic, but not greatly so, *i.e.*, they do not want to accept large variations in the level of public services provided over time.

Table 2: Model Parameters

Param.	Value	Definition	Source
β	0.979	Discount factor	Calibrated
α	0.710	Labor income share	Data average
δ^p	0.082	Depreciation rate on private capital	Data average
δ^g	0.037	Depreciation rate on public capital	Data average
ψ_1	0.350	Weight on consumption in utility	Calibrated
ψ_2	0.500	Weight on leisure in utility	Calibrated
ψ_3	0.150	Weight on government services in utility	Set
σ	0.950	Curvature parameter of the government services utility	Set
φ	2.318	Scale parameter of government work transaction cost	Calibrated
γ	0.620	Labor share in public services production	Data average
τ^k	0.160	Effective tax rate on capital income	Data average
τ^l	0.409	Effective tax rate on labor income	Data average
A	1.000	Steady-state level of total factor productivity	Set
ρ^a	0.943	AR(1) parameter total factor productivity	Estimated
σ_a	0.014	SD of total factor productivity innovation	Calibrated

below, where $\bar{r} = (1 - \tau^k)(r - \delta^p)$ denotes the after-tax and net of depreciation real return to private physical capital.

The model captures relatively well the long-term data averages. It slightly overestimates average consumption and underestimates the investment shares in output. However, the model accurately captures the long-run after-tax capital return, where the latter is proxied by the average return on 10-year generic bonds net of CPI inflation. Moreover, the imputed government services is also predicted to make a significant share of output.

Along the labor market dimension, the model was calibrated to match the average time spent working, and the wage and employment ratios in data. Given the focus on the losses from rent-seeking in the public sector, the framework was calibrated to reproduce those stylized facts in the steady state, as this framework will provide an important benchmark for the measures use to quantify the loss from opportunistic activities on the economy. Next, the ratio of time spent rent-seeking to public employment is a non-trivial figure in steady-state: Using $p \equiv \frac{w^g}{w^p}$ to denote the steady-state wage ratio, one can obtain $\frac{rs}{n^g} = \frac{(p-1)n^g}{n^g} = p - 1 = 0.20$. This value is consistent with the results obtained in Angelopoulos *et al.* (2009), who found that 18 % of time in Germany is spent rent-seeking. Similarly, the model predicts that in the steady-state, the frictional cost incurred from government work equals 10 % of the time worked in that sector. Thus, the non-productive opportunistic behavior, as well as the convex cost incurred from working in the public sector are both generating a significant waste on aggregate level.

Table 3: Data averages and long-run solution

	Description	GE Data	Model
c/y	Consumption-to-output ratio	0.590	0.784
i/y	Private investment-to-output ratio	0.210	0.192
g^i/y	Public investment-to-output ratio	0.023	0.023
k^p/y	Private capital-to-output ratio	2.350	2.346
k^g/y	Public capital-to-output ratio	0.630	0.630
s^g/y	Public services-to-output ratio	0.193	0.225
g^t/y	Public transfers-to-output	0.170	0.228
$w^p n^p/y$	Private labor share in output	0.710	0.710
$w^g n^g/y$	Public wage bill share in output	0.130	0.145
rk/y	Private capital share in output	0.290	0.290
w^g/w^p	Public/Private wage ratio	1.200	1.200
w^p	Private sector wage rate	-	1.006
w^g	Public sector wage rate	-	1.207
\tilde{w}^p	After-tax private wage rate	-	0.595
\tilde{w}^g	After-tax public wage rate	-	0.714
n	Total employment	0.296	0.296
n^p	Private employment level	0.253	0.253
n^g	Public employment level	0.043	0.043
rs	Time spent rent-seeking	-	0.009
n^g/n^p	Public/private employment ratio	0.170	0.170
$\varphi(n^g)^2/n^g$	Real-rigidity-cost-to-public-hours ratio	-	0.100
\bar{r}	After-tax net return to capital	0.036	0.035

5 Long-Run Cost of Rent-seeking

The model in this paper naturally suggests estimates of the loss from rent-seeking. It also provides estimates that aim to quantify the loss from the opportunistic behavior in the public sector in terms of output. In turn, given the calibration procedure adopted in this paper which matched steady-state hours in each sector, the values for other EU countries can be easily obtained from data averages after some transformations. Given the calibrated values for different countries in EU, a ranking can be constructed using OECD data for the EU-12 countries.¹¹ Finally, the model-based estimates are compared to empirical measures of institutional quality. One such index is the compound International Country Risk Guide (ICRG), where the values for a selected set of European countries were obtained from Angelopoulos *et al.* (2009).¹² Additionally, a second set of indicators, the Worldwide Governance Indicators (WGI) were extracted from the WDI database. The chosen indices reflected government size, expenditure effectiveness of public funds, government effectiveness, and the efficiency of public administration.

¹¹France and UK were excluded due to the very low public wage premium featured there.

¹²For more detailed discussion of this index, interested readers should consult Knack and Keefer (1995)

The first model-based measure to be used in the comparison with indices is the steady-state rent-seeking time itself, which was computed in the symmetric solution to be

$$rs = (p - 1)n^g. \quad (5.0.1)$$

Second, rent-seeking time could be also expressed in relative terms as a share of public hours¹³ to obtain:

$$\frac{rs}{n^g} = \frac{(p - 1)n^g}{n^g} = p - 1. \quad (5.0.2)$$

From the results above, we see that this ratio is directly proportional to the public-to-private wage ratio. Next, an estimate of the loss imposed on the economy, in terms of output, was also calculated. The expression could be interpreted as a "wasteful lobbying cost," as it represents the cost of the time spent in opportunistic activities, which is not directly productive.¹⁴ The analytical representation of this loss relative to output is as follows:

$$\frac{w^g rs}{y} = \frac{pw^p(p - 1)n^g}{y} = \frac{(p - 1)pn^g}{n^p} \frac{w^p n^p}{y} = \alpha(p - 1)p \frac{n^g}{n^p}. \quad (5.0.3)$$

As seen from above, in the long run, the loss expressed as a share in output depends only on the private labor share in output, the gross public wage mark-up p (i.e. the average public/private wage ratio), as well as the average public/private employment ratio. Thus, the model predicts that countries with a high labor share in aggregate production function, a high public employment share in total, and high wages in the public relative to the private sector, will feature the highest losses, as illustrated in the ranking in Table 4 on the next page.

Since the model was constructed to match those labor market dimensions in data, estimates of the measures above were easily computed from OECD (2011) data for a cross-section of EU countries, without explicitly calibrating the model for all the countries, but rather by simply computing the required averages for the corresponding country from OECD data directly. All measures are presented and ranked in Table 4 on the next page, together with the ICRG index. A lower rent-seeking cost corresponds to a higher ranking. A higher value of the ICRG index reflects better institutions, and a higher ranking for the country.¹⁵

Results in Table 4 above show that the cost of lobbying is 2.9 % of GDP for Germany (the smallest in the group), but can reach 9 % of GDP in Greece, 11.8 % in the Netherlands, and 11.32 % in Spain. The size of the loss in terms of output is comparable to the estimates in Angelopoulos *et al.* (2009), who use a DSGE framework with a rent-seeking extraction of

¹³Since rent-seeking occurs only in the public sector, it does not make much sense to express it relative to the total labor supply.

¹⁴Instead, it only indirectly increases the probability of winning the contestable prize, and/or increases the labor income from government work), instead of using the time to produce public services, which have utility-generating effect.

¹⁵Overall, countries with larger shares of the government wage bill in output also feature higher tax rates. However, since this paper focuses on the relationship between rent-seeking and the government wage bill, and not on the effect of rent seeking on tax revenues, this stylized fact in data is not discussed.

Table 4: Rent-seeking results in EU member countries

Country	rs	w^g/w^p	n^g/n^p	$\frac{w^g rs}{y}$	ICRG
Austria	0.016(4)	1.28(4)	0.207(4)	0.050(4)	47.22(5)
Belgium	0.021(6)	1.28(5)	0.285(9)	0.066(6)	47.46(4)
Finland	0.003(1)	1.03(1)	0.353(10)	0.008(1)	48.76(3)
Germany	0.010(2)	1.20(2)	0.170(2)	0.029(2)	48.92(2)
Greece	0.038(10)	1.41(8)	0.260(7)	0.090(8)	34.36(10)
Ireland	0.015(3)	1.22(3)	0.236(6)	0.036(3)	44.37(6)
Italy	0.025(7)	1.30(6)	0.266(8)	0.070(7)	40.90(7)
Netherlands	0.028(9)	1.69(10)	0.166(1)	0.118(10)	49.40(1)
Portugal	0.020(5)	1.30(7)	0.217(5)	0.052(5)	40.13(9)
Spain	0.034(9)	1.60(9)	0.195(3)	0.112(9)	40.40(8)

the government tax revenue to calculate the cost to be in the range of 0-16 % of GDP across the EU-12 countries.

Next, as documented in Table 5 on the next page, rent-seeking time estimates and model-based loss measures are found to be moderately- to highly-correlated to other empirical indices of institutional quality. As expected, rent-seeking time in steady-state is very strongly negatively related to the indices of bureaucratic efficiency, where the values range between -0.50 and -0.73 . The public wage premium is also moderately negatively related to institutional quality - between -0.2 and -0.4 . This finding could be an indicator that public sector wages are indeed determined by factors unrelated to productivity, such as budgetary considerations. Lastly, the public/private employment ratio is essentially uncorrelated with the index values, hinting that the effect of high public employment is of secondary importance and only works indirectly through the inefficiently high public sector wages. The two model-based loss measures, rent-seeking relative to government hours and the lobbying cost, are moderately to strongly negatively correlated with different indicators of bureaucratic efficiency.

Table 5: Correlation matrix

Index	rs	p	n^g/n^p	rs/n^g	$\frac{w^g rs}{y}$
ICRG index	-0.68	-0.27	0.01	-0.27	-0.39
public administration index	-0.50	-0.12	-0.02	-0.12	-0.26
expenditure effectiveness index	-0.73	-0.37	0.12	-0.37	-0.50
government effectiveness index	-0.57	-0.19	0.04	-0.19	-0.31

In the next section, the behavior of the model outside of the steady-state is investigated. In particular, the second moments of the model variables and the responses of the variables in the face of a surprise technological innovation are presented and discussed.

6 Model solution, goodness-of-fit and impulse responses

The equilibrium non-linear system of equations is log-linearized around the stationary DCE equations, and the linearized version of the model is solved numerically. Simulated time series were produced, the second moments of all the model variables were computed, and then compared to their empirical counterparts. Table 6 on the next page summarizes the empirical and simulated business cycle statistics for the model calibrated to German data.

Table 6: Business Cycle Statistics Germany, 1970-2007

	GE Data	Model
$\sigma(y)$	0.0154	0.0154
$\sigma(c)/\sigma(y)$	1.11	0.55 [0.52,0.58]
$\sigma(i)/\sigma(y)$	3.57	3.00 [2.94,3.07]
$\sigma(n^p)/\sigma(y)$	1.05	0.26 [0.25,0.28]
$\sigma(n^g)/\sigma(y)$	1.06	2.25 [2.24,2.26]
$\sigma(n)/\sigma(y)$	0.73	0.54 [0.53,0.55]
$\sigma(w^p)/\sigma(y)$	1.16	0.77 [0.76,0.79]
$\sigma(w^g)/\sigma(y)$	3.50	1.41 [1.40,1.42]
$\sigma(rs)/\sigma(y)$	-	8.90 [8.89,8.91]
$corr(c, y)$	0.80	0.96 [0.95,0.97]
$corr(i, y)$	0.85	0.98 [0.97,0.99]
$corr(n^p, y)$	0.60	0.90 [0.86,0.94]
$corr(n^g, y)$	0.11	1.00 [1.00,1.00]
$corr(n, y)$	0.60	0.98 [0.97,0.99]
$corr(rs, y)$	-	1.00 [1.00,1.00]
$corr(w^p, y)$	0.60	0.99 [0.99,0.99]
$corr(w^g, y)$	0.35	1.00 [1.00,1.00]
$corr(n, n^p)$	0.92	0.97 [0.96,0.98]
$corr(n, n^g)$	0.43	0.99 [0.98, 0.99]
$corr(n^p, n^g)$	0.12	0.92 [0.88,0.95]
$corr(n^p, w^p)$	0.21	0.83 [0.76,0.89]
$corr(n^g, w^g)$	-0.38	0.99 [0.99,1.00]
$corr(w^p, w^g)$	0.48	1.00 [1.00,1.00]

In the German data, relative consumption volatility exceeds one, as it is a combination of non-durables and durables. Since a major force in all the three models is consumption smoothing, as dictated by the Euler equation, the model under-predicts consumption volatility and investment variability. The lower variability of both consumption and investment in the model could be due to the fact that labor markets interaction are much more important quantitatively for the short-run dynamics of the model. After all, the simulation horizon in the annual model is only 38 periods, given the span of data available for Germany.

In terms of labor market fluctuations, private sector employment and private wage in the model also vary less compared to data; total employment in German data also varies less than either private or public employment. However, this is a common deficiency of this class of RBC models. It is evident from Table 6 above that the model underestimates public wage volatility; still, this simple model generates public wage that varies twice as much as the private sector wage. Therefore, the introduction of a real rigidity in the government sector is a step in the right direction. Another shortcoming is that public employment in the model varies too much in the model, as compared to the volatility exhibited in German data. Lastly, rent seeking varies eight times more than output. Unfortunately, there is no empirical time-series measure that it can be evaluated against. Overall, the convex cost of working in the public sector, together with opportunistic behavior by government bureaucrats, seems to have a somewhat important quantitative effect in the German economy, especially when describing public sector labor market fluctuations.

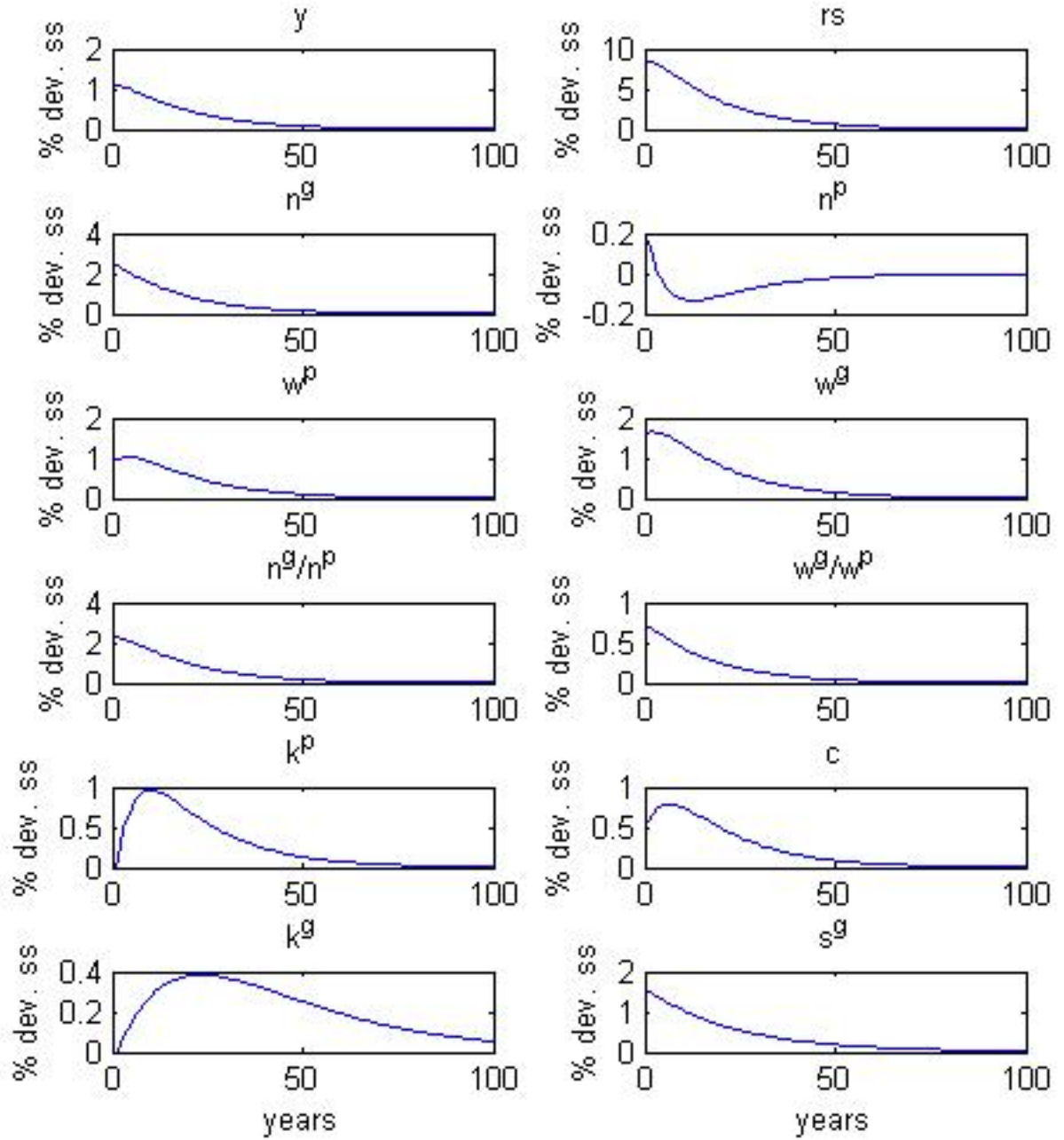
The model also captures relatively well the high contemporaneous correlations of main variables with output. The time spent in opportunistic activities, rent-seeking time, is also predicted to be perfectly correlated with output. Moreover, public sector variables are also pro-cyclical, but not as much as the models predict. Lastly, the model captures quite well the co-movement between labor market variables. However, the dimension where the model underperforms, is the correlation between public sector hours and wages: in German data, it is negative, while the model predicts a perfect positive linear relationship. Overall, the model with real rigidities in the public sector labor market and rent-seeking mechanism captures relatively well the labor market dynamics in Germany.¹⁶ Furthermore, the setup addresses dimensions that were ignored in earlier RBC models. Thus, the existence of such real frictions in the public sector proves to be an important ingredient in RBC models when studying German labor markets. The next section reinforces the intuition of the model mechanics by analyzing how the economy responds to an unexpected one-time technological innovation.

6.1 The Effect of a positive productivity shock

Figure 1 on the next page shows the impact of a 1% surprise TFP innovation on the model economy. There are two main channels through which the TFP shock affects the model economy. A higher TFP increases output directly upon impact. This leads to increase in both private and public consumption and investment, as well as in government transfers (not illustrated). In addition, the positive TFP shock increases both the marginal product of private sector capital and labor, hence the real interest rate (not illustrated) and the private wage rate increase. The household responds to the price signals and supplies more hours in the private sector, as well as increasing investment. Furthermore, the increase of private hours expands output further, thus both output and government spending categories increase slightly more than the amount of the shock upon impact. Over time, as private physical capital stock accumulates, marginal product of capital falls,

¹⁶In Vasilev (2015b), a standard RBC was parametrized for Germany, which showed that without the rigidity the fit is much worse.

Figure 1: Impulse Responses to a positive 1% productivity shock in Germany



which decreases the incentive to invest.

With regard to public sector labor dynamics, however, there is the additional effect from the initial increase in TFP, which led to an increase in income and consumption. Higher income in turn leads to greater tax revenue. As a result, the additional funds are available to be spent on government investment, transfers and the wage bill. The increase in the latter leads to an expansion in both public sector wages and hours. Thus, the model in this paper generates interesting dynamics in the wage and hours ratio, which is not present in models with stochastic public employment, such as Linnemann (2009). The two wage rates, as well as the two types of hours move together, but less than perfectly so, thus making the model consistent with the empirical evidence presented in Lamo *et al.* (2007, 2008). In addition, as in the data, public sector labor variables react much more strongly to positive technological innovations than do their private sector counterparts.

Given that both public wages and hours react strongly and positively to technological improvements, the new variable in the model, rent-seeking time, also increases. That is, during unexpectedly good times, tax revenues are larger than usual, increasing the amount of extractable funds, which are then expropriated by government bureaucrats in the form of excessive salaries to government bureaucrats. Rent-seeking time in the model thus responds very strongly to the dynamics of output, as it is related to the tax base in the labor income generated in the economy.

Overall, a positive innovation to total factor productivity has a positive effect on the allocations and prices in the economy. The novelty is that the endogenous public sector hours model generates an important difference in the composition of household's labor income with the public sector share increasing at a much faster rate than the private sector labor income. This is also reinforced by the presence of the extraction mechanism in the government sector. Another important observation to make is that the TFP shocks, being the main driving force in the model, induce pro-cyclical behavior in public wages and hours.

7 Conclusions

This paper studied the wasteful effect of bureaucracy on the economy by addressing the link between opportunistic behavior of government bureaucrats and the public sector wage bill. In particular, public officials were modeled as individuals competing for a larger share of those public funds. A simple extraction technology in the government administration was incorporated in an otherwise standard Real-Business-Cycle (RBC) setup augmented with detailed public sector. The model was calibrated to German data for the period 1970-2007. The main findings are: (i) the model performs well *vis-a-vis* the data; (ii) Due to the existence of a significant public sector wage premium and the high public sector employment, a substantial amount of working time is spent in opportunistic activities, which in turn leads to significant losses in terms of output; (iii) The model-based loss measures obtained for the EU-12 countries are highly-correlated to indices of bureaucratic inefficiency.

Data Sources: Due to data limitations, the model calibrated for Germany is for the period 1970-2007, while the subperiod 1970-91 covers West Germany only. Data on real output per capita, household and government consumption per capita, and population were taken from the World Development Indicators (WDI) database. The OECD statistical database was used to extract the long-term interest rate, CPI inflation, average annual earnings in the private and public sector, average hours, private, public, and total employment in Germany. Public transfers ratio were calculated from the CES-Ifo DICE Database (2011). Public and private investment and capital stock series were obtained from EU Klems Database (2009). German average annual real public compensation per employee was estimated by dividing the real government wage bill (OECD Statistical Database 2014) by the number of public employees. Because of data limitations on the average hours worked in each sector, employment statistics were used. To make empirical variables comparable with model variables, employment series in Germany were normalized by total population.

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