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The regional distribution of public employment: theory and evidence

Sebastian G. Kessing^a and Chiara Strozzi^b

ABSTRACT

The regional distribution of public employment: theory and evidence. *Regional Studies*. This article analyzes the optimal regional pattern of public employment in an information-constrained second-best redistribution policy. It shows 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. Empirically, using a panel of European regions from 1995 to 2007, the analysis finds evidence that public employment is systematically higher in low-productivity regions. The latter effect is stronger in countries with higher levels of regional inequality.

KEYWORDS

public employment; redistribution; regional inequality; European regions

摘要

公共就业的区域分布：理论与证据。 *Regional Studies*。本文分析在资讯受到限制的次佳再分配政策中，公共就业的最理想区域模式。本文显示，公共就业的区域差异，能够作为支出面的标示机制，绕过或缓和公平—效率的权衡取舍。最适模式在低度生产力的区域中展现出较高度度的公共就业，且区域不均的程度越高便越显著。在经验而上运用欧洲区域自1995年至2007年的面板分析，发现公共就业在低度生产力的区域中系统性地较高之证据。后者的影响，在区域不均层级较高的国家中更为显著。

关键词

公共就业；再分配；区域不均；欧洲区域

RÉSUMÉ

La distribution régionale des emplois publics: la théorie et la pratique. *Regional Studies*. Cet article cherche à analyser la distribution régionale optimale des emplois publics dans le cadre d'une politique de redistribution optimale de second rang où l'information s'avère limitée. On montre que les emplois publics différenciés sur le plan régional peuvent servir de balisage-côté des dépenses, contournant ou bien assouplissant le compromis entre ce qui est équitable et ce qui est efficace. La distribution optimale présente des niveaux plus élevés d'emploi public dans les régions à faible productivité et s'avère plus marquée plus la inégalité régionale est élevée. À partir d'un panel de régions européennes pour la période allant de 1995 jusqu'à 2007, l'analyse trouve d'un point de vue empirique que les emplois publics sont systématiquement plus élevés dans les régions à faible productivité. Ce dernier effet est plus fort dans les pays où les inégalités régionales sont plus élevées.

MOTS-CLÉS

emplois publics; redistribution; inégalité régionale; régions européennes

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ZUSAMMENFASSUNG

Regionale Verteilung der öffentlichen Beschäftigung: Theorie und Beweise. *Regional Studies*. In diesem Beitrag wird die optimale regionale Verteilung der öffentlichen Beschäftigung in einer informationsbegrenzten zweitbesten Umverteilungspolitik analysiert. Es zeigt sich, dass eine regional differenzierte öffentliche Beschäftigung als Instrument zur Kennzeichnung der Ausgabenseite eingesetzt werden kann, wobei der Zielkonflikt zwischen Gerechtigkeit und Effizienz umgangen oder entspannt wird. Die optimale Verteilung weist ein höheres Maß an öffentlicher Beschäftigung in Regionen mit niedriger Produktivität auf und ist umso ausgeprägter, je höher das Maß der regionalen Ungleichheit ausfällt. Die empirische Analyse mithilfe eines Panels der europäischen Regionen im Zeitraum von 1995 bis 2007 liefert Beweise dafür, dass die öffentliche Beschäftigung in Regionen mit niedriger Produktivität systematisch höher ausfällt. Der zweite Effekt ist in Ländern mit stärkerer regionaler Ungleichheit ausgeprägter.

SCHLÜSSELWÖRTER

Öffentliche Beschäftigung; Umverteilung; Regionale Ungleichheit; Europäische Regionen

RESUMEN

Distribución regional del empleo público: teoría y evidencia. *Regional Studies*. En este artículo analizamos la distribución regional óptima del empleo público en una política alternativa de redistribución con información limitada. Demostramos que el empleo público diferenciado regionalmente puede servir de instrumento para marcar los gastos, omitiendo o relajando el conflicto entre la eficiencia y la igualdad. La distribución óptima muestra niveles más altos de empleo público en las regiones con baja productividad y está más pronunciado cuanto más alto es el grado de desigualdad regional. El análisis empírico mediante un panel de las regiones europeas de 1995 a 2007 refleja que el empleo público es sistemáticamente más alto en las regiones con baja productividad. El segundo efecto es más fuerte en países con niveles más altos de desigualdad regional.

empleo público; redistribución; desigualdades regionales; regiones europeas

JEL H11, J45, R12

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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 trade-off. Alesina, Danninger, and Rostagno (2001) document the regional differences in public employment in Italy. They show that these differences generate substantial redistributive effects and point out the associated efficiency costs due to an inter-regionally inefficient allocation of publicly provided goods and services, or due to detrimental productivity effects of a bloated public sector. Such findings raise the question whether regionally differentiated public employment is an appropriate redistributive instrument, and whether it is possible to characterize the inherent equity-efficiency trade-off of such a policy.

The potential role of public employment for efficient redistribution has originally been addressed 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 favour of high- or low-skilled individuals. As the author shows, the optimal policy involves a distortion of the public workforce composition, but its direction depends crucially on whether or not human capital formation is endogenous. Nichols and Zechhauser (1982) and Blumkin, Margalioth, and Sadka (2009), among others, have subsequently analyzed how government expenditures and regulation can potentially

improve the efficiency of the tax-transfer system. None of these contributions, however, considers the regional policy dimension, which is the focus of this analysis. Only De la Fuente (2004) studies regionally differentiated policies as instruments of a second-best redistribution policy, but he focuses only on investment.¹

This article develops an optimal taxation framework to study the equity-efficiency trade-off inherent in the regional differentiation of public employment. The analysis shows that a regionally differentiated employment policy can be used as an expenditure side-tagging device. Akerlof (1978) was the first to point out that the correlation of earnings ability with observable personal characteristics ('tags') can improve the efficiency of tax-transfer schemes. However, for reasons of horizontal equity, or of practical and political feasibility, such tags are usually not applied in real-world tax systems. This is also true for the regional dimension, since income taxes set by central governments are typically not differentiated by region. The present paper argues that public employment can be an expenditure-side substitute that also allows the tagging of low-productivity individuals, and it identifies several channels on 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.

Most existing empirical studies on the determinants of public employment, such as Rodrik (2000) and Martínez-Vázquez and Ming-Hung (2009), consider data at the country level, so they do not provide any evidence regarding the regional distribution of public employment. A few studies have already considered the regional dimension of public employment for specific countries. Alesina et al. (2001) study regional public employment in Italy, whereas Borge and Matsen (2004) consider the role of public employment for risk sharing at the regional level in Norway.

The empirical analysis in this article goes beyond individual country-level approaches and explicitly considers a cross-country dimension. The 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. The article assesses the regional distribution of public employment in Europe using an hitherto unexploited panel dataset of regional public employment. The 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.

THEORETICAL FRAMEWORK

A baseline model

Consider an optimal direct taxation model in the Stiglitz (1982) tradition. There are two regions $i = 1, 2$, with their respective population normalized to 1; and two types of individuals $j = L, H$. The types differ in their productivity, so that $w_H > w_L$, 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, all individuals have the same preferences, which are given by a simple quasi-linear specification:

$$U_{ij} = x_{ij} - b(l_{ij}) + v(g_i) \quad (1)$$

with $b'(l) > 0$, $b''(l) > 0$, $v'(g) > 0$, $v''(g) < 0$, where x_{ij} is private good consumption; l_{ij} is individual labour supply; $b(l_{ij})$ is disutility of labour; and g_i is a locally consumed public good. The latter can be interpreted as public employment, implicitly assuming a public sector with a linear technology.² The prices of private and public goods are normalized to 1.

Society is inequality averse, which is captured by a constant elasticity of substitution (CES)-type social welfare

function:

$$W = \sum_{i=1,2} \sum_{j=L,H} m_{ij} \frac{U_{ij}^\rho}{\rho}, \text{ with } 0 \neq \rho < 1 \quad (2)$$

as in Blumkin et al. (2009), where the parameter ρ is a measure of inequality aversion.³ The government implements a tax system that defines taxes $T_j = T(w_j l_j)$ as a function of gross income. The government cannot condition the tax system on the region of residence. Taxes determine net income and private consumption, $x_j = w_j l_j - T(w_j l_j)$. Since the government cannot directly observe individuals' productivity and conditions taxes on gross income, the tax system needs to be incentive compatible. The analysis only considers the downward incentive compatibility constraint:

$$x_H - b(l_H) \geq x_L - b(\hat{l}) \quad (3)$$

where the hat on a variable indicates a high-productivity individual mimicking a low-productivity individual, such that $\hat{l} = (w_L/w_H) l_L$. Public employment does not enter the incentive compatibility constraint since both types of workers consume the public goods provided in their region. Finally, taxes redistribute and finance public employment. To facilitate comparative statics, an exogenous average level of public employment g is assumed, and $g_1 = (1+a)g$ and $g_2 = (1-a)g$, so that the parameter $a \in [-1, 1]$ summarizes regional differentiation. The government's budget constraint is:

$$(m_{1H} + m_{2H})(w_H l_H - x_H) + (m_{1L} + m_{2L})(w_L l_L - x_L) \geq 2g \quad (4)$$

The government maximizes (2) subject to (3) and (4). Solving (3) and (4) for x_L and x_H , and substituting into (2), it maximizes (2) by choosing l_L , l_H and a . The first order condition with respect to a is:

$$\begin{aligned} & \left[m_{1L} U_{1L}^{p-1} + m_{1H} U_{1H}^{p-1} \right] v'(g_1) \\ & = \left[m_{2L} U_{2L}^{p-1} + m_{2H} U_{2H}^{p-1} \right] v'(g_2) \end{aligned} \quad (5)$$

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

Proposition 1. If regions differ in their average productivity and the government cannot observe individual productivity, social welfare maximization will entail $a^* > 0$.

Optimal public employment should be higher in the low-productivity region. 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. The next proposition addresses the degree of regional inequality.

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 Kessing and Strozzi (2012).

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

Endogenous wages and public sector production

Regionally differentiated public employment not only affects the economy via regionally differentiated levels of public goods and services that are consumed by the local population. As stressed by Alesina et al. (2001), among others, there are also important effects on regional labour markets. These originate from public labour demand, which can drive up regional private sector wages. Additionally, optimal public employment should take into account the specific structure of public sector production which typically exhibits lower regional variation in productivity relative to the private sector. In order to study these aspects the model now considers employment and production in the public sector explicitly and allows for endogenous wages.

The model concentrates on the case of perfect correlation between individual productivity and the place of residence by setting $m_{1L} = m_{2H} = 1$ and $m_{1H} = m_{2L} = 0$, such that one can drop the subscripts L and H . This perfect correlation assumption is for expositional clarity. The government's objective simplifies to:

$$W = \sum_{i=1,2} U_i^\rho / \rho$$

The model again assumes that the government knows the regional productivity shares but is not allowed to condition the tax schedule on the region of residence.⁴

Individuals either work in the private or in the public sector. The fraction of individuals in the public sector is n_i , such that $1 - n_i$ work in the private sector. Private good production q_i is determined by a regional production function $f_i(\cdot)$, $f_i'(\cdot) > 0$, $f_i''(\cdot) < 0$, while total labour input in the private sector is given as the share of private sector workers times their individual labour supply:

$$q_i = f_i(l_i(1 - n_i)) \quad (6)$$

This implies the existence of pure profits. As in related studies, such as Blackorby and Brett (2004), these are assumed to be fully taxed. The publicly provided good is locally produced according to the linear relationship:

$$g_i = n_i l_i \quad (7)$$

Labour is equally productive in the public sector in both regions with a constant marginal productivity. This is a useful benchmark given that regional productivity

dispersion is typically smaller in the public sector. Moreover, private production can now be expressed as $q_i = f_i(l_i - g_i)$. Region 2 is the more productive region, which is captured by a higher marginal labour productivity. Assuming labour is paid its private sector marginal product, the productivity difference between regions is:

$$w_2 = f_2'(l_2 - g_2) > f_1'(l_1 - g_1) = w_1 \quad (8)$$

The model assumes that the public and the private sector pay the same wage in each region, and there is again no migration. Given these assumptions, an increase in regional public labour demand reduces private employment, which increases the marginal product of labour and regional wages. The inter-regional wage ratio is defined as:

$$z \equiv \frac{w_1}{w_2} = \frac{f_1'(l_1 - g_1)}{f_2'(l_2 - g_2)} \quad (9)$$

The wage ratio is increasing in the public good production in region 1, $\partial z / \partial g_1 > 0$, but decreasing in public good production in region 2, $\partial z / \partial g_2 < 0$. The government's constraints are now the incentive compatibility constraint:

$$x_2 - b(l_2) \geq x_1 - b(zl_1) \quad (10)$$

and the aggregate resource constraint:

$$x_1 + x_2 \leq f_1(l_1 - g_1) + f_2(l_2 - g_2) \quad (11)$$

which implies the government's budget constraint. Again assuming a total countrywide public output of $2g$, we focus on the differentiation parameter a , where $g_1 = (1 + a)g$ and $g_2 = (1 - a)g$. The government maximizes the simplified version of (2) by choice of x_1 , x_2 , l_1 , l_2 , a subject to (10) and (11). Optimality requires the first order condition with respect to a :

$$U_2^{\rho-1} v'(g_2) - U_1^{\rho-1} v'(g_1) = \lambda l_1 b'(\hat{l}) \left[\frac{\partial z}{\partial g_1} - \frac{\partial z}{\partial g_2} \right] + \mu [f_2'(l_2 - g_2) - f_1'(l_1 - g_1)] \quad (12)$$

where λ and μ denote the Lagrange multipliers corresponding to (10) and (11), respectively. This implies the next proposition.

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. See Kessing and Strozzi (2012).

Comparing (5) with (12) indicates two additional reasons for regional differentiation. First, while productivity in the public sector is the same in both regions, opportunity costs are different. This is evident from the second term on the right-hand side of (12), which is the regional difference in marginal productivity, valued at the society's shadow value of additional private goods.

The second effect relates to the role of regionally differentiated public employment for efficient redistribution. It is

embodied in the first term on the right-hand side of (12):

$$\lambda_1 h'(\hat{t})[\partial z/\partial g_1 - \partial z/\partial g_2]$$

This effect is also positive. Increasing public employment in the low-productivity region and decreasing it in the high-productivity region reduces the wage differential. This effect makes it less attractive for high-income earners to mimic low-income workers. Thus, regionally differentiated public employment relaxes incentive compatibility.

Finally, one can again ask how, in the case of endogenous wages, optimal regional differentiation of public employment changes as the degree of regional inequality changes. Using further functional assumptions about regional productivity differences, it can be shown that a combination of an Inada-type condition on the production function and a sufficiently high level of average public employment is sufficient to derive a result paralleling Proposition 2. This is intuitive, since the higher the average provision level the stronger are the marginal effects on wages and redistribution.

Extensions

The theoretical framework has deliberately abstracted from a number of aspects that are potentially relevant. These are, in particular, as follows.

- *Inequality aversion*: more inequality averse policy-makers will unambiguously favour more redistribution for given efficiency costs. As the scope of redistribution increases, so does the possibility of using public employment as an expenditure side tagging device.
- *Public sector wage premia*: public sector wage premia would introduce an additional inefficiency into production, would increase the utility of public sector workers, and could put upward pressure on private-sector wages (as private firms may be forced to increase wages). Overall, they should reduce the level of public employment, but their effect on its regional distribution is not evident.
- *Regional differences in unemployment*: moving workers out of unemployment into public employment implies lower opportunity costs than moving a worker from the private to the public sector. On the other hand, with slack in the labour market, the positive effect on private sector wages and the resulting effects on incentive compatibility are dampened.
- *Regional and local governments*: sub-national governments play an important role in public employment. However, they usually depend on financing from central government. Accordingly, central government has more options to differentiate its policy regionally. The lower-level governments typically only have the discretion to decide whether to spend the money directly or to use it for public employment. Thus, differentiated grants may also be interpreted as similar expenditure side-tagging devices to complement the redistributive tax system.

- *Migration*: with heterogeneous migration costs, for the non-marginal individuals the efficiency gains from tagging are still present. With costly mobility there will thus be a trade-off between tagging using regionally differentiated policies to improve the efficiency of redistribution and the desire to increase migration from the low to the high-productivity region.
- *Organized crime*: in countries with weaker governance regional policies can be affected by the presence of organized crime (see Pinotti, 2015, for the case of Italy, for example). The presence of organized crime can affect regional productivity, and public investment may be used to substitute a lack of private activity in affected regions. However, the low efficiency of public investment may also make public employment relatively more attractive as an instrument for redistribution.

EMPIRICAL ANALYSIS

Data

To investigate empirically the link between regional public employment per capita and regional productivity in Europe, this section assembles a dataset with regional data at the NUTS-2 level for 17 European countries.⁵ All regional data are taken from EUROSTAT regional statistics and range from 1995 to 2007. For all details about data and sources, see [Appendix A](#) below.

The main measure of public employment is the number of people employed in the NACE sector ‘Public administration and defense; compulsory social security’.⁶ This measure is used although it does not include public employment in sectors such as education and healthcare. This choice is mainly due to the fact that the EUROSTAT Labour Force Survey (LFS) data do not allow one to distinguish private and public sector workers in these sectors, where private firms or non-profit organizations play an important role, and this role may vary substantially across regions and countries. The measure does include, however, some important locally provided public services such as the police and firefighters. From a consumption perspective, this implies that this measure partly captures services that predominantly benefit the local population, but also includes public goods and services, such as defence, that accrue to the entire population. While the measure does not contain the entire public sector, it is consistent across regions and countries. Since the focus here is on the regional distribution of public employment from a cross-country perspective and not on 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. However, for robustness, the investigation also considers a more comprehensive measure of public employment that additionally includes the health and education sectors. As productivity measure the analysis adopts regional wages and salaries per number of employed persons in manufacturing.

Preliminary evidence of the link between regional public employment per capita and regional productivity is presented

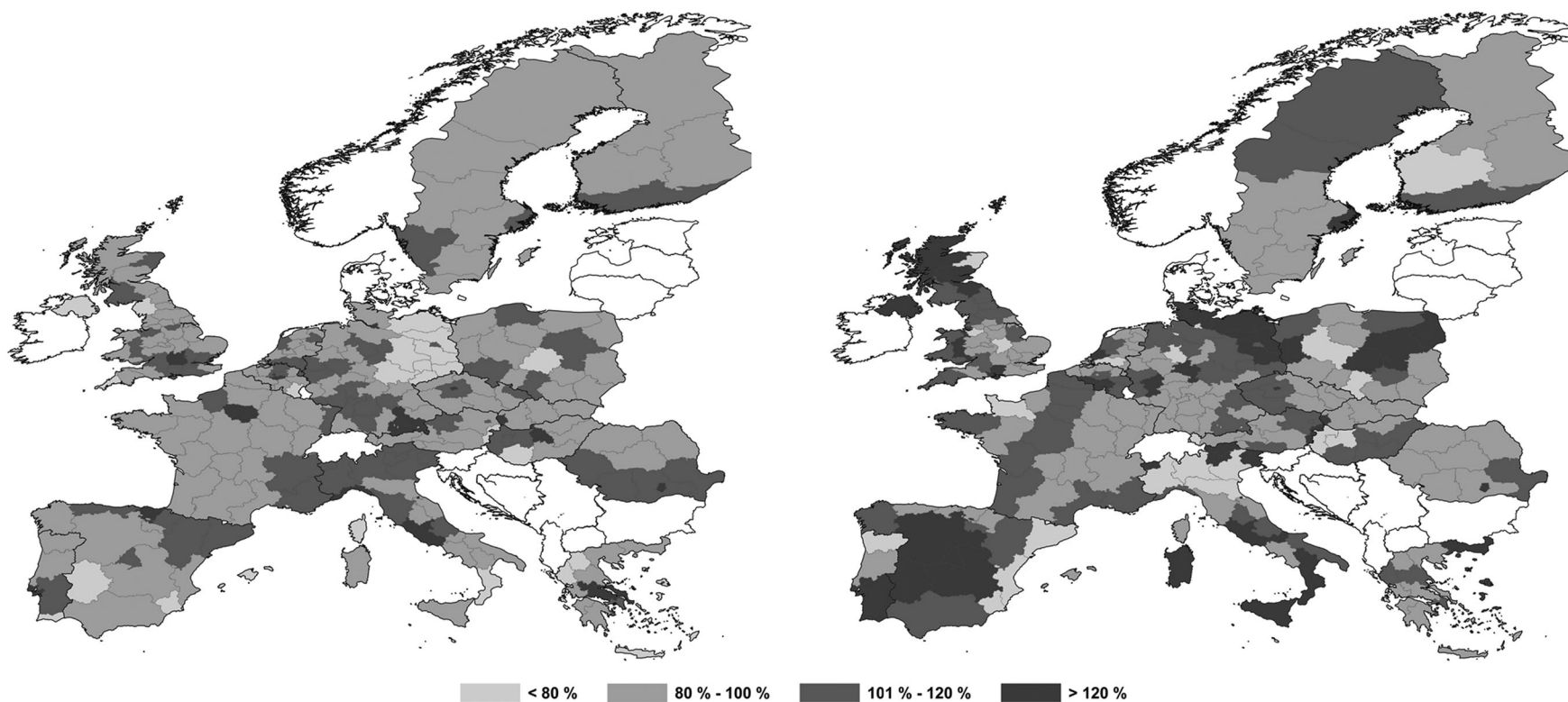


Figure 1. Regional productivity (left) and regional public employment per capita (right) relative to country average. European regions, 2007.
Source: EUROSTAT Regional Labour Force Statistics.

Table 1. Summary statistics.

Variable	Observation	Mean	SD	Minimum	Maximum
Public employment	2668	0.031	0.009	0.008	0.073
Public employment (edu-health)	2671	0.100	0.028	0.035	0.210
Productivity	2303	0.023	0.010	0.001	0.050
Inequality	2410	0.135	0.040	0.014	0.254
GDP per capita	2671	19246	6504	3400	47800
Population density	2415	0.250	0.425	0.003	3.656
Dependency ratio	2675	0.505	0.048	0.374	0.627
Relative compensation	2386	1.136	0.277	0.841	2.192
Unemployment rate	2676	0.089	0.052	0.012	0.334
Fiscal decentralization	2613	0.131	0.106	0.008	0.332
Fiscal decentralization (alt.)	2495	0.183	0.101	0.015	0.368
HRST as a % of active population	2570	0.312	0.083	0.095	0.601
Patent applications	1777	106.694	126.352	0.018	1018.304

Note: GDP, gross domestic product; HRST, human resources in science and technology; SD, standard deviation. See also [Appendix A](#) below for data description and sources.

in Figure 1. It 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. 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 there is substantial dispersion of relative regional productivity and relative regional public employment. In addition, in some countries there is evidence of a correspondence between a relatively low level of productivity and a relatively high level of public employment (e.g., Italy and Germany).⁷

The empirical analysis excludes outlier regions from the initial sample and uses 221 regions of the 243 regions of the raw dataset.⁸ The summary statistics of the variables included in the final sample are presented in Table 1. These show that, according to the chosen definition of public employment per capita, which only includes public employment in public administration ('Public employment'), on average 3% of the population works in the public sector. The more comprehensive employment measure including employment in education and health sectors ('Public employment (edu-health)') shows that on average 10% of the population works in the public sector. Moreover, the average relative public to private compensation is 1.134, evidencing the presence of public sector wage premia.

Empirical specification

The theoretical framework implied that (1) regions with lower productivity should have higher levels of public employment and (2) the negative correlation between regional public employment and regional productivity should be more pronounced in countries with higher regional inequality. The empirical investigation adopts a specification that uses the nested structure of regions within the European countries, and focuses on three key variables: public employment per capita, productivity and the degree

of regional inequality. The reference empirical specification is:

$$\begin{aligned} \text{publemp}_{ikt} = & \beta_0 + \beta_1 \text{prod}_{ikt} + \beta_2 \text{ineq}_{kt} \\ & + \beta_3 \text{prod}_{ikt} \text{ineq}_{kt} + \beta_4 Z_{ikt} + z_i \\ & + x_t + \varepsilon_{ikt} \end{aligned} \quad (10)$$

where i indicates region; k indicates country; and t indicates time (year). The unit of analysis is region-country-year.

The dependent variable publemp_{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 ($\text{prod}_{ikt} \text{ineq}_{kt}$). While productivity and public employment per capita are measured at the regional level, the degree of regional inequality is evaluated at country level and is measured by the coefficient of variation.⁹ The cumulative effect of productivity on public employment per capita is then captured by β_1 and $\beta_3 \text{ineq}_{kt}$, and varies with the degree of regional inequality within the country. The vector Z_{ikt} is a vector of additional control variables at the regional level: among them the analysis includes population density, to account for size effects, and its squared term, to account for a possibly non-linear impact of it. A further regional-level control is the dependency ratio. To account for the potential role of public sector wage premia and of regional unemployment differentials, the investigation includes as controls the ratio of public to private compensation and the regional unemployment rate, together with its squared term. The analysis also controls for the degree of fiscal decentralization.¹⁰ Finally, z_i is time-invariant region-specific characteristics; x_t is time fixed effects; and ε_{ikt} is the error term.

RESULTS

Baseline results

Table 2 presents the results of nine different empirical specifications. All specifications are panel data regressions:

Table 2. Determinants of public employment.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Productivity	−0.139 [0.091]	−0.086 [0.088]	0.14 [0.098]	0.012 [0.093]	0.033 [0.094]	0.045 [0.097]	0.03 [0.094]	0.071 [0.097]	0.075 [0.086]
Inequality		0.015** [0.006]	0.042*** [0.012]	0.034*** [0.012]	0.035*** [0.012]	0.044*** [0.011]	0.045*** [0.011]	0.046*** [0.011]	0.049*** [0.011]
Productivity*Inequality			−1.783*** [0.461]	−0.822* [0.432]	−0.909** [0.436]	−1.505*** [0.429]	−1.475*** [0.424]	−1.548*** [0.432]	−1.826*** [0.416]
Dependency ratio				−0.078*** [0.012]	−0.078*** [0.012]	−0.059*** [0.013]	−0.060*** [0.013]	−0.063*** [0.013]	−0.047*** [0.009]
Population density				0.007 [0.016]	−0.033 [0.038]	−0.033 [0.043]	−0.042 [0.043]	−0.039 [0.042]	−0.015*** [0.003]
Population density squared					0.008 [0.005]	0.01 [0.006]	0.011* [0.006]	0.011* [0.006]	0.004*** [0.001]
Relative compensation						−0.019*** [0.003]	−0.018*** [0.003]	−0.020*** [0.003]	−0.021*** [0.003]
Unemployment rate						−0.012 [0.009]	−0.043*** [0.017]	−0.040** [0.017]	−0.028* [0.016]
Unemployment rate squared							0.119* [0.068]	0.114 [0.071]	0.083 [0.068]
Fiscal decentralization								0.020*** [0.008]	0.020*** [0.008]
Constant	0.033*** [0.002]	0.030*** [0.002]	0.026*** [0.002]	0.065*** [0.008]	0.072*** [0.010]	0.084*** [0.011]	0.088*** [0.011]	0.087*** [0.011]	0.079*** [0.007]
Observations	2296	2296	2296	2060	2060	1816	1816	1816	1816
R ²	0.0822	0.086	0.0947	0.158	0.159	0.208	0.211	0.215	.
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of groups	221	221	221	219	219	202	202	202	202

Notes: Robust standard errors are given in parentheses, clustered at the regional level. Regional public employment per capita in public administration is the dependent variable. Columns (1) to (8) are fixed-effects regressions at the regional level; column (9) is a random-effects regression at the regional level.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

while columns (1) to (8) include region-fixed effects, column (9) provides a random effects specification.¹¹ The dependent variable is public employment per capita. Column (1) includes only productivity, column (2) adds inequality, column (3) includes the key regressor, i.e., the interaction term between regional productivity and inequality. The results in column (3) 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 implications of the previous theoretical framework: the negative relationship between productivity and public employment is more pronounced in countries with higher degrees of regional inequality. In addition, country-level regional inequality goes along with higher public employment.

Column (4) adds to the specification of column (3) two key control variables: the dependency ratio and population density. Population density is insignificant, which may be explained by its low variation over time. The dependency ratio is negative and significant. The latter finding may be due to the nature of the public employment measure, which does not include employment in the education and healthcare sectors. Moreover, once the focus is on the differences over time within regions, one must consider that a decrease in working-age population (as the denominator of the dependency ratio) should have *ceteris paribus* a negative effect on both public and private employment. Column (5) of Table 2 includes squared population density, which is positive but only becomes significant when one adds further explanatory variables. Column (6) adds to the previous regressors public to private relative compensation and the regional unemployment rate, while column (7) adds the squared unemployment rate. Relative compensation is negative and significant, as expected. Moreover, there is some evidence that there is a non-linear relationship between unemployment and public employment with a negative effect of the unemployment rate, but a

positive effect of its squared term. Given the range of unemployment rates in the regions, the combined effect is always negative, however. Column (8) adds to column (7) the measure of fiscal decentralization: this column represents the full specification. As a measure of fiscal decentralization the analysis considers the ratio of the sum of local and regional tax revenues to total government tax revenues. As it appears from column (8), fiscal decentralization is positive and significant, which is in line with Martínez-Vázquez and Ming-Hung (2009). Again, the interaction term between productivity and inequality maintains its sign and significance level: the full specification hence indicates that the key findings are robust to the inclusion of a range of relevant control variables. Finally, the random effects estimates of the full specification in column (9) confirm the fixed effects results. Since a Hausman test reveals that the fixed effects approach is superior to the random effects approach, column (8) is the reference specification.¹²

Next, the investigation considers how the total effect of productivity on public employment is influenced by a country's degree of inequality. Figure 2 illustrates the total marginal effect of productivity as a function of regional inequality according to the reference specification. The total effect of productivity on public employment is significantly negative above a certain degree of inequality (about 0.15).

From a quantitative perspective, the average marginal effect of a productivity increase as measured by an increase in the average salary of a worker in the manufacturing sector by €1000 corresponds to a decrease of regional public employment by 0.45%. This average effect hides the heterogeneity of countries. Consider Finland and Italy with a low and a high degree of inequality, respectively. Finland has an average degree of inequality (as measured by the coefficient of variation in the sample) equal to 0.037, while for Italy this measure has a value of 0.171. Average public employment per 100 inhabitants is about 3.2 in Italy and about 2.2 in Finland. The results imply that an increase in regional productivity, again measured by an increase in the average salary of a worker in the manufacturing sector by €1000, corresponds to a decrease in regional public employment per capita of 0.6% in Italy, while it corresponds to an increase in Finland (even if, however, only of 0.063% of public employment).

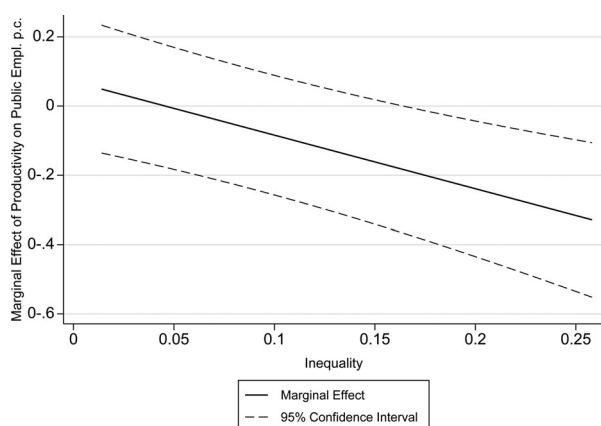


Figure 2. Total effect of productivity according to the degree of inequality.

Note: The graph refers to the estimates of the reference regression in column (8) of Table 2. The total effect of productivity on public employment includes the direct effect of productivity and the effect depending on the degree of inequality.

The role of additional factors

The analysis now considers in more detail the role of additional factors that can influence the link between productivity, inequality and public employment. First, the investigation focuses on inequality aversion. Conceptually, the theoretical model predicts that higher levels of inequality aversion should result in stronger regional differentiation of public employment.¹³ To define inequality aversion, the analysis uses a measure constructed from the 2009 International Social Survey Programme (ISSP) 'Social Inequality IV', which includes opinion data in 13 out of the 17 countries of the original sample: Austria, Belgium, Finland, France, Germany, Hungary, Italy, Poland,

Table 3. Role of additional factors.

	(1) IA = 0	(2) IA = 1	(3) WP = 0	(4) WP = 1	(5) UD = 0	(6) UD = 1	(7) DEC = 0	(8) DEC = 1	(9) IMM = 0	(10) IMM = 1	(11) CRI = 0	(12) CRI = 1
Productivity	−0.258 [0.288]	0.415 [0.475]	−0.490** [0.224]	0.004 [0.127]	−0.159 [0.106]	0.509 [0.350]	−0.089 [0.107]	−0.379 [0.262]	0.305** [0.117]	0.456 [0.397]	0.23 [0.333]	0.204 [0.560]
Inequality	−0.089 [0.061]	0.039** [0.019]	−0.090** [0.043]	0.052*** [0.014]	0.016 [0.011]	0.094** [0.035]	0.022* [0.012]	−0.053* [0.027]	0.024** [0.011]	0.119*** [0.040]	0.071*** [0.020]	−0.007 [0.040]
Productivity*Inequality	2.387 [1.900]	−3.633* [2.093]	3.408** [1.445]	−1.734** [0.860]	−0.116 [0.569]	−3.426** [1.382]	−0.056 [0.540]	1.860* [1.091]	−1.845*** [0.604]	−4.816*** [1.385]	−6.521*** [1.900]	−3.089 [2.908]
Dependency ratio	−0.071*** [0.018]	−0.052*** [0.019]	−0.090*** [0.020]	−0.032* [0.018]	−0.017 [0.023]	−0.032 [0.020]	−0.026 [0.027]	−0.035** [0.015]	−0.102*** [0.015]	−0.045** [0.023]	0.004 [0.042]	−0.024 [0.018]
Population density	−0.012 [0.060]	0.387* [0.217]	0.024 [0.060]	−0.278*** [0.072]	−0.071 [0.046]	0.003 [0.073]	−0.095* [0.049]	−0.01 [0.061]	−0.037 [0.051]	0.032 [0.077]	−0.233 [0.173]	0.396 [0.295]
Population density squared	0.006 [0.008]	−0.54 [0.408]	0 [0.008]	0.139*** [0.043]	0.016** [0.007]	−0.002 [0.023]	0.019*** [0.007]	−0.001 [0.021]	0.01 [0.007]	−0.011 [0.019]	0.466 [0.519]	−0.528 [0.457]
Relative compensation	0.006 [0.011]	−0.028*** [0.006]	0.011 [0.012]	−0.019*** [0.003]	−0.004 [0.004]	−0.033*** [0.008]	−0.008 [0.005]	−0.029*** [0.006]	−0.016*** [0.004]	−0.005 [0.006]	0.005 [0.003]	−0.036*** [0.007]
Unemployment rate	−0.106*** [0.032]	−0.068** [0.030]	−0.086*** [0.026]	−0.003 [0.023]	−0.006 [0.021]	−0.081* [0.045]	−0.004 [0.022]	−0.080*** [0.026]	−0.101*** [0.024]	−0.022 [0.028]	−0.068* [0.035]	−0.043 [0.033]
Unemployment rate squared	0.242** [0.121]	0.127 [0.083]	0.085 [0.070]	0.074 [0.082]	−0.017 [0.071]	0.224* [0.120]	−0.041 [0.066]	0.218*** [0.080]	0.342*** [0.089]	−0.06 [0.090]	0.185 [0.147]	0.042 [0.080]
Fiscal decentralization	0.032 [0.026]	0.034*** [0.011]	0.03 [0.030]	0.009 [0.011]	0.01 [0.020]	0.055*** [0.011]	−0.017 [0.029]	0.061*** [0.012]	0.017 [0.016]	0.01 [0.023]	0.069*** [0.021]	0.035** [0.014]
Constant	0.074*** [0.026]	0.052*** [0.020]	0.078** [0.030]	0.098*** [0.014]	0.061*** [0.016]	0.066*** [0.024]	0.071*** [0.020]	0.084*** [0.015]	0.104*** [0.015]	0.048* [0.028]	0.024 [0.019]	0.053** [0.027]
Observations	855	701	969	847	1208	608	1051	765	586	683	393	556
R ²	0.267	0.26	0.242	0.317	0.249	0.378	0.268	0.329	0.357	0.319	0.291	0.291
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of groups	96	83	102	100	139	63	120	82	102	100	51	58

Notes: Robust standard errors are given in parentheses, clustered at the regional level. Regional public employment per capita in public administration is the dependent variable. IA = 0(1): subsample of countries with low (high) inequality aversion; WP = 0(1): subsample of countries with low (high) public wage premia; UD = 0(1): subsample of countries with low (high) unemployment dispersion; DEC = 0(1): subsample of countries with low (high) fiscal decentralization; IMM = 0(1): subsample of countries with low (high) stock of immigrants in the population; CRI = 0(1): subsample of countries with low (high) level of crime (homicides). All regressions are fixed-effects regressions at the regional level.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Portugal, the Slovak Republic, Spain, Sweden and the UK. The adopted measure of inequality aversion focuses on the respondents' degree of agreement with the statement 'It is the responsibility of the government to reduce the differences in income between people with high incomes and those with low incomes', which captures individual attitudes towards government redistribution.¹⁴ There are five possible degrees of agreement to the above statement: 'Strongly agree', 'Agree', 'Neither agree nor disagree', 'Disagree' and 'Strongly disagree'. For each country the combined average of 'Strongly agree' and 'Agree' was retrieved. After computing the average across countries of this combined percentage, a dummy equal to 1 was defined, if in a certain country this combined percentage was equal or above the average, and equal to 0 otherwise.

Columns (1) and (2) of Table 3 replicate the reference regression of column (8) of Table 2 for the countries that are less inequality averse (column (1)) and for the inequality averse countries (column (2)). The negative relationship between regional productivity and public employment is stronger for inequality averse countries, as predicted. These findings may be regarded as additional evidence that regionally differentiated public employment may indeed be used for redistributive purposes.

Following the above discussion (in the second section), the analysis also investigates empirically the role of additional aspects that could be relevant for the pattern of the regional distribution of public employment. These potential factors are the role of public sector wage premia, unemployment dispersion, fiscal decentralization, migration and crime. As already stressed, the effects of these factors on regional public employment are a priori ambiguous. As a consequence, the empirical analysis of this section is mainly explorative. The countries are again split into two respective groups according to the following binary categories. The first distinction is between countries with a positive and a negative public sector wage premia. The second between countries with a high or a low regional dispersion of unemployment. The third differentiation considers whether fiscal decentralization is relatively high or not. The fourth distinction is between countries with a high stock of international migrants as a percentage of the population and those with a low stock. Finally, the initial sample is split into countries with high or low crime rates.¹⁵ For each subsample of countries, the analysis then estimates the full specification regression (Table 3).

For countries with positive wage premia the results are similar to those of the full sample. However, with negative wage premia there is a negative direct effect of productivity and a positive interaction effect (see columns (3) and (4)), indicating that negative wage premia reduce the attraction of public employment as a redistributive instrument in regionally more heterogeneous countries. Columns (5) and (6) correspond to countries with high and low unemployment dispersion, respectively. Only countries characterized by high unemployment dispersion show the pattern of higher regional public employment in regions with lower productivity. This may be driven by the higher tagging potential in such countries. Splitting the sample of countries into high and low fiscal decentralization countries

generates fewer significant coefficients for the variables of interest (columns (7) and (8)). While the total marginal effect of productivity, including the direct and the interaction effect, is still negative for both groups, the estimated coefficients are no longer significant. Next, given that no data on interregional migration are available, the analysis uses national-level data on international immigration to identify countries where migration is important. The extent of immigration can be regarded as a proxy for the migration frictions within a country. The results shown in columns (9) and (10) indicate that the main results are robust for both groups, but that the interaction between inequality and productivity is more pronounced in high-migration countries. Explanations for this finding could be a stronger perceived need for regional redistribution in these countries, or the correlation between immigration and more pronounced welfare states, where the latter also implies that there is more scope for targeted redistribution via regionally differentiated public employment. Finally, the analysis considers the role of crime. As a proxy for the prevalence of organized crime, the number of homicides per capita at the country level is adopted. As is evident from columns (11) and (12), results are quite different for the two groups. The analysis finds strong effects for the low-crime countries, in line with the baseline findings. However, for the high-crime countries, the variables of interest are all insignificant, indicating that high-crime levels can interfere with the baseline predictions.

Robustness checks

Table 4 presents several robustness checks of the previous empirical investigation. Column (1) reports the estimates of the reference specification (i.e., column (8) of Table 2) while the following columns report the robustness checks. Column (2) tests the role of additional controls: the focus is here on the share of skilled workers, since results of Proposition 2 are derived by assuming a constant share of skilled labour. The regression in column (2) additionally includes a measure of skilled labour: human resources in science and technology (HRST) as a share of the economically active population. The coefficients of the three main variables of interest (productivity, inequality and the interaction term between the two) have the same sign and significance as in the reference regression. Column (3) investigates an alternative fiscal decentralization measure: the share of local and regional government expenditure in total government expenditure. This alternative measure has the same sign as before and the significance of the coefficient is broadly similar. Column (4) tests an alternative dependent variable: it considers a public employment measure which also includes employment in education and health sectors. The results show that there are important differences compared with the reference regression of column (1): productivity is positive and significant. The positive sign of the productivity coefficient may be explained by the high-income elasticity of the goods and services provided by these sectors. This is relevant for public and private employment in these sectors; however, since this alternative measure aggregates private and public employment, one

Table 4. Robustness checks.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Productivity	0.071 [0.097]	0.062 [0.094]	0.053 [0.089]	0.721*** [0.238]	-2.368 (2.132)	0.090 [0.092]	0.085 [0.091]	0.066 [0.084]	0.752*** [0.220]	-1.121 (1.240)
Inequality	0.046*** [0.011]	0.048*** [0.011]	0.027*** [0.009]	0.088*** [0.026]	0.020 (0.022)	0.045*** [0.011]	0.048*** [0.011]	0.026*** [0.008]	0.087*** [0.023]	0.024* (0.014)
Productivity*Inequality	-1.548*** [0.432]	-1.266*** [0.442]	-1.167*** [0.373]	-2.257** [0.908]	-3.050* (1.701)	-1.563*** [0.416]	-1.344*** [0.426]	-1.161*** [0.363]	-2.493*** [0.819]	-2.701** (1.116)
Dependency ratio	-0.063*** [0.013]	-0.060*** [0.013]	-0.065*** [0.012]	-0.055** [0.024]	-0.066** (0.030)	-0.063*** [0.012]	-0.060*** [0.012]	-0.067*** [0.011]	-0.046** [0.023]	-0.063*** (0.021)
Population density	-0.039 [0.042]	-0.043 [0.043]	-0.035 [0.040]	0.010 [0.063]	0.384 (0.306)	-0.029 [0.021]	-0.038* [0.020]	-0.027 [0.020]	-0.075* [0.044]	0.040 (0.063)
Population density squared	0.011* [0.006]	0.012* [0.006]	0.010* [0.006]	0.002 [0.009]	-0.040 (0.036)	0.002 [0.001]	0.002** [0.001]	0.002 [0.001]	0.004 [0.002]	-0.001 (0.003)
Relative compensation	-0.020*** [0.003]	-0.020*** [0.003]	-0.020*** [0.003]	-0.032*** [0.004]	-0.043*** (0.013)	-0.020*** [0.003]	-0.020*** [0.003]	-0.020*** [0.003]	-0.031*** [0.004]	-0.033*** (0.008)
Unemployment rate	-0.040** [0.017]	-0.038** [0.016]	-0.068*** [0.017]	-0.157*** [0.032]	-0.167** (0.075)	-0.039** [0.017]	-0.038** [0.016]	-0.065*** [0.017]	-0.157*** [0.031]	-0.131*** (0.047)
Unemployment rate squared	0.114 [0.071]	0.125** [0.063]	0.174** [0.069]	0.475*** [0.099]	0.488** (0.246)	0.110 [0.071]	0.123* [0.063]	0.166** [0.069]	0.476*** [0.096]	0.382** (0.164)
Fiscal decentralization	0.020*** [0.008]	0.018** [0.008]		-0.003 [0.012]	0.009 (0.057)	0.022*** [0.008]	0.020*** [0.007]		-0.001 [0.011]	0.037 (0.035)
HRST as a % of the active population		0.032*** [0.007]					0.031*** [0.007]			
Fiscal decentralization (alt.)			0.018* [0.010]					0.020** [0.009]		
Constant	0.087*** [0.011]	0.077*** [0.011]	0.093*** [0.010]	0.142*** [0.018]		0.088*** [0.009]	0.080*** [0.009]	0.093*** [0.008]	0.161*** [0.018]	
Observations	1816	1725	1718	1816	1163	1940	1845	1828	1940	1236
R ²	0.215	0.244	0.206	0.511		0.213	0.237	0.205	0.499	
Time effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of groups	202	202	195	202	176	217	217	209	217	188

Notes: Robust standard errors are given in parentheses, clustered at the regional level. Public employment per capita is the dependent variable. The robustness checks for the reference regression are included in column (8) of Table 2. Column (1) replicates the reference regression. Columns (2) to (4) test, respectively: the role of skilled labour, an alternative fiscal decentralization measure (based on government expenditures), and an alternative measure of public employment as dependent variable (which includes public employment in education and health sectors). Column (5) performs a two-stage least squares (2SLS) regression using total patent applications to the European Patent Office (EPO) as an instrument for regional productivity. Columns (6) to (10) replicate the results of columns (1) to (5) for a sample which includes the capital regions. All regressions are fixed-effects regressions at the regional level.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

cannot identify whether this effect is more or less important in either sector, or whether the overall effect of productivity is entirely driven by the private component of the dependent variable. The total effect of productivity is now positive for all levels of inequality. However, this positive effect is less pronounced in countries that are regionally more unequal, indicating that the effect of higher public employment in more productive regions is reduced in these countries, in line with this article's theoretical argument.

Table 4 also addresses the potential endogeneity of regional productivity. Regional public employment can affect regional productivity due to a number of reasons. First, increased public employment may provide important inputs, such as security, swift contract enforcement, rule of law, etc. that increase private sector productivity. Second, as discussed in the second section, public sector employment may directly reduce employment in the private sector, driving up marginal productivity. Finally, the most productive individuals and the entrepreneurial talents may be attracted by the public sector, given its potential advantages in terms of job security and wage premia. This could have a negative effect on productivity.

To meet this challenge, the analysis additionally considers instrumental variables estimations. Column (5) of Table 4 shows the two-stage least squares (2SLS) estimates, which takes the potential endogeneity of public employment into account. The chosen instrument for regional productivity is the total number of patent applications to the European Patent Office (EPO) per million inhabitants. This variable can be considered sufficiently exogenous given that the main public employment variable does not include employment in education, research and healthcare, etc.¹⁶ While the significance of the coefficients is somewhat reduced in the 2SLS relative to the fixed-effects benchmark, overall the 2SLS estimates confirm the key findings. The analysis again finds a negative relationship between regional productivity and the level of regional public employment, and this relationship is more pronounced in countries characterized by higher regional productivity differences. Quantitatively the effects are even stronger as is evident from the higher coefficient (in absolute terms) of the interaction term.

Finally, columns (6) to (10) test the role of outliers and replicate the specifications in columns (1) to (5) by using a sample which includes all the capital regions. The results confirm signs, magnitude and significance of all the key variables of interest reported in the previous columns.

CONCLUSIONS

This paper presents a theoretical framework which shows that public employment can serve as an expenditure side-tagging device to improve the efficiency of tax-transfer schemes. It allows targeting 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. Using a panel dataset of European regions from 17 countries, the

empirical investigation finds evidence that the regional distribution of public employment is consistent with the 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. Moreover, these findings are more pronounced in countries characterized by a relatively high stock of immigrants, or by relatively high unemployment, both important factors on the European policy agenda.

Finally, some caveats regarding the policy implications of the analysis should be stressed. First, intervening in the labour market by adjusting public employment regionally may cause additional negative side-effects, such as the potential sorting of talented individuals from the private sector into the public sector. Second, interregional migration affects the degree to which regional differentiation of public employment can be a sensible policy instrument. Finally, regionally differentiated public employment needs to be comprehensively compared with alternative policy instruments such as regionally differentiated grants, taxation and regulation.

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DISCLOSURE STATEMENT

No potential conflict of interest was reported by the authors.

SUPPLEMENTAL DATA

Supplemental data for this article can be accessed at <https://doi.org/10.1080/00343404.2016.1156239>

NOTES

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, Knight, & Sabot, 1991), to disguise the amount of transfers channelled to some favoured minority group (Alesina, Baquir, & Easterly, 2000), or to create commitment within a bureaucracy (Kessing & Konrad, 2008).
2. Alternatively, the regionally provided goods g_i could be produced privately and only purchased by the public sector.

This implies that the analysis of this section also applies to the regional distribution of public spending.

3. As $\rho \rightarrow 1$, one approaches the Utilitarian case, and as $\rho \rightarrow -\infty$, one approaches the Rawlsian case. Here, given that individual preferences are linear in consumption, inequality aversion is a necessary condition for the desirability of redistribution and, accordingly, also for public employment to potentially increase the efficiency of redistribution.

4. With perfect correlation, allowing the government to condition taxation on residence would enable it to implement the first best. Moreover, if the government itself did not know which region was the high- or the low-productivity region, the incentive compatibility constraint would have to be adjusted.

5. The countries are Austria, Belgium, the Czech Republic, Finland, France, Germany, Greece, Hungary, Italy, the Netherlands, Poland, Portugal, Romania, Spain, Sweden, the Slovak Republic and the UK. NUTS = Nomenclature des Unités Territoriales Statistiques.

6. NACE = Nomenclature statistique des activités économiques dans la Communauté européenne.

7. Appendix B in the supplemental data online also presents scatter plots between relative public employment and relative regional productivity for individual countries.

8. From the initial sample of 243 regions, all 17 capital regions are excluded. In the Netherlands, South Holland instead of North Holland is not used in the analysis since The Hague and not Amsterdam is the administrative capital. In addition, Ceuta-y-Melilla and Northern Ireland are eliminated due to the large presence of security personnel (see also the scatter plots in Appendix B in the supplemental data online). The analysis also leaves out the three Atlantic islands from the sample (Canarias, Madeira and Açores) in line with the standard practice in empirical studies on European regions. A sensitivity analysis shows that the results do not hinge on these exclusions. See also the fourth section for the capital regions.

9. The coefficient of variation is conceptually independent of country size, but can be affected by average region size. *Ceteris paribus*, if a country is characterized by smaller regions on average, this should result in a higher coefficient of variation. However, NUTS-2 regions have a predetermined average population range between 800 000 and 3 million people. Moreover, in the sample the coefficient of variation shows itself to be positively correlated with average region size at the country level.

10. For lack of relevant data at the regional level, relative public-to-private compensation is measured only at country level, as is fiscal decentralization, given the nature of this variable.

11. The corresponding pooled ordinary least squares (OLS) regressions are given in Appendix B in the supplemental data online. *F*-test results show that the null hypothesis of no fixed effects is strongly rejected with *F*-statistics around or above 30. It is also worth pointing out that these regression results cannot be interpreted strictly in a causal way. However, they are relevant to uncover some meaningful correlations among the variables

of interest. Endogeneity issues are considered in the fourth section.

12. The Hausman test compares the model in column (8) with the model in column (9) of Table 2. The results show that the null hypothesis is rejected and thus that the preferred model is the fixed-effects model. The relevant Chi-squared statistics is $\text{Chi}^2(11) = 40.31$.

13. See note 3 above and the second section.

14. This question has also been included in the 1999 ISSP 'Social Inequality III'. The correlation between the answer shares in the 1999 survey and the 2009 survey is about, or more than, 0.90 for the countries of the sample which are included in both surveys. Accordingly, since the 1999 survey includes substantially fewer countries of the sample than the 2009 survey, this latter survey was taken as the reference.

15. The thresholds are the mean values of the respective variables over the interval 1995–2007. For migration, the stock of the immigrant population as a share of the total population from EUROSTAT's Migration and Migrant Population Statistics is used, and for (organized) crime the number of homicides (per capita) are from EUROSTAT statistics on 'Crime and Criminal Justice'. The investigation additionally splits the sample according to the median of the classification variable. The results (not reported here) do not change much, with the exception of crime, where the differences between the high- and low-crime countries largely disappear. The results are available from the authors upon request.

16. If regional productivity is endogenous, the interaction between regional productivity and inequality will be endogenous. Since inequality is measured by regional productivity dispersion, in principle it can be endogenous as well. However, since inequality is a country-level measure, at the regional level it may be considered rather exogenous. In line with this, the 2SLS estimates treat both productivity and the interaction between productivity and inequality as endogenous variables, and the analysis uses inequality with a lag. As evidenced by the relevant tests, the endogenous regressors are jointly significant (column (5): Anderson–Rubin–Wald test $\text{Chi}^2(2) = 11.59$, $p = 0.0030$; column (10): Anderson–Rubin–Wald test $\text{Chi}^2(2) = 9.8$, $p = 0.0072$). The instruments are in general significant in the auxiliary regressions.

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APPENDIX A: DATA DESCRIPTION AND SOURCES

All data at regional level are from EUROSTAT regional statistics. Public employment data have been kindly provided by EUROSTAT staff. All remaining regional data can be found on the EUROSTAT website. Additional data at country level are from the Organisation for Economic Co-operation and Development (OECD).

Public employment. Number of people employed in the NACE sector ‘Public administration and defence; compulsory social security’ (sector L, NACE rev. 1.1) divided by the total population (NACE = Nomenclature statistique des activités économiques dans la Communauté européenne). Source: EUROSTAT (Regional Labour Force Statistics – LFS). Period: 1995–2007. Geographical aggregation level: NUTS-2.

Public employment (edu-health). Number of people employed in the NACE sectors ‘Public administration and defence; compulsory social security’ (sector L, NACE rev. 1.1), ‘Education’ (sector M, NACE rev. 1.1), and ‘Health and social work’ (sector N, NACE rev. 1.1) divided by total population. Source: EUROSTAT (Regional LFS). Period: 1995–2007. Geographical aggregation level: NUTS-2.

Productivity. Wages and salaries per number of people employed in the NACE sector ‘Manufacturing’. Source: EUROSTAT (Regional structural business statistics). Period: 1995–2007. Geographical aggregation level: NUTS-2. Unit of measure: millions of euros.

Inequality. Coefficient of variation of regional productivity. Regional productivity has been weighted by the population share of the corresponding region. Source: authors’ calculation from EUROSTAT data. Period: 1995–2007. Geographical aggregation level: NUTS-0 (country level).

Population density. Total population per square kilometre. 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 of age over the working-age population. 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 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. Unemployed people as a percentage of the labour force. Source: EUROSTAT (Regional LFS). Period: 1995–2007. Geographical aggregation level: NUTS-2.

Fiscal decentralization. Fiscal decentralization. Ratio of the sum of local and regional tax revenue over total general government tax revenues. Source: OECD (OECD Fiscal Decentralization Database). Period: 1995–2007. Geographical aggregation level: NUTS-0 (country level).

Fiscal decentralization (alt.). Alternative fiscal decentralization measure, equal to 1 minus the ratio of central government expenditures over total government expenditures. Source: International Monetary Fund (IMF) (Government Finance Statistics – GFS). Period: 1995–2007. Geographical aggregation level: NUTS-0 (country level).

HRST as a % of active pop. Human resources in science and technology (HRST) as a percentage of the active population. HRST includes those who have completed an education at the third level in a science and technology field or who are employed in an occupation where such an education is normally required. Active population is composed by individuals aged 25–64 years. Source: EUROSTAT (Regional LFS). Period: 1995–2007. Geographical aggregation level: NUTS-2.

Patent applications. Patent applications to the European Patent Office (EPO) per million inhabitants. Source: EUROSTAT (Regional Science and Technology Statistics). Period: 1995–2007. Geographical aggregation level: NUTS-2.