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ABSTRACT

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We analyze the optimal regional pattern of public employment in an information-constrained second-best redistribution policy showing that regionally differentiated public employment can serve as an expenditure side tagging device, bypassing or relaxing the equity-efficiency trade-off. The optimal pattern exhibits higher levels of public employment in low productivity regions and is more pronounced the higher is the degree of regional inequality within the country. Empirically, using a panel of European regions from 1995-2007, we find evidence that public employment is systematically higher in low productivity regions. The latter effect is stronger in countries with higher levels of regional inequality.

JEL Classification: H11, J45, R12

Keywords: public employment, redistribution, regional inequality, European regions

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1 Introduction

Governments can regionally differentiate their policies along several dimensions. One important dimension is the regional differentiation of public employment, which can give rise to a critical equity-efficiency tradeoff. Alesina et al. (2001) document the regional differences in public employment for the case of Italy. They also show that these differences generate substantial redistributive effects, also pointing out the associated efficiency costs. The latter can either be due to an inter-regionally inefficient allocation of publicly provided goods and services, or to the detrimental effects a bloated public sector may have on productive efficiency. Such findings raise the question whether public employment is an appropriate instrument of a redistributive policy and, in particular, whether it is possible to characterize the equity-efficiency tradeoff inherent in regionally differentiated public employment.

The potential role of public employment for efficient redistribution has been addressed originally by Wilson (1982). He uses a framework of optimal linear taxation and studies whether the public sector should alter the composition of its workforce in favor of high or low-skilled individuals. As he shows, the optimal policy involves a distortion of the public workforce composition, but its direction depends crucially on whether human capital formation is endogenous or not. Nichols and Zeckhauser (1982), Boadway and Keen (1993), Pirttilä and Tuomala (2005), Lundholm and Wijkander (2008), Blumkin et al. (2009), and Blomquist et al. (2010), among others, have subsequently analyzed how the government's expenditure decisions, its employment choices, and its regulatory interventions in the labor market can improve the efficiency of the tax-transfer system. None of these contributions, however, considers the regional policy dimension, which is the focus of our analysis.[1]

In this paper we develop a coherent optimal taxation framework to study the equity-efficiency tradeoff inherent in the regional differentiation of public employment. The aim is to explore whether this differentiation can be a sensible element of an incentive-compatible redistribution policy. Our analysis shows that a regionally differentiated employment policy can be used as an expenditure side tagging device helping the government to implement an incentive-compatible redistribution scheme. Akerlof (1978) was the first to point out that the correlation of earnings ability with certain personal characteristics (such

[1]There is also a political economy and bureaucracy literature, where public employment is seen as an instrument for politicians to channel rents to specific groups either to generate political support (Gelb et al. (1991), López-de-Silanes et al. (1989)), to disguise the amount of transfers channelled to some favored minority group (Alesina et al. (2000)), or to create commitment within a bureaucracy (Kessing and Konrad (2008)). The regional dimension of public employment in a political economy framework has recently been discussed by Jaimovich and Rud (2009). The latter contribution can be regarded as complementary to our approach.

as race, gender, the region of residence, etc.) can be exploited to improve the efficiency of tax-transfer schemes. However, for reasons of horizontal equity, or of practical and political feasibility, such tags are typically not applied in real world tax systems (see Boadway and Pestieau (2006)). This is also true for the regional dimension, since income taxes set by central governments are typically not differentiated by region.

We argue that public employment can be an expenditure side substitute that also allows the tagging of low productivity individuals, and we identify several channels how regionally differentiated public employment may improve efficiency. First, public employment generates goods and services which are consumed locally. Higher public employment in low productivity regions thus generates a direct targeted consumption effect, without violating incentive compatibility. This channel works identically for regionally differentiated government spending. Second, because public sector productivity tends to be less regionally dispersed than private sector productivity, the opportunity costs of moving a worker from the private to the public sector tends to be lower in low productivity regions. Finally, a regional differentiation of public employment eases incentive compatibility, if regional private sector wages depend on regional public employment. These latter two channels do not typically arise with regionally differentiated public spending.

We then assess empirically the regional pattern of public employment in Europe using a rich panel data set including 220 NUTS 2 regions from 17 European countries over the period 1995-2007. The data on public employment have been directly provided by Eurostat and have the advantage that they exclude information on sectors such as education, research and health care, where the amount of workers with a private employer is relevant. In our analysis we go beyond individual country-level approaches and explicitly consider a cross-country dimension. Our aim is to detect regularities in the regional patterns of public employment across countries and to explore the possibility that such patterns are systematically correlated with the degree of regional inequality within each country. Our findings indicate that public employment is significantly higher in low productivity regions and that this relationship is more pronounced in countries with higher degrees of regional inequality. These results are robust to different specifications and are in line with our theoretical analysis of an inherent equity-efficiency trade-off of regionally differentiated public employment.

Existing empirical cross-country studies on the determinants of public employment, such as Rodrik (2000), and Martínez-Vázquez and Ming-Hung (2009), only consider data at country level, so they do not provide any evidence regarding the regional distribution of public employment. At country level, instead, a few studies have already considered the regional dimension of public employment. Jaimovich and Rud (2009), for example,

analyze the regional evolution of public employment from a political economy perspective, with a focus on Argentina. Alesina et al. (2001) study the regional public employment in Italy, whereas Borge and Matsen (2004) consider the role of public employment for risk sharing at regional level for the case of Norway. Finally, Alesina et al. (2000) and Mattos and França (2010) focus on public employment at the municipal level in the US and Brazil, respectively, although they do not explicitly take the regional dimension into account.

The paper is organized as follows. We set up our basic theoretical framework in Section 2, which is divided into three parts. We first investigate the consumption channel of regionally differentiated public employment; we then consider in more detail the labor market effects; finally, we discuss several extensions of our theoretical framework. Section 3 presents our empirical analysis: we describe the dataset we use, we introduce our baseline empirical specification and we present our results. Section 4 concludes.

2 Theoretical framework

2.1 A baseline model

We consider an optimal direct taxation model, similar to Stiglitz (1982). There are two regions $i = 1, 2$, each with their respective population normalized to one, and two types of individuals $j = h, l$. The types differ in their productivity such that we have $w_h > w_l$, where w_h is the wage of high productivity individuals and w_l is the wage of low productivity individuals. The share of individuals of type j in region i is m_{ij}. Region 2 has a higher productivity on average than region 1, so that $1 \geq m_{2h} > m_{1h} \geq 0$. As usual in the optimal taxation approach, we assume that all individuals have the same preferences, which, similar to Diamond (1998), are given by a simple quasi-linear specification

$$U_{ij} = x_{ij} - h(l_{ij}) + v\left(g_i\right), \tag{1}$$

with derivatives $h'(l) > 0$, $h''(l) >$, $v'\left(g\right) > 0$, $v''\left(g\right) < 0$, where x_{ij} is private good consumption, l_{ij} is individual labor supply and g_i is a public good, which can only be consumed locally. We interpret the latter as public employment, implicitly assuming a public sector with a linear technology which relates public goods and public employment, as in the private sector.[2] In the following we introduce public employment explicitly to identify

[2]Alternatively, the regionally provided goods g_i could be produced privately and could only be purchased by the public sector. Such an interpretation implicates that the analysis of this section not only relates to public employment but also applies to the regional distribution of public spending more generally.

further channels which determine the optimal regional pattern of public employment. The prices of private and public goods are normalized to one.

Society is inequality averse. As in Blumkin et al. (2009), we first employ a CES-type social welfare function

$$W = \sum_{i=1,2} \sum_{j=h,l} m_{ij} \frac{U_{ij}^{\rho}}{\rho}, \text{ with } 0 \neq \rho < 1. \tag{2}$$

The government implements a tax system that defines tax or subsidy payments $T_i = T_i(w_i l_i)$ as a function of gross income only, since it cannot observe individual productivity directly. While the government may differentiate public employment by region, we assume that it cannot condition the tax system on the region of residence. This may be due to political or monitoring constraints. The tax payments determine individual net income and thus private consumption, $x_i = w_i l_i - T(w_i l_i)$. Since the government cannot directly observe individuals' productivity and conditions taxes on gross income, the tax system needs to be incentive compatible. We only consider downward incentive compatibility, i.e. high income earners should not have an incentive to mimic low income workers. The incentive compatibility constraint is

$$x_h - h(l_h) \geq x_l - h\left(\hat{l}\right), \tag{3}$$

where the hat on a variable indicates a high productivity individual mimicking a low productivity individual, such that $\hat{l} = \frac{w_l}{w_h} l_l$. Note that public employment does not enter into the incentive compatibility constraint since both types of workers consume the public goods provided in their region. Finally, taxes not only serve to redistribute between high and low income workers but also finance public employment in both regions.[3] To facilitate comparative statics, we assume an exogenous average level of public employment equal to g and assume that $g_1 = (1+a)g$ and $g_2 = (1-a)g$, so that the parameter $a \in [-1, 1]$ summarizes regional differentiation of public employment. The government's budget constraint is thus

$$(m_{1h} + m_{2h})(w_h l_h - x_h) + (m_{1l} + m_{2l})(w_l l_l - x_l) \geq 2g. \tag{4}$$

The government maximizes (2) subject to (3) and (4). Solving (3) and (4) for x_1 and x_2, and substituting into (2), it maximizes (2) by choosing l_l, l_h, and a.[4] The first order

[3] In practice, regional and local governments often play a key role in the determination of regional public employment. We abstract from them for simplicity and discuss their potential role along with other extensions in Section 2.3.

[4] See the proof of Proposition 2 in Appendix A1.

condition with respect to a is

$$\left[m_{1l}U_{1l}^{\rho-1} + m_{1h}U_{1h}^{\rho-1}\right] v'(g_1) = \left[m_{2l}U_{2l}^{\rho-1} + m_{2h}U_{2h}^{\rho-1}\right] v'(g_2). \tag{5}$$

The optimal solution thus requires $v'(g_1^*) < v'(g_2^*)$ and therefore $g_1^* > g_2^*$ and $a^* > 0$, where the asterisks indicate optimal values. We summarize this in Proposition 1.

Proposition 1 *If regions differ according to their average productivity and the government cannot observe individual productivity directly, the solution to the social welfare maximization problem entails $a^* > 0$. Optimal public employment should be higher in the region with lower average productivity.*

Intuitively, since the locally consumed public goods provided through public employment do not enter the incentive compatibility constraint (3), they can be used for redistribution. The optimum trades off the welfare gains from redistribution with the costs of distorted public goods supply.

We now turn to the role of regional inequality for regional differentiation of public employment. This leads us to Proposition 2.

Proposition 2 *An increase in productivity differences across regions, keeping the total share of high and low productivity individuals constant, increases the optimal degree of regional differentiation of public employment.*

Proof. *See Appendix.* ■

If regional productivity differences are more pronounced, the optimal policy requires a stronger differentiation of public employment. Intuitively, with more regional inequality, public employment becomes a better targeted instrument in the context of an optimal redistribution policy.

Proposition 1 and Proposition 2 are valid regardless of whether the regional differentiation refers to public employment or to public spending, since local consumption is driving the results. We now consider more in detail additional aspects of regionally differentiated public employment, which are typically not present in the case of regionally differentiated public spending.

2.2 Endogenous wages and public sector production

Alesina et al. (2001) stress the double role of public employment. According to this perspective, there are not only distributional effects originating from the consumption of regionally differentiated levels of public goods and services, but there are also important

effects on regional labor markets. These originate from the substantial role played by public sector labor demand, which can drive up regional private sector wages. This makes wages endogenous. Additionally, the optimal regional public employment policy should also take into account the specific structure of public sector production which typically exhibits lower variation in productivity levels relative to the private sector. In order to study how these effects relate to the optimal regional distribution of public employment, we now drop the assumption of a one-to-one relationship between the regional level of public good supply and the regional level of public employment. Moreover, we depart from the assumption of exogenous wages. In particular, we now model employment and production in the public sector explicitly and allow for endogenous wages. To keep the analysis tractable, we only consider the case of perfect correlation between individual productivity and the place of residence, by setting $m_{1l} = m_{2h} = 1$ and $m_{1h} = m_{2l} = 0$. Accordingly, we drop the subscripts h and l, and we now employ a Utilitarian welfare function

$$W = \sum_{i=1,2} u\left(x_i\right) - h(l_i) + v\left(g_i\right), \tag{6}$$

with utility being strictly concave in private consumption, $u'(x) > 0$, $u''(x) < 0$. This objective function closes down the consumption channel of regionally differentiated public employment studied in Section 2.1.[5]

Individuals in both regions either work in the private or in the public sector. We denote the fraction of individuals in the public sector of each region by n_i, such that $1 - n_i$ work in the private sector. Private good production q_i is determined by regional production conditions summarized by a production function $f_i(.)$, $f_i'(.) > 0$, $f_i''(.) < 0$, while total labor input in the private sector is given as the share of private sector workers times their individual labor supply

$$q_i = f_i\left(l_i\left(1 - n_i\right)\right). \tag{7}$$

Note that this implies the existence of pure profits in both regions. As in related studies, such as Blackorby and Brett (2004), these are assumed to be fully taxed by the government. The publicly provided good g_i is locally produced by the public sector according to the simple linear relationship

$$g_i = n_i l_i. \tag{8}$$

[5]Using the objective function (6) in Section 2.1 would not result in differentiated public employment in the optimum. An encompassing formulation includes this objective function and a higher relative welfare weight for low productivity individuals.

Note that (8) implies that labor is equally productive in the public sector in both regions. We regard this as a useful benchmark illustrating the fact that regional productivity dispersion is typically smaller in the public sector relative to the private sector. We discuss the implications of alternative assumptions about public sector production in Section 2.3. Note also that our qualitative results do not depend on this specific production function. However, this form makes the interaction between the public and the private sector particularly simple, since private production can be expressed as $q_i = f_i(l_i - g_i)$.

Differences in personal productivity in the private sector are now only due to the location of workers and do not originate from some innate differences between individuals. Region 2 is the more productive region, which we capture by the assumption of a higher marginal labor productivity there. Assuming labor is paid its marginal product in the private sector, the productivity difference between regions can be stated as

$$w_2 = f_2'(l_2 - g_2) > f_1'(l_1 - g_1) = w_1. \tag{9}$$

We assume that the public and the private sector pay the same wage in each region, and there is no migration between the two regions. The additional implications of public sector wage premia and migration are discussed in Section 2.3 below. We define the inter-regional wage ratio as

$$z \equiv \frac{w_1}{w_2} = \frac{f_1'(l_1 - g_1)}{f_2'(l_2 - g_2)}. \tag{10}$$

The wage ratio is increasing in the public good production in region 1 ($z_{g_1} > 0$), but decreasing in public good production in region 2 ($z_{g_2} < 0$).

The government's problem is now to choose x_1, x_2, l_1, l_2, a to maximize (6) subject to the incentive compatibility constraint

$$u(x_2) - h(l_2) \geq u(x_1) - h(zl_1) \tag{11}$$

and subject to the aggregate resource constraint

$$x_1 + x_2 \leq f_1(l_1 - g_1) + f_2(l_2 - g_2). \tag{12}$$

This latter condition requires that total private consumption cannot exceed total private production and is equivalent to the government budget constraint. The first order condition with respect to a is

$$v'(g_2) - v'(g_1) = \lambda l_1 h'(\hat{l})[z_{g_1} - z_{g_2}] + \mu[f_2'(l_2 - g_2) - f_1'(l_1 - g_1)], \tag{13}$$

where λ and μ are the Lagrange multipliers corresponding to the constraints (11) and (12), respectively. This directly leads to Proposition 3:

Proposition 3 *With endogenous wages the optimal policy requires public employment and public goods production to be higher in the region with lower average productivity:* $n_1^* > n_2^*$, $g_1^* > g_2^*$, *and* $a^* > 0$.

Proof. Both terms on the right hand side of (13) are positive since $f_2'(l_2 - g_2) > f_1'(l_1 - g_1)$ and $z_{g_1} - z_{g_2} > 0$ given that $z_{g_1} > 0$ and $z_{g_2} < 0$. This implies $v'(g_2^*) > v'(g_1^*)$, and thus $g_1^* > g_2^*$ and, by (8), $n_1 l_1 > n_2 l_2$, which implies $n_1^* > n_2^*$, since $l_1^* < l_2^*$. ■

Thus, even without tagging via regionally differentiated consumption levels of public goods and services, the optimal policy requires public employment to be higher in the low productivity region. There are two additional reasons for this regional differentiation. First, there is a difference in opportunity costs. While productivity in the public sector is the same in both regions, moving a worker from the private to the public sector is more costly in the high productivity region. This is evident from the second term on the right hand side of (13), which is the regional difference in marginal productivity in the private sector, valued at the society's shadow value of additional private goods. The second effect is less obvious and directly relates to the role a regionally differentiated public employment policy can play for efficient redistribution. It is embodied in the first term on the right hand side of (13), $\lambda \hat{u}_l^2 [z_{g_1} - z_{g_2}]$. This effect is also positive and thus drives the optimal marginal utilities from public good consumption in the two regions further apart. Increasing public employment in the low productivity region and decreasing it in the high productivity region both reduce the wage differential between regions, thus relaxing incentive compatibility. The effect of public employment on wages makes it less attractive for high income earners to mimic low income workers. Thus, regionally differentiated public employment relaxes incentive compatibility. This relates to the results of Naito (1999), Blackorby and Brett (2004), and Gaube (2005), who have also shown that endogenous wages can provide a rationale for distorting production to improve an information-constrained redistribution policy.

2.3 Extensions

Our theoretical approach has taken the simplest route to highlight the channels that can provide a normative rationale for regionally differentiated public employment. Such policies can apparently be useful as expenditure side tagging devices that can improve the targeting of redistribution policies via the consumption side of public goods and services. Moreover, they can exploit regionally different opportunity costs of public employment.

Finally, they mitigate the incentive compatibility constraint inherent in redistribution under asymmetric information. Our framework has abstracted from a number of aspects that are potentially relevant in practice which we - as much as possible - take into account in our empirical analysis in Section 3. We consider the theoretical implications of these additional aspects one by one.

Public sector wage premia. Public sector wage premia would generate several additional effects. First, they would introduce an additional inefficiency into production. Second, they would increases the utility of public sector workers. Third, they could put upward pressure on private sector wages by themselves, as private firms may be forced to increase wages to keep their workers. Overall, they should reduce the level of public employment, but their effect on the regional distribution is not evident.

Regional differences in unemployment. Regional unemployment differences would also modify our analysis. On the one hand, moving workers out of unemployment into public employment has lower opportunity costs than moving a worker from the private to the public sector. On the other hand, with slack in the labor market, the positive effect on private sector wages and the resulting effects on incentive compatibility are dampened, thus weakening the channel that identifies regionally differentiated public employment policies as an element of an efficient incentive-compatible redistribution policy.

Heterogenous goods. The presence of heterogenous goods would have the following implications. If the regional private sectors produce different goods (such as, for example, agricultural and industrial products), diverging price developments for the respective goods may be driving regional inequality. However, also in this case, the argument for regional tagging via public employment remains valid, since, for a government concerned about redistribution, it does not matter whether regional wage differences originate from diverging prices or from other underlying structural differences.

Regional and local governments. Additional government tiers were not included in the analysis but play an important role for public employment in practice. However, they typically depend strongly on financing from the central government. Thus, the regionally differentiated policy of the central government also includes the distribution of grants: in this way, the central government has more policy options to regionally differentiate its policy. However, the lower level governments typically only have the discretion to decide whether to spend their revenue directly, or whether to use it for public employment. As a consequence, the omission of lower level governments does not pose a fundamental challenge to our analysis and their inclusion would not change our argument qualitatively. Of course, an encompassing approach that takes the sub-national government-levels into account would additionally have to consider their incentives, which would substantially

complicate the analysis.[6]

Migration. By assumption, migration between regions is not possible in our framework. However, our model could easily be extended to allow for it. As long as there are migration costs, allowing for migration between the two regions of our model would not change our results qualitatively, although a lower degree of optimal regional differentiation in public employment would result.

More general production technologies. Differences in labor intensity could not show up in our simple framework, since we did not allow for other factors of production apart from labor. As it is clear from the work of Naito (1999), a more general production function with an additional production factor could be set up. In such a framework, regional differentiation of both public employment and labor intensity would arise at the same time. Similarly, even with only a single factor of production, we could have used a less specific production function for public sector production in Section 2.2. Clearly, with regional productivity dispersion also in the public sector, the opportunity cost argument in favor of regionally differentiated public employment is reduced, although it remains relevant as long as regional public sector productivity is more compressed than private sector productivity. The consumption channel, and the incentive compatibility channel, however, remain unaffected by an increase in the public sector's regional productivity differential.

Positive analysis. In line with the optimal taxation tradition we have used a normative framework to analyze whether there is a rationale for using regionally differentiated public employment from a benevolent policy maker's perspective. Of course, with a view to our subsequent discussion on the empirical evidence we show, the argument of an inherent equity-efficiency trade-off could be extended to a positive analysis, where individuals' welfare feeds back into the political success of politicians.

3 Empirical analysis

3.1 Data

To empirically investigate the link between regional public employment per capita and regional productivity in Europe, we assemble a dataset with regional data at NUTS2 level for 17 European countries.[7] All regional data are taken from Eurostat regional statistics

[6]The role of government decentralization in terms of public employment is the focus of the recent paper by Martínez-Vázquez and Ming-Hung (2009).

[7]The countries in our sample are: Austria Belgium, Czech Republic, Germany, Finland, France, Greece, Hungary, Italy, Netherlands, Poland, Portugal, Romania, Spain, Sweden, Slovak Republic, United Kingdom. Our largest sample includes 243 NUTS2 regions, while the sample under investigation includes

and range from 1995 to 2007. For all details about data and sources, see the Appendix.

Our measure of public employment is the number of people employed in the NACE sector "Public administration and defence; compulsory social security". Accordingly, the measure excludes information on public employment in sectors such as education, research and health care. This level of data disaggregation is not publicly available and has been kindly provided by the Eurostat staff. [8] While this somewhat narrow definition of public employment may appear as a limitation, it actually has the advantage of excluding workers of those sectors where private firms and non-profit organizations are relevant, and where there are substantial differences in their relevance depending on the country and region. Indeed, since the LFS only classifies workers by sector and not by employer, publicly employed workers in sectors such as health, education and others cannot be distinguished from privately employed ones, thus implying that the actual amount of public employment at regional level cannot be retrieved. In other words, using workers from NACE sector "Public administration and defence; compulsory social security" guarantees us that the measure of regional public employment we adopt is largely representative only of workers with a public employer. Moreover, since our focus is the regional distribution of public employment from a cross-country perspective and not the overall size of the public sector, a narrower but consistent measure of public employment is more useful than a broader measure with regional and/or cross-country inconsistencies. As far as productivity is concerned, the measure we adopt is regional wages and salaries per number of employed persons in manufacturing and is taken from Eurostat Structural Business Statistics.

Preliminary evidence of the link between regional public employment per capita and regional productivity is presented in Figure 1. The figure shows two maps of 243 European regions classified according to their regional productivity per worker (left) and regional public employment per capita (right) with respect to their country average in 2007. To calculate the country averages, each regional measure has been weighted by the population share of the corresponding region. For clarity, regions have been grouped into four categories according to their relative position with respect to their country average: <80%, 80-100%, 100-120% and >120%. The maps show that in Europe there is a substantial dispersion of both regional relative productivity and regional relative public employment. In addition, in some countries there is clear evidence of a correspondence between a relatively low level of productivity and a relatively high level of public employment with respect to the country average (e.g. Italy and Germany). This evidence closely relates to the scatter-plots presented in Figure 2, which show the correlation between

220 regions. As it will be clarified below, the sample we consider excludes the capital regions and a number of outliers.

[8] See the Appendix for details.

Figure 1: Regional productivity (left) and regional public employment per capita (right) relative to country average. European regions, 2007.

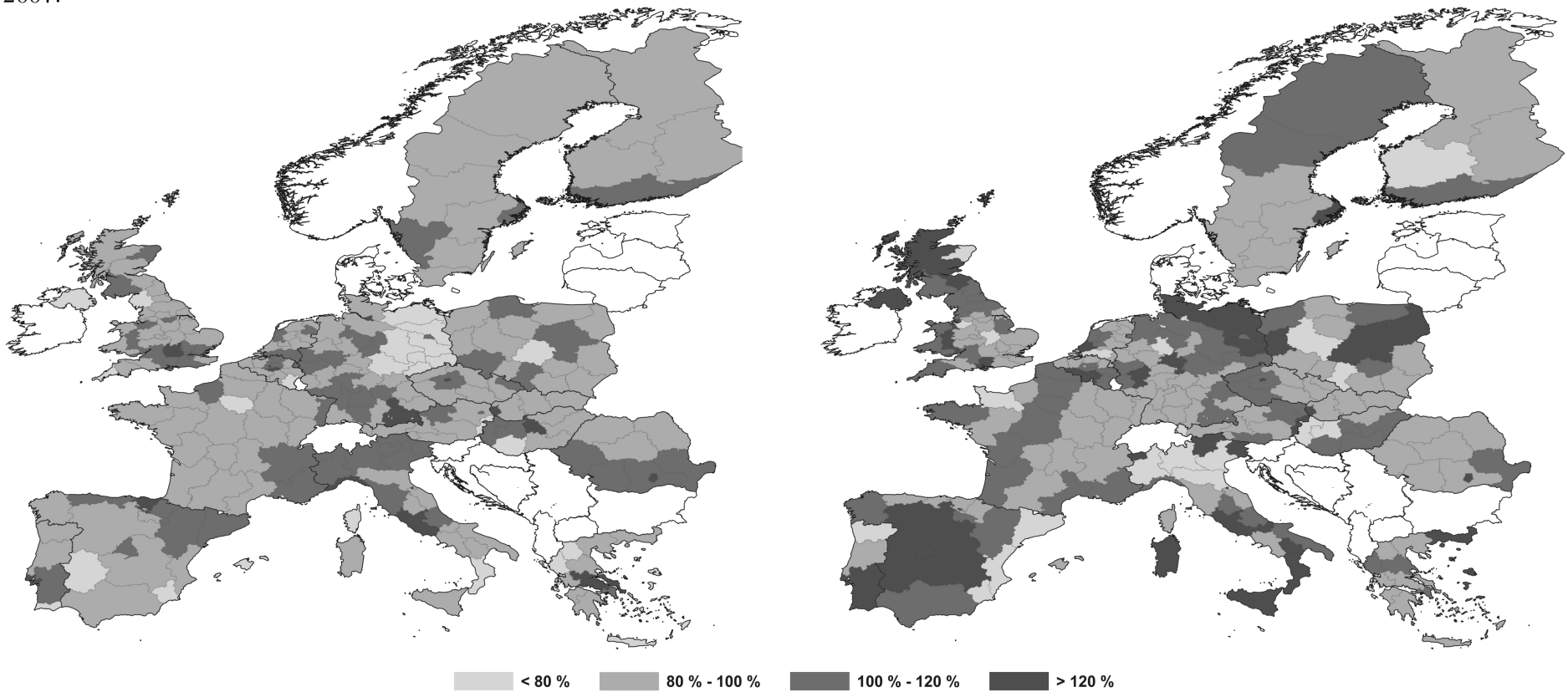
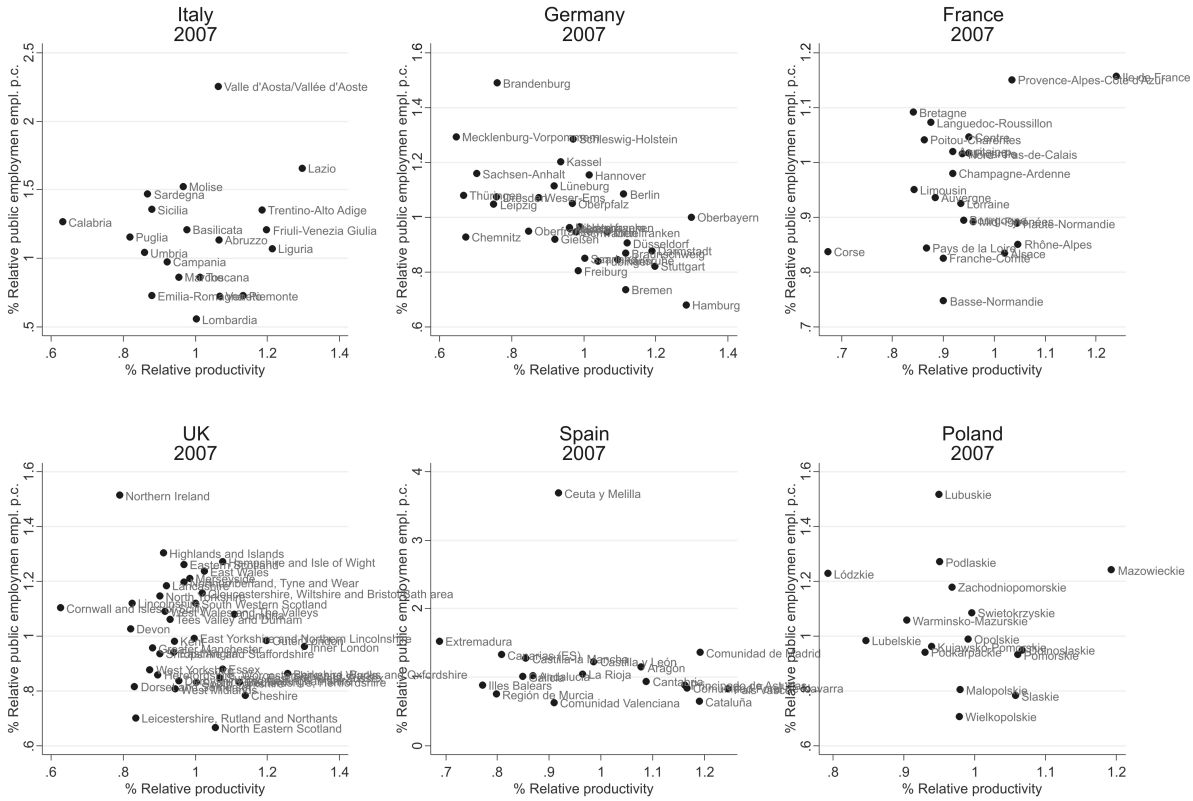


Figure 2: Relative regional productivity and relative regional public employment per capita in the six biggest European countries, 2007.



regional relative productivity and regional relative public employment per capita in the six biggest European countries in terms of population in 2007. A negative relationship between regional productivity and regional public employment appears to be visible for most of the countries, while not for all of them (e.g. France).

The figure also illustrates the unambiguously high level of relative public employment per capita in the capital regions of our sample (e.g. Lazio and Ile de France) and in some other regions (e.g. Ceuta y Melilla). In line with the above evidence, in the empirical analysis we perform, we focus on the relationship between regional public employment and regional productivity by excluding from the initial sample the regions which are evident outliers. First of all, we exclude the capital regions. Indeed, all capital regions are natural outliers since public employment is substantially higher there due to the specific tasks that are carried out at the seat of government. In addition, we take out a number of regions whose peculiar level of public employment is due to historical or geographical reasons. We then end up with a sample composed of 220 European regions.[9]

[9]From the initial sample of 243 regions we first take out all the 17 capital regions, i.e. the regions where the capital is located. The only exception is The Netherlands, where we exclude South Holland instead of North Holland since we take into consideration that The Hague and not Amsterdam is the administrative capital of the country. In addition, we eliminate Ceuta-y-Melilla in Spain and Northern Ireland in Ireland since their level of public employment per capita is abnormally high (see Figure 2),

Table 1: Summary statistics.

Variable	Observations	Mean	Std. dev.	Min	Max
Public employment p.c.	2655	0.030	0.008	0.008	0.061
Productivity	2291	0.023	0.010	0.001	0.050
Inequality	2398	0.136	0.040	0.014	0.257
Population density	2402	0.251	0.426	0.003	3.656
Dependency ratio	2662	0.505	0.048	0.374	0.627
Relative compensation	2373	1.134	0.277	0.841	2.192
Unemployment rate	2663	0.089	0.052	0.012	0.334

NOTE: The sample under consideration include 220 European NUTS2 regions. From the available sample of 243 regions we exclude the following outliers: all the capital regions, Northern Ireland, Ceuta y Melilla, Canarias, Madeira, Açores and Valle d'Aosta. For explanations see the text.

The summary statistics of the sample under consideration are presented in Table 1. In our sample, according to our narrow definition of public employment, on average 3% of the population work in the public sector. The average dependency ratio is about 50%, meaning that the group of people below 15 and over 64 years correspond to half of the working age population (i.e. the population aged between 15 and 64). Moreover, the average relative public to private compensation is 1.134, evidencing that our sample is characterized by the presence of public sector wage premia. Finally, the average regional unemployment rate is about 9%.

In the following, we investigate the relationship between regional public employment and regional productivity more in details.

3.2 Empirical specification

Our theoretical framework implied that i) regions with lower productivity should have higher levels of public employment and ii) the negative correlation between regional public employment and regional productivity should be more pronounced in countries with higher regional inequality. To investigate these issues, we adopt an empirical specification which makes use of the nested structure of regions within the European countries. Our goal is to study the actual regional pattern of public employment in Europe and to check whether this pattern is in line with our normative conclusions. To this aim, in our analysis we focus on the following three key variables: public employment per capita, productivity and the degree of regional inequality. The reference empirical specification is

$$publempl_{ikt} = \beta_0 + \beta_1 prod_{ikt} + \beta_2 ineq_{kt} + \beta_3 prod_{ikt} ineq_{kt} + \beta_4 Z_{ikt} + z_i + x_t + \varepsilon_{ikt}, \quad (10)$$

due to the large presence of security personnel. We also take out the three Atlantic islands of the sample (i.e. the Spanish region of Canarias and the Portuguese regions of Madeira and Açores) in line with the standard practice of empirical studies on European regions. Finally, we eliminate Valle d'Aosta in Italy because of its very high level of relative public employment per capita (see Figure 2) and since it is a very small region with a special autonomous status.

with i indicating region, k indicating country and t indicating time (year). The unit of analysis is a region-country-year.

The dependent variable $publempl_{ikt}$ is public employment per capita. The three main variables of interest are: productivity ($prod_{ikt}$), inequality ($ineq_{kt}$) and the interaction term between productivity and inequality ($prod_{ikt}ineq_{kt}$). While productivity and public employment per capita are measured at regional level, the degree of regional inequality is evaluated at country level, and is measured by the coefficient of variation.[10] The cumulative effect of productivity on public employment per capita is then captured by β_1 and $\beta_3 ineq_{kt}$, and varies with the degree of regional inequality within the country. The vector Z_{ikt} is a vector of additional control variables at regional level: among them we include population density, to account for size effects, and its squared term, to account for the possibility of a non-linear impact of it. A further regional-level control is the dependency ratio, which is a traditional key control variable in the reference literature on the determinants of public employment. To account for the potential role of public sector wage premia and of regional unemployment differentials, we include as controls the ratio of public on private compensation and the regional unemployment rate, together with its squared term.[11] Finally, the z_i are time-invariant region-specific characteristics, x_t are time fixed effects and ε_{ikt} is the error term.

3.3 Results

Table 2 presents the results of seven different empirical specifications which investigate the link between regional productivity and public employment per capita. All specifications are pooled OLS regressions with country and time fixed effects. The dependent variable is regional public employment per capita. Column (1) includes only productivity, which shows to be negative and strongly significant, in line with our theoretical framework and with the evidence shown before. Column (2) adds inequality, showing that productivity is negative and significant, and that inequality is insignificant. Our key regressor, i.e. the interaction term between regional productivity and inequality, is included in column (3). The results show that while productivity is insignificant, inequality is positive and strongly significant and the interaction term is negative and strongly significant. These findings are in line with the normative implications of our theoretical framework and show the key role of the interaction between productivity and inequality for the regional public employment distribution: the negative relationship between productivity and public employment is more pronounced in countries with higher degrees of regional inequality. In addition,

[10] For further details about the calculation of our inequality measure, see the Appendix.

[11] For lack of relevant data at regional level, relative public to private compensation is measured only at country level. See the Appendix for details.

Table 2: The link between regional public employment and regional productivity. Ordinary least squares estimations.

VARIABLES	(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5) OLS	(6) OLS	(7) OLS
Productivity	-0.407***	-0.401***	0.004	0.125	0.163	0.248	0.257
	[0.087]	[0.090]	[0.154]	[0.166]	[0.158]	[0.160]	[0.160]
Inequality		0.006	0.053***	0.067***	0.065***	0.066***	0.065***
		[0.011]	[0.021]	[0.023]	[0.022]	[0.020]	[0.020]
Productivity∗Inequality			-2.787***	-3.240***	-3.009***	-2.959***	-2.984***
			[0.772]	[0.859]	[0.825]	[0.770]	[0.769]
Dependency ratio				0.008	0.004	0.011	0.010
				[0.012]	[0.012]	[0.012]	[0.011]
Population density				-0.002*	-0.012***	-0.011***	-0.011***
				[0.001]	[0.003]	[0.003]	[0.003]
Population density^2					0.003***	0.003***	0.003***
					[0.001]	[0.001]	[0.001]
Relative compensation						-0.019***	-0.019***
Relative compensation						[0.003]	[0.003]
Unemployment rate						0.026***	0.050**
						[0.010]	[0.025]
Unemployment rate^2							-0.097
							[0.091]
Constant	0.041***	0.040***	0.033***	0.026***	0.029***	0.038***	0.038***
	[0.002]	[0.003]	[0.004]	[0.009]	[0.009]	[0.009]	[0.009]
Observations	2284	2284	2284	2048	2048	1804	1804
R-squared (adjusted)	0.448	0.447	0.453	0.421	0.444	0.402	0.403
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of groups	220	220	220	218	218	201	201

NOTE: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses, clustered at regional level. Regional public employment per capita is the dependent variable.

country-level regional inequality goes along with higher public employment.

Column (4) adds to the specification of column (3) three key control variables: the dependency ratio, population density and population density squared. The dependency ratio is insignificant, while standard considerations suggest that it should be positive. Indeed, higher dependency ratios are often associated to higher levels in the provision of public goods such as public health and public education. In our findings the absence of a positive effect could be explained by the fact that our measure of public employment does not include employment in sectors such as health and education. Population density is negative and significant, while its squared term is positive and significant. This suggests the existence of a non-linear effect of population density on public employment. In other words, while for regions which are not highly populated the effect of population density is negative, for highly populated regions this effect is positive, suggesting that regional size (in terms of population density) matters for regional public employment distribution.[12] Column (5) of Table 2 includes public to private relative compensation, which is negative and significant, as expected: a higher public wage premium reduces public employment. Column (6) adds to the previous regressors the regional unemployment rate. The results

[12]The point of inflexion corresponds to a level of population density equal to 2000 inhabitants per square kilometer.

Table 3: The link between regional public employment and regional productivity. Panel data estimations.

VARIABLES	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) FE	(7) FE	(8) RE
Productivity	-0.141	-0.099	0.136	0.031	0.051	0.053	0.041	0.049
	[0.092]	[0.093]	[0.099]	[0.094]	[0.095]	[0.099]	[0.097]	[0.083]
Inequality		0.009	0.040***	0.032***	0.033***	0.041***	0.042***	0.046***
		[0.006]	[0.011]	[0.011]	[0.011]	[0.011]	[0.010]	[0.010]
Productivity∗Inequality			-1.896***	-0.958**	-1.040**	-1.568***	-1.541***	-1.913***
			[0.456]	[0.421]	[0.425]	[0.426]	[0.423]	[0.397]
Dependency ratio				-0.080***	-0.079***	-0.061***	-0.062***	-0.042***
				[0.012]	[0.012]	[0.013]	[0.013]	[0.009]
Population density				0.007	-0.033	-0.032	-0.040	-0.014***
				[0.016]	[0.038]	[0.043]	[0.043]	[0.003]
Population density^2					0.008	0.010	0.011*	0.004***
					[0.005]	[0.006]	[0.006]	[0.001]
Relative compensation						-0.019***	-0.019***	-0.020***
						[0.003]	[0.003]	[0.003]
Unemployment rate						-0.012	-0.042**	-0.025
						[0.009]	[0.017]	[0.016]
Unemployment rate^2							0.113*	0.072
							[0.068]	[0.065]
Constant	0.033***	0.031***	0.027***	0.066***	0.073***	0.086***	0.090***	0.075***
	[0.002]	[0.002]	[0.002]	[0.008]	[0.010]	[0.011]	[0.011]	[0.006]
Observations	2284	2284	2284	2048	2048	1804	1804	1804
R-squared (within)	0.0832	0.0846	0.0950	0.158	0.159	0.212	0.215	-
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Effects	-	-	-	-	-	-	-	Yes
Number of groups	220	220	220	218	218	201	201	201

NOTE: *p<0.1, **p<0.05, ***p<0.01. Robust standard errors in parentheses, clustered at regional level. Regional public employment per capita is the dependent variable.

show that, ceteris paribus, regions with higher unemployment rates also have higher levels of public employment. Finally, column (7) adds the squared unemployment rate and represents our full specification: while the squared unemployment rate is insignificant, all the other variables behave as shown before. Most important, in our full specification the interaction term between productivity and inequality maintains its sign and significance level, as it happens in all the preceding specifications.[13]

In Table 3 we illustrate the results of two panel data methods which include the presence of region-specific time invariant effects. Columns (1) to (7) apply the fixed effects specification to the regressions of Table 2. As the results illustrate, all our main variables of interest (i.e. productivity, inequality and the interaction terms between productivity and inequality) have the same effects as before: our main findings are hence robust to the inclusion of region-specific fixed effects. As far as the additional control variables are concerned, they almost entirely replicate the results of the ordinary least squares

[13]It is important to note that in a set of regressions equivalent to those in columns (3) to (7) but where both inequality and the interaction term between inequality and productivity are not considered, regional productivity is always negative and significant, as it is in columns (1) and (2). Although in line with our intuition, we prefer to present only the results of the encompassing specifications to reveal the key role of the interaction between regional productivity and inequality at country level. Note additionally that productivity is negative and significant also in panel estimations analogous to those presented in Table 3 but where inequality and the interaction term are not present.

regressions. The only exceptions are the dependency ratio, which shows to be consistently negative and significant, and population density, which is now insignificant. The reason why the dependency ratio has a negative sign may be related to the fact that in the fixed effects specification there are some cyclical effects that are not picked up by time effects.[14] Population density is no more significant since most of its effect is now picked up by regional fixed effects, being a variable that hardly changes over time. The last column of Table 3 illustrates the findings of a random effects specification. The reference set of regressors is that of the full specification in column (7). As the results show, all our key variables maintain the same sign and significance levels they had before. Moreover, the fixed effects approach proves to be superior to random effects through the Hausman test.[15]

To sum up, both, the ordinary least squares specifications results and the panel specifications results, are in line with our normative theoretical perspective. Public employment per capita is higher in regions with lower productivity, and this effect is more pronounced in countries with a higher degree of regional inequality.

4 Conclusions

In this paper we have provided a first step in the analysis of the regional distribution of public employment. We have developed a normative theoretical framework which integrates regionally differentiated public employment into an optimal taxation framework. In our model the optimal pattern of public employment exhibits higher levels of public employment in low productivity regions; at the same time, the negative link between public employment and productivity is more pronounced in countries with higher levels of regional inequality. Our results show that the regional differentiation of public employment can serve as an expenditure side tagging device to improve the efficiency of tax-transfer schemes. It allows better targeting of low productivity individuals via local consumption of public goods, via the exploitation of regional differences in opportunity costs, and through a beneficial effect on incentive compatibility of the tax-transfer system.

These findings may provide an alternative perspective on regional public sector productivity. Alesina et al. (2001) find substantial productivity differences in the public sector across Italian regions which are mainly caused by the high levels of public employment in Southern Italy. Our theoretical analysis illustrates that such regional productivity

[14]For example, the dependency ratio could pick up the effects of migration on regional working age (and total) population, which are in turn related to regional economic performance.

[15]The Hausman test gets a significant p-value of 0.000, indicating that the preferred model is fixed effects versus the alternative random effects.

differences may not necessarily be taken as an indicator of public sector inefficiency by itself, but could, at least partly, be interpreted as a by-product of an efficient redistribution policy.

In order to provide empirical evidence on the actual regional pattern of public employment, we have then analyzed empirically the regional distribution of public employment in Europe. Using a novel panel dataset of European regions from 17 countries, we find evidence that the regional distribution of public employment is actually consistent with our normative analysis. Public employment is significantly higher in low productivity regions and this relationship is significantly stronger in countries with a higher degree of regional inequality. These findings are robust to a number of different empirical specifications.

For completeness, we would like to stress that we have only partially discussed alternative policy instruments which, from an encompassing perspective, could prove superior as expenditure side tagging devices. We have shown that regionally differentiated public spending has similar effects, but that regionally differentiating public employment can have additional merits rooted in differences in opportunity costs or in its effects on incentive compatibility. On the other hand, intervening in the labor market may cause additional negative side effects, which are outside the scope of our theoretical framework but must be considered in an encompassing policy assessment.

A Appendix

A.1 Proof of Proposition 2

The welfare maximization problem is

$$\max_{\{x_i,l_i,a\}_{i=1,2}} W = \sum_{i=1,2} m_{ij} \frac{U_{ij}^{\rho}}{\rho} \text{ s.t.} \tag{A1}$$

$$w_h l_h - x_h + w_l l_l - x_l \geq 2g \;\; \text{and} \; x_h - h\left(l_h\right) \geq x_l - h\left(\hat{l}\right) \tag{A2}$$

with $m_{2h} = m_{1l} = \left(\frac{1}{2} + \Delta\right)$ and $m_{1h} = m_{2l} = \left(\frac{1}{2} - \Delta\right), 0 < \Delta < \frac{1}{2}$. Solving the two constraints for x_l and x_h and inserting into (A1) leaves us with three choice variables l_l, l_h, and a. This gives the three first order conditions

$$\begin{aligned} l_l: \qquad 0 = & \left(\frac{1}{2} + \Delta\right)\left[\frac{w_l + zh'\left(\hat{l}\right)}{2} - h'(l_l)\right] U_{1l}^{\rho-1} \\ & + \left(\frac{1}{2} - \Delta\right)\left[\frac{1}{2}\left(w_l + zh'\left(\hat{l}\right)\right) - h'(l_l)\right] U_{2l}^{\rho-1} \\ & + \left(\frac{1}{2} - \Delta\right)\left[\frac{w_l - zh'\left(\hat{l}\right)}{2}\right] U_{1h}^{\rho-1} + \left(\frac{1}{2} + \Delta\right)\left[\frac{w_l - zh'\left(\hat{l}\right)}{2}\right] U_{2h}^{\rho-1} \equiv \Phi^l \end{aligned} \tag{A3}$$

$$l_h: \qquad 0 = \left[\begin{array}{c} \left(\frac{1}{2}+\Delta\right) U_{1l}^{\rho-1} + \left(\frac{1}{2}-\Delta\right) U_{2l}^{\rho-1} \\ + \left(\frac{1}{2}-\Delta\right) U_{1h}^{\rho-1} + \left(\frac{1}{2}+\Delta\right) U_{2h}^{\rho-1} \end{array} \right] \frac{w_h - h'(l_h)}{2} \equiv \Phi^h \tag{A4}$$

$$\begin{aligned} a: \qquad 0 = {} & v'(g_1)\left[\left(\frac{1}{2}+\Delta\right) U_{1l}^{\rho-1} + \left(\frac{1}{2}-\Delta\right) U_{1h}^{\rho-1}\right] \\ & - v'(g_2)\left[\left(\frac{1}{2}-\Delta\right) U_{2l}^{\rho-1} + \left(\frac{1}{2}+\Delta\right) U_{2h}^{\rho-1}\right] \equiv \Phi^a \end{aligned} \tag{A5}$$

The first order conditions define the three endogenous variables l_1^*, l_2^*, and a^*. We are interested in the sign of $\frac{\partial a^*}{\partial \Delta}$. Linearizing the system of (A3), (A4), and (A5) using the partial derivatives of $\Phi_s^r, r = l, h, a$, and $s = l, h, a, \Delta$, the comparative statics can be calculated as

$$\frac{\partial a^*}{\partial \Delta} = -\frac{\begin{vmatrix} \Phi_l^l & \Phi_h^l & \Phi_\Delta^l \\ \Phi_l^h & \Phi_h^h & \Phi_\Delta^h \\ \Phi_l^a & \Phi_h^a & \Phi_\Delta^a \end{vmatrix}}{\begin{vmatrix} \Phi_{l_l}^l & \Phi_{l_h}^l & \Phi_a^l \\ \Phi_{l_l}^h & \Phi_{l_h}^h & \Phi_a^h \\ \Phi_{l_l}^a & \Phi_{l_h}^a & \Phi_a^a \end{vmatrix}} = -\frac{\begin{vmatrix} \Phi_l^l & 0 & \Phi_\Delta^l \\ 0 & \Phi_h^h & 0 \\ \Phi_l^a & 0 & \Phi_\Delta^a \end{vmatrix}}{\begin{vmatrix} \Phi_{l_l}^l & \Phi_{l_h}^l & \Phi_a^l \\ \Phi_{l_l}^h & \Phi_{l_h}^h & \Phi_a^h \\ \Phi_{l_l}^a & \Phi_{l_h}^a & \Phi_a^a \end{vmatrix}}, \tag{A6}$$

where the zero entries in the matrix in the numerator follow from $w_h = h'(l_h)$ which follows from (A4). Due to the second order condition we have

$$sign\left(\frac{\partial a^*}{\partial \Delta}\right) = sign \begin{vmatrix} \Phi_l^l & 0 & \Phi_\Delta^l \\ 0 & \Phi_h^h & 0 \\ \Phi_l^a & 0 & \Phi_\Delta^a \end{vmatrix}. \tag{A7}$$

Signing $\Phi_l^l, \Phi_h^h, \Phi_\Delta^a, \Phi_l^a$, and Φ_Δ^lwe find $\Phi_l^l < 0, \Phi_h^h < 0, \Phi_\Delta^l > 0, \Phi_\Delta^a > 0$, and $\Phi_l^a > 0$. Evaluating the determinant

$$\begin{vmatrix} \Phi_l^l & 0 & \Phi_\Delta^l \\ 0 & \Phi_h^h & 0 \\ \Phi_l^a & 0 & \Phi_\Delta^a \end{vmatrix} = \Phi_l^l \Phi_h^h \Phi_\Delta^a - \Phi_l^a \Phi_h^h \Phi_\Delta^l > 0, \tag{A8}$$

and thus

$$\frac{\partial a^*}{\partial \Delta} > 0 \ \blacksquare \tag{A9}$$

A.2 Data description and sources

All data at regional level are from Eurostat regional statistics. Public employment data have been kindly provided by the Eurostat staff. All remaining regional data can be found on the Eurostat website. Additional data at country level are from OECD. Details follow.

Public employment p.c.: Public employment per capita. Public employment is the number of people employed in the NACE sector "Public administration and defence; compulsory social security" (sector L, NACE rev. 1.1). Source: Eurostat (Regional Labour Force Statistics-LFS). Period: 1995-2007. Geographical aggregation level: NUTS 2. Public employment per capita is the ratio between public employment and population.

Productivity: Wages and salaries per number of person employed in the NACE sector "Manufacturing". Source: Eurostat (Regional structural business statistics). Period: 1995-2007. Geographical aggregation level: NUTS 2. Units of measure: Millions of euro.

Inequality: Coefficient of variation of regional productivity. The measure has been calculated for each country. Each regional productivity has been weighted by the population share of the corresponding region. Source: authors' calculation from Eurostat data on productivity

(see above). Period: 1995-2007. Geographical aggregation level: NUTS 0 (country level).

Population density: Total population per square kilometers. Source: Eurostat (Regional demographic statistics). Period: 1995-2007. Geographical aggregation level: NUTS 2. Unit of measure: Thousands.

Dependency ratio: Ratio of persons who are below 14 and above 64 years over the working age population (i.e. the persons who are aged between 15 and 64 years). Source: Eurostat (Regional demographic statistics). Period: 1995-2007. Geographical aggregation level: NUTS 2.

Relative compensation: Ratio of public to private compensation per capita. Public compensation is compensation of persons engaged (total employment) in the NACE sector "Public administration and defence; compulsory social security". Private compensation is compensation of people engaged in the NACE sector "Manufacturing". Source: OECD (STAN). Period: 1995-2007. Geographical aggregation level: NUTS 0 (country level). Per capita public (private) compensation has been derived as the ratio between public (private) compensation and public (private) employment, taken from OECD (STAN).

Unemployment rate: Unemployment rate. Source: Eurostat (Regional Labour Force Statistics-LFS). Period: 1995-2007. Geographical aggregation level: NUTS 2.

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