# **The Consequences of Public Employment: Evidence from Italy's Municipalities** FIRST DRAFT: FOR COMMENTS & SUGGESTIONS DO NOT CIRCULATE

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#### Abstract

We investigate the consequences of public employment on the local economy. We start by presenting a spatial-equilibrium framework, which highlights that: (i) the housing market is a relevant channel through which a variation in public employment percolates to private employment, and (ii) the impact on house prices depends on household mobility costs. We then bring the theory to data, exploiting decadal changes in public employment across Italians municipalities between the last two Censuses (2001-2011). We use an IV identification strategy that exploits the fact that variations in local public employment were strongly influenced by the central government decisions, with little reference to the economic conditions of the municipalities. We document that exogenous increases in public employment crowd out private jobs and that competition in the housing market seems to be an important channel for displacement.

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# 1. Introduction

The interaction between public and private employment is a long-standing issue in the policy debate. The expansion of public jobs may come as a policy reaction to low private employment. At the same time, private employment may react to public employment. On the one hand, the goods and services produced by the public sector may favor a business friendly environment or better amenities and, further, boost the demand for privately produced goods. On the other hand, public employment may crowd out the private sector employment, as it can raise the costs of production by increasing the local cost of scarce resources, and/or reduce the labor supply available to the private sector. Which one of the two effects dominates is an empirical question, which is essential to understand whether an increase in public jobs motivated by unemployment concerns is effective or not.

Given the relevance of this question, the macroeconomic literature has recently witnessed an expanding number of contributions that model the public sector in a search framework. Burdett (2012) and Gomes (2014) suggest that higher public wages lead to a contraction in private employment. From the empirical point of view, this crowding out effect is confirmed by previous studies based on international comparisons (Boeri et al, 2000; Algan et al, 2002; Behar and Mok, 2013).

Although most policy decisions are made at the national level, the expansion of the public sector is usually very differentiated at the local level, both because of historical reasons, in particular past policies, and administrative concerns, for instance the need of a minimum set of services even in low density areas. The analysis at the local (sub-national) level can therefore exploit this source of variation to shed light on the relation between private and public employment and to understand which are the main mechanisms behind it, studying also the effect on local prices. In our perspective, the existing estimates obtained from cross-country comparisons might be plagued by concerns about the causal interpretation. Furthermore, forecasts obtained by macro-econometric models, which are usually based on time series at the national level, rely on strict identification assumptions (Moretti, 2010). Therefore, our estimates, which exploit the variability at the local level, might provide additional empirical evidence to inform the macro debate.

In Italy, public sector wages are higher than in the private sector (Giordano, 2010; Depalo et al, 2015). Thus, an exogenous increase of public employment in one area will likely lead to an upward pressure on salaries, and also increase the demand for locally produced goods, in particular housing. This demand-driven push may have beneficial effects on the non-tradable sector but, at the same time, if house prices increase, private sector workers are likely to leave for other areas. On the other hand, the presence of a larger public sector can directly have an impact on the productivity of local firms, if the additional public employment allows for the provision of better services. Employment in the tradable and non-tradable sectors might, therefore, have an additional (supply-driven) push. Nevertheless, this effect could also go the other way round if, for example, a larger public sector generates obstacles to doing business.

Empirically, Faggio and Overman (2014) provide a thorough econometric analysis of the impact of annual variations in public employment on private employment and working age population growth, focusing on British Local Labor Markets. They find no crowding out for aggregate private employment, but this is the result of a negative effect on manufacturing (tradable) and a positive impact on services and constructions (non-tradable). Caponi (2014) proposes a regional search model and calibrates it with Italian data, finding significant crowding out. Faggio (2015) studies the effects of a relocation policy for civil service workers in Britain. She finds a positive multiplier effect on the private sector in receiving areas, mostly driven by services. Jofre-Monseny et al (2016) propose a matching model and, using Spanish data, estimate that an increase of local public employment crowds-in non-tradable jobs and crowds-out tradable ones. Finally, Becker et al (2015) evaluate the impact of public employment on private sector activity, by considering a relocation episode: the move of the German federal government from Berlin to Bonn in the wake of the Second World War. They basically find no effect on private employment. Our work is also related to previous work on regional disparities and, in particular, on the effect of nationwide-set public wages on heterogeneous regional labor markets (Bodo and Sestito, 1991). Among the papers in this stream of research, Casavola et al (1995) find a small positive impact of Public Administration on local wages in small private firms at the provincial level.

We contribute to the existing literature by focusing on the displacement effect driven by competition in the housing market. We start by outlining a spatial-equilibrium model with public employment.<sup>1</sup> In the model, an increase in local public employment will create an upward pressure on housing prices. This may decrease the relative attractiveness of the area for private workers, as their real wage tends to decrease. Depending on their idiosyncratic preference for the area, they may move to other places. In the absence of any impact of public employment variations on local productivity and the quality of amenities, the interplay between private and public employment is entirely driven by the competition in the local housing market. However, the actual impact of public employment is ambiguous whenever local productivity or amenities are positively affected by the expansion of the public sector.

Starting from the theoretical background, we provide empirical evidence on the local consequences of public employment using data from Italy at the municipality level between 2001-2011. We build on Faggio and Overman

<sup>&</sup>lt;sup>1</sup> Our spatial model is related to Jofre-Monseny et al (2016) who, however, explicitly consider a local non-tradable sector. There, public employment crowds-out activity in the local tradable sector, while crowding-in employment in local non-tradables. The net effect on private employment is, thus, ambiguous. This issue is also quite central in the model presented in Becker et al (2015), where different tradable goods are produced in different areas and transportation across locations involves iceberg costs.

(2014), but we explicitly focus on the joint equilibrium adjustments in private employment and house prices.<sup>2</sup> Moreover, differently from Faggio and Overman, we use Census data at the municipality level and analyze variations over a decade instead of annual growth rates. Finally, while Becker et al (2015) analyze a single episode of public employment relocation, though very relevant in Germany, our analysis covers to the universe of Italy's municipalities.

The empirical strategy we adopt makes us of the huge amount of information available in Italy for small local areas. However, the availability of a large number of covariates does not shelter our estimates from the concerns related to omitted variables and simultaneity. Therefore, we resort to an IV strategy that exploits the fact that variations in local public employment are decided in Italy at the central government level. During the 2001-2011 period, central authorities cut down local public employment, essentially for nationwide budgetary reasons with little reference to the economic conditions of the municipalities.

Our main results highlight clean crowding out: one additional public employees reduces private employment by 0.6/0.8 unit on average. The result seems to be driven by the competition on the housing market, because house prices rise, as predicted by the theory. Section 2 presents the theoretical model and its main predictions. Section 3 discusses the identification strategy and presents the data. Results are showed in subsection 3.3. Conclusions follow.

# 2. Theoretical Background

In order to analyze the role of public employment, we outline a Roback spatial model with "mobility costs", as in Moretti (2011). The details and the solution of the model sketched here are reported in the online Appendix A. The economy is composed of two regions, denoted by  $c = \{a, b\}$ . Firms are fully

<sup>&</sup>lt;sup>2</sup> Also Jofre-Monseny et al (2016) do not estimate the impact on house prices.

mobile across areas and produce a *tradable* good with a Cobb-Douglas, constant-returns-to-scale technology.<sup>3</sup> Production requires only skilled and unskilled labor and sells at a price equal to one across areas. Skilled and unskilled individuals, instead, do have idiosyncratic preferences for locations. The utility of a skilled individual living, say, in area a is denoted by  $U_a^s = A_a^s \cdot x_a^{1-\gamma} \cdot L_a^{\gamma} \cdot \varepsilon_a^s$ , an increasing function of the consumption of tradables,  $x_a$ , and housing services,  $L_a$ . Utility is also increasing in local amenities, denoted by  $A_a^{s}$ , and in the realization of the preference shock  $\mathcal{E}_a^{s}$ for location a. A high realization of  $\mathcal{E}_a^s$  implies that the individual may be unwilling to move from place a to b even when amenities and the wage-rent ratio in location b are larger than in location  $a^4$ . Hence, preference shocks generate "mobility costs": labor supply is not perfectly elastic across locations, differently from the basic Roback's model. Unskilled workers have similar preferences, given by  $U_a^u = A_a^u \cdot x_a^{1-\gamma} \cdot L_a^{\gamma} \cdot \varepsilon_a^u$ . The model is closed by the equilibrium condition for the market of local housing services. Individual demands for housing, L, are aggregated across skilled and unskilled individuals employed in the private and public sector. Housing supply is an increasing function of both residential land and local rents.

Public employees can be skilled and unskilled. The size and allocation of public employment across regions is exogenously determined by the central

<sup>&</sup>lt;sup>3</sup> The models in Faggio and Overman (2014), and Jofre-Monseny et al. (2016) allow for the presence of both local tradable and non-tradable sectors. In Jofre-Monseny et al., a local "scarce" factor also guarantees decreasing returns. We also developed a two-sector version of the model, where the non-tradable local sector is subject to "multiplier effects", after Moretti (2010). The two-sector model is available as an additional Appendix in the authors' website (Auricchio et al, 2016).

<sup>&</sup>lt;sup>4</sup> Clearly the decision depends on the difference in the idiosyncratic preference shocks for the two areas, but here only  $\mathcal{E}_a^s$  matters because we fixed (without loss of generality)  $\mathcal{E}_b^s = 1$ .

government. We also postulate that the wages for public employees may differ between skilled and unskilled, but within each category they are equal across regions, and set at the national level. Consistently with evidence from Italy reported in Giordano (2010) and Depalo et al (2015), wages in the public sector are taken to be larger than the corresponding ones in the private sector.<sup>5</sup> The basic mechanism at work in the present framework hinges on the local housing market. Suppose, at least initially, that local public employment has no impact on local amenities and productivity. Then, the only effect of public employment is that public employees will come to compete on the local housing markets with individuals employed in the private sector. In particular, an increase in the mass of local employees will increase the local demand for housing, and displace individuals who were employed in the local private sector. The effect on local rents is thus driven by such two opposing effects on housing demand.

These implications can be made sharper by introducing some notation. As is clear from the online Appendix A, the model is solved by log-linearizing equations and calculating deviations around "symmetry". In other words, we derive our results by assuming that the two areas are initially identical, and then we suppose that public employment in location *b* increases more than public employment in location *a*. In symbols, we denote such an event as  $\tilde{\Pi} > 0$ . We then ask how *private* employment in area *b* will change, relative to private employment in area *a*, after the public employment shock. By denoting the relative changes in skilled and unskilled private employment respectively by  $\tilde{N}$  and  $\tilde{n}$ , and the change in relative rents by  $\tilde{r}$ , we obtain the following solutions:

<sup>&</sup>lt;sup>5</sup> As in Faggio and Overman (2014), we abstract from the explicit consideration of the public sector budget constraint by postulating that local public sector wages are financed from *national* taxation: such taxation, indeed, does not alter the *relative* conditions of the two areas considered.

$$\widetilde{N} = B_1 \cdot \widetilde{\Pi}; \quad \widetilde{n} = B_2 \cdot \widetilde{\Pi}; \text{ and } \widetilde{r} = D \cdot \widetilde{\Pi},$$
 (1)

where  $\{B_1, B_2, D\}$  are expressions reported in the online Appendix A which depend on the parameters of the model, including the size of mobility costs. We can thus give a sum-up of the main implications, starting with changes in private employment and, then, consider rents. Notice that in the real world different areas are hardly symmetric at the beginning of any period. In the empirical application we discuss in detail how this heterogeneity is accounted for in the specification choice and in the selection of control variables.

#### Private employment changes.

Independently of the size of mobility costs, we obtain that the direct effect of local public employment is unambiguously negative, since  $\{B_1, B_2\} < 0$ . Thus, if it has no indirect effect through local amenities or productivity, an increase in local public employment will always crowd out private employment.

Also, if skilled and unskilled individuals have the same measure of mobility costs, it will hold that  $B_1 = B_2$ . As a consequence, the impact of public employment on private employees will not change the local skill mix.

The size of private employment displacement depends on the size of mobility costs. Displacement is smaller when mobility costs are higher. In other words, the absolute values of  $\{B_1, B_2\}$  get smaller the larger mobility costs.

Finally, if the skilled bear mobility costs smaller than the unskilled, a local public employment shock will worsen the skill mix, that is, the skilled in the private sector will decrease faster than the unskilled.

# Local rent changes.

For what it concerns change in local rents, given by  $\tilde{r} = D \cdot \tilde{\Pi}$ , it holds that D is non-negative. When mobility costs are negligible, increased demand for local housing by public employees will be matched by a decrease in demand

due to reductions in private sector employment, and local rents will *not* change in equilibrium. Indeed, when workers are fully mobile across areas, they will be ready to leave whenever local rents tend to increase: thus, people will move away until rents stay the same. By contrast, the presence of mobility costs implies a moderate increase in local rents.

As clear from the online Appendix A, the results exposed so far emphasize the crowding-out effect of public employment through the local housing market. However, if local public employment exerts a positive and sizeable effect on the local quality of life, or on local productivity (as, e.g., in Becker et al, 2015), the crowding-out of local private employment gets smaller. At the extreme, public employment may even crowd-in private employment (in this case, however, there will be a larger positive effect on local rents).

# **3.** Empirics

In this section, we provide empirical evidence on the impact of local public employment using data from Italy. We focus on joint adjustments in private employment and local prices by presenting "reduced-form" estimates, meant to deal with causality issues. Then, we discuss how our findings can be interpreted through the lens of the theoretical predictions. We start (Sect. 3.1) by explaining our IV identification strategy. Then we describe the data (Sect. 3.2). The results are shown in Sect. 3.3.

# 3.1 Identification

3.1.1 Specification. Our main equation relates growth in private sector employment to growth in public sector between the Census waves 2001 and 2011 (we focus only on the most recent wave because we do not have earlier information on house prices at the municipality level). We follow Faggio and Overman (2014) and model the relation as linear in *contributions* to overall employment growth:

$$\frac{N_{c,2011}^{priv} - N_{c,2001}^{priv}}{N_{c,2001}} = \beta_0 + \delta \frac{N_{c,2011}^{pub} - N_{c,2001}^{pub}}{N_{c,2001}} + \chi_{c,2001}\beta_x + \epsilon_c$$
(2)

where c = 1, ..., M are Municipalities. In this specification, the coefficient  $\delta$  can be interpreted as the unit change in private employment associated with one unit change in public employment.  $x_{c,2001}$  is a  $1 \times K$  vector of control variables with reference to the beginning of the period. For house prices per square-meter, we instead estimate

$$\frac{pr_{c,2011} - pr_{c,2003}}{pr_{c,2003}} = \gamma_0 + \rho \frac{N_{c,2011}^{pub} - N_{c,2001}^{pub}}{N_{c,2001}} + x_{c,2001}\gamma_x + \varepsilon_c .$$
(3)

The variation is taken with respect to 2003 because of data constraints (see the data section below). In this case, the coefficient of interest can be read as the percent change in house prices associated with a 1% contribution of public employment to growth (the s.d. of the latter is 5%). Peri and Sparber (2011) suggest that this specification avoids the problem of spurious correlation that affects growth-to-growth or changes-to-changes specifications (for a similar specification, see also Card, 2007).

Our unit of observation is the municipality. That is, the smallest administrative jurisdiction unit in Italy and the ideal geographic reference point for our analysis, which focuses on the local impact of the public-employment variations that are decided at the administrative level (not at the functional one, such as the local labor market).

3.1.2 Baseline controls. The choice of considering administrative entities, however, comes at some costs. The possibility that what happens in one single municipality spills over borderline municipalities cannot be excluded: this occurrence would put our identification strategy in dangerby invalidating the SUTVA (Stable Unit Treatment Value Assumption). This is why we include in  $x_{c,2001}$  some control variables that are likely to differentiate out the potential linkages between the single municipality that experiences a given

variation in public employment and its surroundings. Monte et al (2015) suggest that commuting to other areas captures most of the cross-border spillovers. Thus, we include the best available proxy for mobility, which is the fraction of the population aged below 64 resident in the municipality that moves daily to other municipalities for work or study.

Although the theoretical model assumes perfectly competitive markets, several areas in Italy are far from full employment. This may lead to bias in our results. Places characterized by a larger fraction of non-employed individuals are likely to display a smaller crowding out, since increased demand for public employment meets an excess of labor supply. We thus control also for the unemployment rate (in population aged 15 or more) and for the overall participation rate. By the same token, we control for slackness in the housing market and add an index of housing availability equal to the fraction of vacant housing units over total housing in the municipality. Moreover, given that each municipality might have ties with the surrounding ones, we include the simple average of these four variables across the other municipalities of the same Local Labor Market (LLM), defined by ISTAT as an approximately selfcontained area in terms of commuting (on the basis of census data).<sup>6</sup> In Sect. 3.3 we also check whether our results are driven by reallocations of workers and residents from nearby municipalities, by switching the unit of analysis to the LLM level. If all the results are simply driven by reallocations within very short distances, then we should find milder effects - if any - at the LLM level of aggregation. All these variables, including the mobility index, are defined with reference to the beginning of the period.

From an econometric perspective, our equation is basically a difference-indifferences specification, with a continuous regressor, and therefore we are worried about the possible failure of the parallel trend assumption. We

<sup>&</sup>lt;sup>6</sup> Some of these indicators for commuting and idle labor are not perfect (for instance, they include age groups that we are not interested in) but, to the best of our knowledge, they are the closest approximation that we can build on the available data.

therefore include in  $x_{c,2001}$  the past trends (between 1991 and 2001) of private and public employment contributions to growth, plus the past growth in working age population (expressed as a contribution over employment).<sup>7</sup> Similarly, we include the past trends for the same variables in the rest of the LLM.

As our main dependent and explanatory variables have previous total employment as denominator, we also include the initial levels (in 1991) of the log of employment, total population and house prices.

*3.1.3 Additional controls.* We select all the above covariates guided by theory and econometric concerns. However, we have a much wider set of available variables at the municipality level from a recently released database (*ottomilacensus*). These variables are indices calculated from the 1991-2001 population and housing censuses, and include information on demographic structure, housing conditions, self-reported occupational status, commuting and social vulnerability. A complete list is available in the online Appendix B, while we refer to the website of *8milacensus* for further details.<sup>8</sup> Given that our estimates might depend on these characteristics, we also include all available variables (with no missing information) measured both in 2001 and 1991.<sup>9</sup> To address concerns about the inclusion of too many additional covariates, which may lead to imprecise estimates, we select only the most relevant ones by following the "double selection" procedure proposed by Belloni et al (2014). In detail, we use a LASSO algorithm to select those additional covariates (apart from the baseline ones) that help explaining the

<sup>9</sup> We use the time series of data with municipality boundaries fixed at

<sup>&</sup>lt;sup>7</sup> Unfortunately, we do not have house price trends at the municipality level for that period.

<sup>&</sup>lt;sup>8</sup> Note that these also include the 1991 values for the four indices mentioned above (unemployment rate, labor force participation rate, fraction of empty houses, commuting index).

<sup>2001.&</sup>lt;u>http://ottomilacensus.istat.it/fileadmin/download/Descrizione\_degli\_indicatori\_serie\_con\_fini\_2011.xlsx</u> (last access: 07/12/2015)

variability of the outcomes, the endogenous variable (contribution of public sector to employment growth) and the instrument. For each outcome, the set of selected variables is the union of the different selections, and therefore the set may be different according to the outcome. In practice, we assume that among the whole set of covariates only some have non-zero coefficient and use a penalized criterion (LASSO) to select them, where the penalization is based on the number of selected items. We start from the entire list of additional variables (standardized to have zero mean and unitary variance), and apply the algorithm proposed by Belloni et al (2014).<sup>10</sup> The final estimate for the effect of interest is obtained by running standard 2SLS, including only the selected covariates.

*3.1.4 IV approach.* In spite of the relevance of the baseline and additional controls, we still have two potential problems of identification:<sup>11</sup>

- *Omitted factors* may influence both private and public employment. For instance, an increase in local productivity or quality of life that is not caused by variations in public employment might still spur both private and public demand for labor.
- *Simultaneity* cannot be excluded, as private sector employment may also influence public employment. For example, the local authority may adjust its public employment target by looking at the growth of private employment.

To tackle these issues we adopt an IV strategy, which builds on Faggio and Overman (2014). Our instrument derives from the well-known Bartik (1991) logic, applied to the public sector and to the specification in contributions to growth. We sum up national growth in each sector j of public employment,

<sup>&</sup>lt;sup>10</sup> We use the Stata code made available by the authors. The controls suggested by the theory are included as non-delectable controls and have been standardized as well.

<sup>&</sup>lt;sup>11</sup> Measurement error is less likely to be a concern, given that we are using Census data.

and we multiply it for the public employment weight in *j* for that municipality in the previous period:

$$inst_{c,2011} = \sum_{j \in pub} \frac{N_{j,c,2001}^{pub}}{N_{c,2001}} \times \frac{N_{j,-c,2011}^{pub} - N_{j,-c,2001}^{pub}}{N_{j,-c,2001}^{pub}}$$
(5)  
$$\frac{N_{c,2011}^{pub} - N_{c,2001}^{pub}}{N_{c,2001}} = \gamma_0 + \gamma_1 inst_{c,2011} + x_{c,2001}\beta_x + \eta_c .$$
(6)

To be precise, for each municipality c the national growth is calculated by omitting the municipality itself. Intuitively, the instrument is the predicted contribution of public employment to overall local employment growth, calculated using national trends, which are strongly influenced by the central government decision to downsize the expenditure in human resources.

In order to use this predicted growth as instrument, we impose  $E[(\epsilon_c, \epsilon_c)|1, inst_{c,2011}, x_{c,2001}] = (0,0)$ . This assumption is credible as long as policies at the national level set targets for public employment adjustment that are to be followed at the local level. However, it is not necessary that these rules are precisely followed at the local level (which would, by itself, make public employment exogenous). Such deviations from the rule, which are captured by  $\eta_c$ , are essentially what causes endogeneity (as long as  $E[\eta_c \epsilon_c] \neq 0$  and  $E[\eta_c \epsilon_c] \neq 0$ ). The instrument is going to be valid as long as predicted growth, which captures the policy target, is not related to specific shocks to the private sector ( $\epsilon_c$ ) and to the house prices ( $\epsilon_c$ ).

The instrument seems to be appropriate for the Italian case. First, local public sector employment is overwhelmingly financed through transfers from the central government, not local taxation; consequently, the allocation of public employees over the national territories are mostly decided at the central level. When the public budget constraint is local there would be an obvious link between the local private sector and the public one, as richer local economies can afford better public services. In our case this direct link is not there. However, the fact that decisions are centralized does not necessarily imply that

public servants allocated to a given area do not reflect the economic fortunes of the place. For instance, lagging areas might get an higher share of centrally decided public workers, in an attempt to counterbalance local unemployment (see: Alesina et al., 1999). In the decade we consider this redistributive motive has been greatly impaired, because of the limitation imposed by EU and national legislations. In particular, several laws (in 2002, 2004, 2006) introduced a total or partial stop to new hires leading to a stop in turnover to replace employees entering retirement, especially where the local authorities were not meeting budgetary targets.<sup>12</sup> Such stops in turnover can essentially be interpreted as proportional cuts in employment, where the fraction of public employees entering retirement is not replaced by new hires.<sup>13</sup> Second, the nationwide decisions referring to public employment have a sectoral component, as they are bargained with sectoral labor unions (they also depend on the strength of unions vis-à-vis the incumbent government; for instance, school teacher unions, which are traditionally left-wing oriented, usually get better deals with center-left governments).

The instrument used by Faggio and Overman (2014), which is

$$inst_{c,2011}^{overman} = \frac{N_{c,2001}^{pub}}{N_{c,2001}} \times \frac{N_{-c,2011}^{pub} - N_{-c,2001}^{pub}}{N_{-c,2001}^{pub}},$$
(4)

<sup>13</sup> Clearly, this fraction is not necessarily the same in all towns, as it depends on the age structure of public employment. As we checked, there are not large variations in this structure. Furthermore, as discussed above, the purpose of the instrument is to exclude variations in public employment that may be systematically related to private employment growth. From this perspective, the age structure of the public employment observed in the decade 2001-2011 depends on the hiring decisions made from the 1960s to the 1980s when public sector employment boomed.

<sup>&</sup>lt;sup>12</sup> The regions that did not meet the budgetary targets were essentially those of the South of Italy. In Sect. 3.3 we present results broke down by area and find that the power of our instrument is higher in southern municipalities.

neglects the sectoral composition of public employment and, therefore, uses spatial heterogeneity in the public employment share at the beginning of the period as the only source of variation. However, decisions regarding the size of the public sector are possibly different across different activities. For instance, the cuts imposed on employees in the administration of local authorities may not be the same as those applied to health care centers run by the national health service. Nevertheless, we also checked and the use of inst $_{c,2011}^{overman}$  still delivers very similar results.

## 3.2 Data.

We exploit municipality-level data on private and public employment from the 2001 and 2011 Italian Industry and Service Census. The Census gathers data on local production units of firms, enterprises, institutions at the 31st of December, the reference date of each census. The subjects of the Census are legal-economic units operating in industrial and service sectors, public institutions, non-profit institutions. We focus on employment since, unfortunately, data on wages are not available at the local level, neither for the private nor for the public sector.

In the rest of the paper, "private sector" refers to the industrial and service sectors, which cover all enterprises carrying on economic activities contributing to gross domestic product at market prices, in the fields of industry, commerce and services. Differently, the "public sector" refers to Public Institutions, defined as "economic entities that are capable of producing non-market goods and assets, intended for the benefit of the community and entirely financed by households, enterprises, nonprofit institutions and other public institutions".<sup>14</sup> The municipal undertakings and other government-controlled enterprises are classified in the Census as units operating in the industrial and service sectors. For this reason, privatizations concerning this

<sup>&</sup>lt;sup>14</sup> http://siqual.istat.it/SIQual/visualizza.do?id=8888952 (last access: 06/04/2016).

kind of enterprises in last decades do not raise reclassification issues for our purposes. Still, it is important to underline that our definition of public sector employment excludes those firms that are directly or indirectly owned by central or local governments, as long as they produce market goods or services. In the paper, we exclude the non-profit enterprises because Istat has deeply changed the Census methodology and definition of the sector in the last decades. Furthermore, some changes in legal status have induced transitions between the public and the non-profit sector. This circumstance affects units that are scarcely relevant from the point of view of employment, mostly concentrated in Ministries, Regions and Municipalities (whose legal status has obviously not changed). Unfortunately, ISTAT does not release specific data on these transitions, and we are therefore forced to exclude the non-profit sector from the analysis. In 2011, these organizations included approximately 0.681 million employees, compared to 2.842 million in public institutions and 16.242 in the private sector.

In both private and public sectors, employment includes employees with fixed-term or permanent employment contracts, and the self-employed.<sup>15</sup> The number of contractors (essentially collaborators with non-standard contracts) and the number of temporary workers (apart from those on standard fixed-term contracts) are not taken into account in our definition of employment.<sup>16</sup> The information on these two categories of workers is available only for the Public sector in both 2001 and 2011, while it is not available at the local production level for the Private sector in 2011. In Sect. 3.3 we nevertheless analyze what happens if we include both categories in the definition of public employment.

<sup>&</sup>lt;sup>15</sup> This entry in particular can only concern the private sector employment.

<sup>&</sup>lt;sup>16</sup> Despite it is remain at moderate levels the relative weight of the number of outworkers and the number of temporary workers has grown from 3.4 to 4.3 percent in the public sector between 2001 and 2011 (<u>http://www.istat.it/it/files/2013/07/06-Scheda-Istituzioni-pubbliche-DEF.pdf</u>, last access: 06/04/2016).

The Census data provides information on private and public employment in local units of firms and public institutions. Data are disaggregated at the industry level, with the ATECO 5-digit classification, correspondent to the NACE classification used by Eurostat. However the Istat release for the 1991 and 2001 Census data has implemented the ATECO 5-Digit 1991 Istat classification and the release for the 2011 Census instead has implemented the ATECO 5-Digit 2007 Istat classification. We build an algorithm to solve this reclassification issue that properly aggregates the entries at 3-Digit level using the 2002 Istat classification. The algorithm aggregates the entries for the three different classifications in order to guarantee that each final (re-aggregated) entry in 1991 is assigned to only one (re-aggregated) entry in the 2007 classification (see the online Appendix B for more details). Unfortunately, Census data about employment in local units do not collect information on the skill level of the workforce.

In order to include a set of additional variables and controls, we exploited the information on population and housing Censuses available on *8milacensus* (http://ottomilacensus.istat.it/).<sup>17</sup> The time series on the house price per square meter is, instead, built by using a Bank of Italy Index on the OMI house prices database (see the online Appendix B). However since the available OMI's time series start in 2003 we used prices in 2003 as a proxy for the prices in 2001. As mentioned already, Census data do not provide any information on local wages. To the best of our knowledge there is no available data source on average wages at the municipality level between 2001 and 2011.

In order to exploit an homogeneous set of observations, we have selected only those municipalities that exist in all the censuses considered at each specification.

Since we want to avoid the possibility that our results can be heavily influenced by spurious outliers we winsorized the outcome variables at level

<sup>&</sup>lt;sup>17</sup> We use the time series of data with municipality boundaries fixed at 2001.

5% and 95% levels; we censor all the observations below the 5th percentile to the 5th percentile, and all those above the 95th percentile to the 95th percentile. The instruments have been winsorized only at the  $1^{st}$  and  $99^{th}$  percentiles to avoid losing variability, given that there are few outliers.<sup>18</sup> Descriptive statistics are reported in Table 1. Between 2001 and 2011, employment grew by 0.8% on average across all municipalities (unweighted), but with significant heterogeneity. The private sector contribution has been overall positive (Figure 1), with an average 3.5% increase, while employees of public institutions decreased (-2,6%).

# [Table 1]

#### [Figure 1]

The first panel of Figure 2 shows a positive correlations between variations in private and public employment, although the slope is not very steep. The second panel focuses on the relation between the actual variation in public employment and the predicted one  $(inst_{c,t})$ , which captures the policy rule. The association between averages is quite strong, although for each predicted change there is significant dispersion across different municipalities. Finally, the last panel describes the association of the predicted change (the instrument) with the actual variation in private employment. If the instrument has an effect only through its impact on public employment, as argued in Sect. 3.1, then the correlation between the two should reveal the impact of public employment on the private sector. The picture displays a significant and non-negligible negative relation.

<sup>&</sup>lt;sup>18</sup> Results are extremely similar if we censor both the instrument and the outcomes at the 5<sup>th</sup>-95<sup>th</sup> percentiles or at the 1<sup>st</sup>-99<sup>th</sup>.

# [Figure 2]

3.3 Results.

*3.3.1 Baseline*. Table 2 reports our baseline estimates for a sample of 8,085 Municipalities, over the period 2001-2011. We start by including only the baseline controls. OLS estimates from panel A (Column 1) suggest that public sector employment contribution has a positive impact on private sector employment, while local house prices do not seem to be affected (Column 2). As argued above (Sect. 3.1), however, least-square estimates are hardly convincing.

The 2SLS results obtained by using the modified instrument are presented in Panel B. They suggest that an exogenous increase in public employment brings a substantial displacement of private employment. Therefore, the bias related to omitted variables and reverse causality seems to have biased upward least-square estimates. The most likely explanation is that there are some unobserved shocks which, at the same time, stimulated both private employment and the demand for public services. Simultaneity may have worsened the bias.

The first-stage results suggest that we do not have a problem of weak instruments (the F statistic is well above the ordinary rule of thumb). According to our estimates, an additional public sector worker causes a loss of 0.6 workers in the private sector. Interestingly, our result is in line with macroeconomic estimates, though the magnitude of the crowding out is estimated to be lower. Analyzing a panel of OECD countries, Algan et al (2002) suggest a 1.5 displacement effect; Behar and Mok's (2013) estimates from a panel of 194 countries are around 1.

### [Table 2]

As the model suggests, in the absence of an effect of public employment on amenities and productivity, the displacement of private workers is due to increased demand on the housing market. Nevertheless, the variation of house prices in equilibrium depends on how many private workers will leave the area to move somewhere else, which is ultimately related to their mobility costs. As predicted by the theory, the effect may be zero or positive. Table 2, panel B, displays a not statistically significant effect. The trends in house prices are, nevertheless, likely to be affected by different amenities and past trends. In panel C we therefore include all other variables available at the municipality level from the *ottomilacensus* database. These are indices calculated from the two previous waves (1991 and 2001) of the population and housing censuses, and they broadly refer to the demographic structure (age, education, household compositions), housing conditions (housing availability, housing density, buildings age), self-reported occupational status (also distinguished by main sector of activity), commuting and social vulnerability (defined on the basis of household members characteristics and employment status). See the online Appendix B for a full list of included variables. The estimated impact on private employment is virtually unchanged. Differently, the effect on house prices is now positive, which is in line with the theoretical predictions.<sup>19</sup>

One concern could be the inclusion of too many controls. To this purpose, among the additional one from the *ottomilacensus* database, we selected only some using the LASSO algorithm and the "double selection procedure" proposed by Belloni et al (2014). The list of selected covariates is reported in the online Appendix B. Estimates are similar and in line with the conclusions obtained including the entire set of covariates. The house prices effect is slightly larger and now statistically significant at the 1 per cent level.

In Table 3, columns (1) and (2) we split private employment into different components. Although our model does not distinguish between tradable and

<sup>&</sup>lt;sup>19</sup> For the variation in private employment we also have information about variations in the previous decade (1991-2001). We tried running a pooled regression with changes in both decades, keeping all covariates available in both and adding a decade dummy. The estimated displacement effect is very similar.

non-tradable sectors, this distinction could be relevant. In particular, as in Jofre-Monseny et al (2016), we might consider a basket of non-tradables (which encompasses housing services) which is produced using also a local production factor (e.g. land). Then, the increased demand due to the expansion of the public sector would not be limited to the housing market but also to other non-tradables. In the additional Appendix available on our websites (Auricchio et al, 2016) the interested reader can find an extension of our model which considers both tradables and non-tradables.

## [Table 3]

In the empirical estimates by sector, the dependent variable is always the contribution of the variation in that specific sector to the overall employment growth (the variation between 2001 and 2011 divided by employment in 2001). The effect on local manufacture (Column 1) is negative and significant. The impact on service and construction (Column 2), is quite smaller, though still negative. This is in line with previous empirical work showing that the impact of exogenous increases in local activity percolates mostly on non-tradables (see, for instance, Moretti, 2010, and de Blasio and Menon 2011 for the case of Italy) and with results from Faggio and Overman (2014) and Jofre-Monseny et al (2016).

In column (3) of Table 3 we focus on the changes in working age population. Despite of the displacement effect, an increase in public employment seems to increase the working age population. As shown in Giordano (2010) and Depalo et al (2015), wages in the public sector are larger. Furthermore, jobs in the public sector are generally perceived as more stable. This may induce an increase in the population given that earnings are used to support unemployed family members (see also Boeri et al, 2014). Finally, an increase in public employment may increase the propensity of individuals to stay unemployed longer without leaving the area, as suggested by the aforementioned research, and by Burdett (2012) and Gomes (2015) in a search framework. Calibrating a

macro-model with two regions and a public sector, Caponi (2014) argues that higher public employment is used to prevent out-migration.

Finally, we consider the possibility that our results are driven by changes in local amenities or productivity induced by changes in public employment. For instance, an increase in public employment may enhance the available services for both private citizens and firms, thereby limiting the negative effect on the private sector. By contrast, if the increase is designed only as a redistributive measure, as suggested by Alesina et al. (2000), it may even reduce overall efficiency by raising the level of bureaucracy. The estimates presented so far capture both the effects due to the rise in the cost of local nontradebles and those referring to the potential concomitant variations in local productivity and amenities. Unfortunately, we do not have good proxies for such features at the municipality level. Nevertheless, Nifo and Vecchione (2014) propose an institutional quality index at the provincial level for each year from 2004 to 2012. Three of its elements are likely to capture possible changes in amenities and productivity: (i) Government effectiveness, which accounts for the endowment of economic and social facilities; (ii) Rule of law, which captures the level of crimes against property and justice efficiency; (iii) Corruption. Even if the variables are defined at the provincial level, we expect that their variation between 2004 and 2011 may capture significant changes in the local economic environment that have been taking place contemporaneously with our changes in public employment. If the impact on private employment and house prices is partially due to these changes, then including them together with the other controls may lead to different results. Table 4 shows that the estimates of interest are only marginally affected. Our results do not, therefore, seem to be driven by changes in local amenities or productivity induced by changes in public employment.

### [Table 4]

*3.3.2 Robustness.* As we know from the model, results strongly depend on the mobility of the population and on the attractiveness of public employment in each area. Centre-North vs South differences may play a crucial role. Table 5 provides the results obtained by splitting the sample along the Centre- North vs South dimension. We find that displacement affects both areas, although the effect is larger in the South (see also Alesina et al 1999). The effect on house prices is larger in the South and closer to zero in the other areas.

## [Table 5]

The upper panel of Table 6 illustrates the results obtained by using the Faggio and Overman (2014) instrument. The results are very similar to those depicted so far. Note also that the first-stage power of the original instrument is actually stronger. If the differences between the sectors are not so relevant, then their instrument may actually be empirically more precise as it avoids the measurement error introduced by first calculating the prediction at the sectoral level and then aggregating for the overall instrument.

### [Table 6]

The lower panel of Table 6 shifts the unit of analysis from the municipality to the LLM. We focus on the specification with all controls, though we do not include the average commuting index, as is not relevant for this analysis. Displacement is still confirmed, with a larger coefficient, but still close to 1. The effect on house prices is negative, but largely imprecise. In Panel B we include all controls. The displacement effect is now very close to the one estimated at the municipality level. The effect on house prices is now positive, but still largely imprecise. The noisy estimate may be due to the fact that we had to aggregate house prices at the LLM using population as weight, which may lead to a poor proxy of the actual variable. These results confirm qualitatively the main conclusions. Most importantly, they do not lend support to the possibility that all the effects at the municipality level are simply driven by relocations to/from nearby municipalities. We also tried a different strategy, randomly selecting only one municipality from each LLM. This should limit the possibility of localized spill-overs. We repeated the estimation 999 times and we averaged the estimated coefficients. Results are in line with the regressions at the LLM level.

We also checked whether results are different if we include collaborators and temporary workers (other than those on standard fixed-term contracts, who are already included) in the definition of public employment. Point estimates, available on request, are only slightly affected, although the estimate of the price effect becomes much less precise. Finally, we tried to exclude municipalities with more than 100 thousand inhabitants, like Rome, which has a large share of total public employment. Results are basically unaffected.

# 4. Conclusions

We proposed a spatial equilibrium model to discuss how changes in public employment affect private employment and house prices. In the absence of any effect of public employment on amenities or factors productivity, the interaction between the private and public employees is mainly due to the competition in the local market for housing. An increase in the number of public employees increases the demand for housing. Depending on their idiosyncratic preferences, private workers may leave to avoid increasing local prices, or they may decide to stay despite the drop in their real income.

Our empirical analysis of decadal changes in public employment in Italian municipalities confirms the importance of this channel. We find a marked crowding out of private employment and a positive impact on house prices. According to the theoretical predictions, the increase in house prices suggests that mobility costs (or idiosyncratic location preferences) are important even in the medium run, as captured by decadal changes. Finally, our estimates do not seem to be driven by changes in the local economic environment.

These results are particularly useful in assessing the economic consequences of employment policies in the public sector. Even if public employment may be used to redistribute resources to lag-behind regions, so to limit the outflow of local population, the beneficial effect on local economies is endangered by the negative impact on the private sector and by the increase in rents. This is even more important if we consider that private firms play a crucial role for the sustainability of growth in the longer run, in particular those in the tradable sector, for which crowding out appears to be even more consistent. At the same time, contractions in the public workforce, as in the case of the recent policies that led to a decrease in turnover seem to have induced an increase in private sector jobs.

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# **Tables and figures**

Figure 1. Density of private employment growth, public employment growth and predicted growth in public employment (instrument), 2001-2011



Note: The graphs show densities estimated with a kernel density estimator (Epachnikov kernel, Silverman's rule-of-thumb bandwidth).

Figure 2. Private and public contributions to employment growth, Italian municipalities, 2001-11



Note: each graph is obtained by splitting the distribution of the x-variable in 100 percentiles and then showing the relation between the average y and the average x in each percentile group (with fitted lines); for each percentile it also shows the interquartile range of the y variable.

# **Table 1. Descriptive statistics**

	mean	p50	sd	min	max	count
private empl contribution to empl growth	0.035	0.016	0.188	-0.286	0.457	8085
public empl contribution to empl growth	-0.026	-0.012	0.055	-0.167	0.063	8085
growth in house prices X sqm	0.284	0.211	0.280	-0.098	0.935	8085
high skilled pop var (25-64) wrt empl at t-1	0.483	0.404	0.307	0.103	1.253	8085
low skilled pop var (25-64) wrt empl at t-1	-0.460	-0.360	0.345	-1.311	-0.038	8085
population variation (15-64) wrt empl at t-1	0.018	0.027	0.371	-0.796	0.784	8085
manufacture contribution to empl growth	-0.047	-0.033	0.093	-0.249	0.126	8085
service contribution to empl growth	0.081	0.066	0.143	-0.168	0.403	8085
private employment (total 2011)	2031	461	15508	1	949956	8085
public employment (total 2011)	351	52	3050	0	203607	8085
house price X sqm (total 2011)	1086	951	604	0	11275	8085
population 15-64 (total 2011)	4787	1581	25589	20	1692869	8085
manufacture private employment (total 2011)	478	104	1659	0	70757	8085
service private employment (total 2011)	1553	310	14096	1	888204	8085
employment (total 2011)	2382	527	18377	4	1153563	8085
unemployment rate (2001)	0.101	0.059	0.088	0.000	0.513	8085
labor force participation rate (2001)	0.474	0.478	0.069	0.167	0.714	8085
fraction of empty house over total housing in						
urban areas (2001)	0.254	0.198	0.195	0.000	0.963	8085
mobility index (2001)	0.310	0.317	0.119	0.000	0.639	8085

Table 2. The impact of local public sector employment on house prices				
	(1)	(2)		
	Private employment	House price		
	Panel A: OLS, with baseline covari	ates		
Public employment	0.132***	-0.007		
	(0.048)	(0.087)		
	Panel B: 2SLS, with baseline covari	ates		
Public employment	-0.625***	0.003		
	(0.124)	(0.281)		
First stage F	401	401		
Panel C: 2S	SLS, adding all available covariates at th	e municipality level		
Public employment	-0.767***	0.518**		
	(0.132)	(0.206)		
First stage F	452	452		
Panel D: 2SLS	s selecting with "double selection" only	some of the covariates		
Public employment	-0.626***	0.605***		
	(0.134)	(0.210)		

# Table 2. The impact of local public sector employment on house prices

First stage F

Observations

Notes: \* p-val<0.01, \*\* p-val<0.05, \*\*\* p-val<0.01. The unit of observation is the municipality across 2001-2011. We kept only municipalities that exist in both years. Both public and private employment are expressed as contributions to overall (public+private) employment growth. The dependent variable for house prices is a growth rate ( $[pr_{2011} - pr_{2003}]/pr_{2003}$ ). The standard errors, in brackets, are clustered at the LLM level (2001 definition). We censored the contribution to growth and growth variables at the 5<sup>th</sup> and 95<sup>th</sup> percentiles, while the instrument is censored at the 1<sup>st</sup> and 99<sup>th</sup>. The instrument is *inst<sub>c,2011</sub>*. For the coefficients on covariates in Panel A and B, see Section 3.1 and the online Appendix B. Panel C includes also all the other available controls at the municipality level (with no missing values) released by ISTAT in the *ottomilacensus* database, both in year 2001 and 1991 (see the online Appendix B). The estimates in Panel D are obtained by 2SLS, including all covariates suggested by the theory (Panel B) plus an additional set of covariates from the *ottomilacensus* database, selected following the procedure suggested by Belloni et al (2014) and the ado program written by them. All covariates have been standardized before running the selection (see the online Appendix B for a list of selected covariates). The algorithm converges in few iterations.

426

8.085

426

8.085

# Table 3. The impact of local public sector employment on other outcomes (2SLS regressions)

A			<u> </u>
	(1)	(2)	(3)
	Manufacture private employment	Service private employment	Working age population (15-64)
Public employment	-0.554***	-0.206***	0.925***
	(0.063)	(0.104)	(0.194)
Observations	8,085	8,085	8,085

Notes: \*\*\* p-val<0.01. All the outcomes are expressed as contribution with respect to the overall (public+private) employment growth and they are censored at the 5th and 95th percentiles. Standard errors, in brackets, are clustered at the LLM level (2001 definition). High skilled population refers to those with at least a high school diploma or university degree, the low skilled to the rest. The service sector includes construction, as in Faggio and Overman (2014). The instrument is *inst<sub>c,2011</sub>*; see Table 2 for more details and for the first stage statistics. The regressions include all controls as in panel C from Table 2.

Table 4. The impact of local public sector employment on private employment and house p
rices, including also the variation in institutional quality indices between 2004 and 2011 (2SLS
regressions)

	(1)	(2)
	Private employment	House price
Public employment	-0.762***	0.436**
	(0.155)	(0.219)
Obs	8,085	8,085
First stage F	461	461

Note: \* p-val<0.10, \*\*\* p-val<0.01. Standard errors, in brackets, are clustered at the LLM level (2001 definition). The instrument is  $inst_{c,2011}$ . The regressions include all controls as in panel C from Table 2, plus the variation at the provincial level in three institutional quality indices proposed by Nifo and Vecchione (2014): Government effectiveness, Rule of law and Corruption. We defer to their paper for a detailed discussion of the variables.

# Table 5. The impact of local public sector employment on private employment and house prices, by area (2SLS regressions)

	Centre	-North	South		
	(1) (2)		(3)	(4)	
	Private employment	House price	Private employment	House price	
Public employment	-0.430***	0.101	-1.069***	0.642***	
	(0.172)	(0.274)	(0.203)	(0.243)	
obs	5528	5528	2557	2557	
First stage F	251	251	270	270	

Note: \* p-val<0.10, \*\*\* p-val<0.01. Standard errors, in brackets, are clustered at the LLM level (2001 definition). Censoring of dependent variables and instruments is done at the national level. The instrument *inst*<sub>*c*,2011</sub>; see Table 2 for more details and for the first stage statistics. The regressions include all controls as in panel C from Table 2.

<b>P</b>		••••••••••••
	(1)	(2)
	Private employment	House price
Usi	ng Overman and Faggio's instrument	
Public employment	-0.844***	0.537***
	(0.119)	(0.204)
First stage F	626	626
Obs	8,085	8,085
	Estimates at the LLM level	
Public employment	-1.098***	1.636
	(0.454)	(1.159)
First stage F	33	33
-	686	686

# Table 6. The impact of local public sector employment on private employment and house prices, using the same instrument as in Overman and Faggio (2SLS regressions)

Note: \*\* p-val<0.05, \*\*\* p-val<0.01. Standard errors, in brackets, are clustered at the LLM level (2001 definition). We censored the growth variables at the 5<sup>th</sup> and 95<sup>th</sup> percentiles, while the instruments are. The regressions include all controls as in panel C from Table 2. In the estimates at the LLM level, the average of controls is across municipalities and it is weighted by population size. See Table 2 for other details.

# **Appendices (for online publication)**

# **Appendix A: A Spatial Model with Public Employment**

As mentioned in the main text, the model builds on Roback (1982) and exploits the notion of "mobility costs" (see, e.g., Moretti, 2011). The economy is divided into two regions,  $\{a, b\}$ , possibly characterized by different amenities. All firms use skilled and unskilled labor to produce a *tradable* good. While firms are assumed to be fully mobile across regions, workers are subject to idiosyncratic preference shocks for each location. Such shocks generate "mobility costs" across areas which, in contrast with Roback's original framework, make the local labor supply not perfectly elastic to local real wages. Residential supply in each area may depend on local rent levels, and landowners are absentee.

We now come to the central theme, local public employment. Public employees can be skilled and unskilled. Skilled public employment in regions *a* and *b* is equal, respectively, to  $(\hat{N}_a, \hat{N}_b)$ , with  $\hat{N} \equiv \hat{N}_a + \hat{N}_b$ . Similarly, unskilled public employment in regions *a* and *b* is equal, respectively, to  $(\hat{n}_a, \hat{n}_b)$ , with  $\hat{n} \equiv \hat{n}_a + \hat{n}_b$  The size and allocation of public employment across regions is exogenously determined by the public administration. We also postulate that the wages for (skilled and unskilled) public employees are equal across regions,  $(\overline{w}^s, \overline{w}^u)$  and set at the national level. We also assume that such wages are not smaller than the corresponding levels in the private sector. We now describe the fundamentals of the model, starting with individual preferences.

#### Preferences.

Utility of a *skilled* worker in area  $c = \{a, b\}$  is given by

$$U_{c}^{s} = A_{c}^{s} \cdot x_{c}^{1-\gamma} \cdot L_{c}^{\gamma} \cdot \varepsilon_{c}^{s}$$
(1)

with  $\gamma \in (0,1)$ , and is maximized under the budget constraint  $w_c^s = x_c + r_c \cdot L_c$  The term  $A_c^s$  denotes local amenities that are particularly attractive to educated individuals, while  $\{x_c, L_c\}$  denote, respectively, the consumption of the tradable good (of price equal to one, the *numeraire*), and the consumption of housing services of price equal to  $r_c$ . The preference shock for location c is denoted by  $\varepsilon_c^s$ . We also set  $\varepsilon_b^s = 1$ , and assume that  $\varepsilon_a^s$  is Uniformly distributed over the support  $[1 - \rho^s, 1 + \rho^s]$ , where  $1 > \rho^s \ge 0$ .

Utility maximization by skilled individuals delivers the following indirect utility function:

$$v_c^s = \eta \cdot A_c^s \cdot \frac{w_c^s}{r_c^{\gamma}} \cdot \mathcal{E}_c^s, \qquad c = \{a, b\}$$
(2)

where  $\eta$  is a positive constant. Notice that the marginal individual will be indifferent between the two locations. Thus, since we assumed that  $\varepsilon_b^s = 1$  and  $\varepsilon_a^s$  is Uniformly distributed over  $[1 - \rho^s, 1 + \rho^s]$ , there will be a critical level  $\hat{\varepsilon}$  such that, for  $\varepsilon_a^s < \hat{\varepsilon}$ , a skilled individual will prefer area b to area a. As a consequence,  $\frac{N_b}{N_a + N_b} = \int_{1-\rho^s}^{\hat{\varepsilon}} \frac{1}{2\rho^s} dz = \frac{\hat{\varepsilon} - (1 - \rho^s)}{2\rho^s}$ , which yields  $\hat{\varepsilon} = 1 + \rho^s \cdot \left(\frac{N_b - N_a}{N_a + N_b}\right)$ . By taking logs of (2) and approximating by  $\log \hat{\varepsilon} \approx \rho^s \cdot \left(\frac{N_b - N_a}{N_a + N_b}\right)$ , when an individual is indifferent between locations it holds that:

when an individual is indifferent between locations it holds that:

$$\rho^{s} \cdot \left[\frac{N_{b} - N_{a}}{N_{a} + N_{b}}\right] = \log\left(\frac{A_{b}^{s}}{A_{a}^{s}}\right) + \log\left(\frac{w_{b}^{s}}{w_{a}^{s}}\right) - \gamma \cdot \log\left(\frac{r_{b}}{r_{a}}\right), \tag{3}$$

As in Moretti (2011), equation (3) represents skilled labor supply in area *b*'s private sector relative to area *a*, an increasing function of skilled wages in area *b*, relative to skilled wages in area *a*. Similar expressions hold for *unskilled* workers, who maximize utility  $U_c^u = A_c^u \cdot x_c^{1-\gamma} \cdot L_c^{\gamma} \cdot \varepsilon_c^u$ subject to the budget constraint  $w_c^u = x_c + r_c \cdot L_c$ . Also, we assume that  $\varepsilon_b^u = 1$  and  $\varepsilon_a^u$  is Uniformly distributed over the support  $[1 - \rho^u, 1 + \rho^u]$ , where  $1 > \rho^u \ge 0$ . Recall that, when it holds that  $\rho^s = \rho^u = 0$ , workers are fully mobile across areas, and the local labor supply becomes infinitely elastic to local wages. Following the same procedure adopted above, we obtain the relative labor supply for unskilled individuals:

$$\rho^{u} \cdot \left[\frac{n_{b} - n_{a}}{n_{a} + n_{b}}\right] = \log\left(\frac{A_{b}^{u}}{A_{a}^{u}}\right) + \log\left(\frac{w_{b}^{u}}{w_{a}^{u}}\right) - \gamma \cdot \log\left(\frac{r_{b}}{r_{a}}\right), \tag{4}$$

Technology.

In each area, there are competitive firms which produce a tradable good under constant returns to scale by using skilled and unskilled labor. Local producers of the tradable good use the following technology:

$$X_{c} = Q_{c} \cdot (N_{c})^{\theta} \cdot (n_{c})^{1-\theta}$$
(5)

where  $\theta \in (0,1)$ ;  $Q_c$  is a local productivity shifter, and  $(N_c, n_c)$  are, respectively, the skilled and unskilled labor inputs. Recalling that the economy-wide price for tradables is one, the set of the first-order conditions for profit maximization in the tradable sector can be written as:

$$\theta \cdot X_c = w_c^s \cdot N_c; \quad (1 - \theta) \cdot X_c = w_c^u \cdot n_c \tag{6}$$

#### Housing.

The model is closed by the equilibrium condition for the local housing market. The local supply of housing services is equal to local demand.<sup>a</sup> Since demands for housing by skilled and unskilled individuals are, respectively, equal to  $L = \gamma \cdot \frac{w_c^s}{r_c}$  and  $L = \gamma \cdot \frac{w_c^u}{r_c}$ , the local market clearing condition for housing services can be written as:

$$\bar{\ell}_c \cdot (r_c)^{\delta} = \gamma \cdot \left[ \frac{w_c^s}{r_c} \cdot N_c + \frac{w_c^u}{r_c} \cdot n_c + \frac{\overline{w}^s}{r_c} \cdot \hat{N}_c + \frac{\overline{w}^s}{r_c} \cdot \hat{n}_c \right].$$
(7)

The left-hand side of (7) represents local housing supply, postulated as an increasing function of residential land availability, denoted by  $\bar{\ell}_c$ , and local rents, with  $\delta \ge 0$ . In other words, we assume that local housing supply increases with the level of rents whenever  $\delta$  is strictly larger than zero. On the right-hand side,  $\hat{N}_c$  and  $\hat{n}_c$  represent, respectively, the units of skilled and unskilled employees in the local public sector, while  $N_c$  and  $n_c$  denote the units of skilled and unskilled employees in the local private sector.

<sup>&</sup>lt;sup>a</sup> This is *not* necessarily the case on the local market for tradables, which are supplied in any amount at the economywide price of one. Thus, the local "trade balance" need not be zero. Such issues are very common in the open economies literature, where economic policies have different impact across sectors: see, e.g., Holden (2003), or where fiscal policies aimed at redistribution reduce country's competitiveness: see Alesina and Perotti (1997).

In what follows, the expression  $\Pi_c \equiv \overline{w}^s \cdot \hat{N}_c + \overline{w}^u \cdot \hat{n}_c$ , with  $c = \{a, b\}$ , will denote the local wage-bill for public employment. Moreover, by using expressions (6), we can rewrite (7) as

$$\bar{\ell}_c \cdot \left(r_c\right)^{1+\delta} - \gamma \cdot \Pi_c = \gamma \cdot X_c. \tag{8}$$

By taking logs of (8) and subtracting the expression relative to location a from the corresponding one for location b, we obtain:

$$\log\left(\frac{\bar{\ell}_{b}\cdot(r_{b})^{1+\delta}-\gamma\cdot\Pi_{b}}{\bar{\ell}_{a}\cdot(r_{a})^{1+\delta}-\gamma\cdot\Pi_{a}}\right) = \log\left(\frac{X_{b}}{X_{a}}\right) = \log\left(\frac{Q_{b}}{Q_{a}}\right) + \theta\cdot\log\left(\frac{N_{b}}{N_{a}}\right) + (1-\theta)\cdot\log\left(\frac{n_{b}}{n_{a}}\right).$$
(9)

Profit maximization in the tradables sector implies that:

$$\log\left(\frac{w_b^s}{w_a^s}\right) = \log\left(\frac{Q_b}{Q_a}\right) - (1-\theta) \cdot \log\left(\frac{N_b}{N_a}\right) + (1-\theta) \cdot \log\left(\frac{n_b}{n_a}\right).$$
(10)

and

$$\log\left(\frac{w_b^u}{w_a^u}\right) = \log\left(\frac{Q_b}{Q_a}\right) + \theta \cdot \log\left(\frac{N_b}{N_a}\right) - \theta \cdot \log\left(\frac{n_b}{n_a}\right).$$
(11)

Thus, equation (9) can be re-written as:

$$\log\left(\frac{\overline{\ell}_{b}\cdot(r_{b})^{1+\delta}-\gamma\cdot\Pi_{b}}{\overline{\ell}_{a}\cdot(r_{a})^{1+\delta}-\gamma\cdot\Pi_{a}}\right) = \log\left(\frac{w_{b}^{u}}{w_{a}^{u}}\right) + \log\left(\frac{n_{b}}{n_{a}}\right) = \log\left(\frac{w_{b}^{s}}{w_{a}^{s}}\right) + \log\left(\frac{N_{b}}{N_{a}}\right).$$
(12)

Expressions (3), (4), (10), (11) and (12) constitute a system of five equations which can be differentiated and evaluated around *symmetry*, that is, evaluated for the case when the two locations are initially identical (such that it holds that  $x_a = x_b = x$  for every variable in the system). In what follows, we will denote the *average* number of skilled and unskilled workers across locations respectively as  $\{N, n\}$ , so that  $2N = N_a + N_b$ , and  $2n = n_a + n_b$ . Total differentiation yields:

$$\frac{\rho^{s}}{2} \cdot \left[\frac{dN_{b} - dN_{a}}{N}\right] = \left(\frac{dA_{b}^{s} - dA_{a}^{s}}{A^{s}}\right) + \left(\frac{dw_{b}^{s} - dw_{a}^{s}}{w^{s}}\right) - \gamma \cdot \left(\frac{dr_{b} - dr_{a}}{r}\right), \tag{13}$$

$$\frac{\rho^{u}}{2} \cdot \left[\frac{dn_{b} - dn_{a}}{n}\right] = \left(\frac{dA_{b}^{u} - dA_{a}^{u}}{A^{u}}\right) + \left(\frac{dw_{b}^{u} - dw_{a}^{u}}{w^{u}}\right) - \gamma \cdot \left(\frac{dr_{b} - dr_{a}}{r}\right), \tag{14}$$

$$\left(\frac{dw_b^s - dw_a^s}{w^s}\right) = \left(\frac{dQ_b - dQ_a}{Q}\right) - (1 - \theta) \cdot \left(\frac{dN_b - dN_a}{N}\right) + (1 - \theta) \cdot \left(\frac{dn_b - dn_a}{n}\right).$$
(15)

$$\left(\frac{dw_b^u - dw_a^u}{w^u}\right) = \left(\frac{dQ_b - dQ_a}{Q}\right) + \theta \cdot \left(\frac{dN_b - dN_a}{N}\right) - \theta \cdot \left(\frac{dn_b - dn_a}{n}\right).$$
(16)

$$\left(\frac{dr_{b}-dr_{a}}{r}\right) = H \cdot \left[\left(\frac{dw_{b}^{s}-dw_{a}^{s}}{w^{s}}\right) + \left(\frac{dN_{b}-dN_{a}}{N}\right)\right] + H \cdot \left(\frac{d\Pi_{b}-d\Pi_{a}}{\Pi}\right) = H \cdot \left[\left(\frac{dw_{b}^{u}-dw_{a}^{u}}{w^{u}}\right) + \left(\frac{dn_{b}-dn_{a}}{n}\right)\right] + H \cdot \left(\frac{d\Pi_{b}-d\Pi_{a}}{\Pi}\right) \right] + H \cdot \left(\frac{d\Pi_{b}-d\Pi_{a}}{\Pi}\right)$$
(17)

where  $H = \frac{\overline{\ell} \cdot (r)^{1+\delta} - \gamma \cdot \Pi}{(1+\delta) \cdot \overline{\ell} \cdot (r)^{1+\delta}} \in (0,1)$ , and  $H' = \frac{\gamma \cdot \Pi}{(1+\delta) \cdot \overline{\ell} \cdot (r)^{1+\delta}} \in (0,1)$ .

By using the notation  $\tilde{x} \equiv \frac{dx_b - dx_a}{x}$ , such that  $\tilde{x}$  denotes the difference in percentage change between x in area b and x in area a, the system from (13) to (17) can be written as follows:

$$\frac{\rho^s}{2} \cdot \widetilde{N} = \widetilde{A}^s + \widetilde{w}^s - \gamma \cdot \widetilde{r}$$
(18)

$$\frac{\rho^{u}}{2} \cdot \widetilde{n} = \widetilde{A}^{u} + \widetilde{w}^{u} - \gamma \cdot \widetilde{r}$$
(19)

$$\widetilde{w}^{s} = \widetilde{Q} - (1 - \theta) \cdot \widetilde{N} + (1 - \theta) \cdot \widetilde{n}$$
(20)

$$\widetilde{w}^{u} = \widetilde{Q} + \theta \cdot \widetilde{N} - \theta \cdot \widetilde{n}$$

$$\widetilde{r} = H \cdot \left(\widetilde{w}^{s} + \widetilde{N}\right) + H' \cdot \widetilde{\Pi} = H \cdot \left(\widetilde{w}^{u} + \widetilde{n}\right) + H' \cdot \widetilde{\Pi} .$$
(22)

Equations (18)-(19)-(20)-(21)-(22) constitute a system of five equations in  $\{\tilde{w}^s, \tilde{w}^u, \tilde{N}, \tilde{n}, \tilde{r}\}$ . One can use (22) to substitute  $\tilde{r}$  away from (18)-(19), and combine the ensuing expressions together with (20)-(21). This procedure yields the following equilibrium solutions for private employment changes:

$$\widetilde{N} = \frac{\left[\theta + (1-\theta)\cdot\gamma\cdot H + \frac{\rho^{u}}{2}\right]\cdot\widetilde{A}^{s} + (1-\gamma\cdot H)\left(1+\frac{\rho^{u}}{2}\right)\cdot\widetilde{Q} + (1-\theta)(1-\gamma\cdot H)\widetilde{A}^{u} - \gamma\cdot H\cdot\left(1+\frac{\rho^{u}}{2}\right)\cdot\widetilde{\Pi}}{\gamma\cdot H + \frac{\rho^{u}}{2}\left[1-\theta(1-\gamma\cdot H)\right] + \frac{\rho^{s}}{2}\left[\theta + (1-\theta)\cdot\gamma\cdot H + \frac{\rho^{u}}{2}\right]}$$
(23)

and

$$\widetilde{n} = \frac{\theta(1-\gamma \cdot H) \cdot \widetilde{A}^{s} + (1-\gamma \cdot H)\left(1+\frac{\rho^{s}}{2}\right) \cdot \widetilde{Q} + \left[1-\theta(1-\gamma \cdot H) + \frac{\rho^{s}}{2}\right] \cdot \widetilde{A}^{u} - \gamma \cdot H \cdot \left(1+\frac{\rho^{s}}{2}\right) \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho^{u}}{2} \left[1-\theta(1-\gamma \cdot H)\right] + \frac{\rho^{s}}{2} \left[\theta + (1-\theta) \cdot \gamma \cdot H + \frac{\rho^{u}}{2}\right]}$$
(24)

From (23) and (24) one can immediately notice that skilled and unskilled private employment are increasing in areas which exhibit a relative advantage in terms of amenities (that is,  $\{\tilde{A}^s, \tilde{A}^u\} > 0$ ) or productivity ( $\tilde{Q} > 0$ ). By contrast, the direct impact of an increase of local public employment ( $\tilde{\Pi} > 0$ ) on private employment is negative.

The equilibrium expression for  $\tilde{r}$  can be obtained from (22) by using (23)-(24), together with (20)-(21). In order to concentrate on the impact of public employment on the local economy, we set productivity and amenity terms equal to zero, that is,  $\{\tilde{A}^s, \tilde{A}^u, \tilde{Q}\}=0$ . By doing so, we implicitly assume that local public employment has no impact on local amenities or productivity. Thus, expressions (23) and (24) reduce to:

$$\widetilde{N} = \frac{-\gamma \cdot H' \cdot \left(1 + \frac{\rho^{u}}{2}\right) \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho^{u}}{2} \left[1 - \theta(1 - \gamma \cdot H)\right] + \frac{\rho^{s}}{2} \left[\theta + (1 - \theta) \cdot \gamma \cdot H + \frac{\rho^{u}}{2}\right]} \equiv B_{1} \cdot \widetilde{\Pi}$$
(25)

and

$$\widetilde{n} = \frac{-\gamma \cdot H' \cdot \left(1 + \frac{\rho^s}{2}\right) \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho^u}{2} \left[1 - \theta(1 - \gamma \cdot H)\right] + \frac{\rho^s}{2} \left[\theta + (1 - \theta) \cdot \gamma \cdot H + \frac{\rho^u}{2}\right]} \equiv B_2 \cdot \widetilde{\Pi}$$
(26)

The relative change in local rents induced by an increase in local public employment is given by:

$$\widetilde{r} = \left\{ 1 - \frac{\left(1 + \theta \frac{\rho^{s}}{2} + (1 - \theta) \frac{\rho^{u}}{2}\right) \cdot \gamma \cdot H}{\gamma \cdot H + \frac{\rho^{u}}{2} \left[1 - \theta (1 - \gamma \cdot H)\right] + \frac{\rho^{s}}{2} \left[\theta + (1 - \theta) \cdot \gamma \cdot H + \frac{\rho^{u}}{2}\right]} \right\} \cdot H' \cdot \widetilde{\Pi} \equiv D \cdot \widetilde{\Pi}$$
(27)

While (25) and (26) show that an increase in local public employment unambiguously reduces skilled and unskilled local private employment, the impact on rents is subject to two opposing forces. On the one side, public employment raises the local demand for housing but, on the other side, it displaces private employees. However, it is quite straightforward to show that the net effect on the local housing market, as summarized by D in (27), is non-negative.

In what follows, we analyze three simple cases based on different assumptions about the size of "mobility cost" measures,  $\{\rho^s, \rho^u\}$ .

Case 1. No mobility costs:  $\rho^s = \rho^u = 0$ .

This is the standard case from Roback (1982) onwards. It is immediate to notice from (27) that, absent mobility costs, a relative increase in local public employment ( $\tilde{\Pi} > 0$ ) has *no net impact* on local rents! Thus, when workers are perfectly mobile, the demand for housing generated by public employees is exactly compensated by reductions in private employment. The expression for private employment displacement is given by:

$$\widetilde{N} = \widetilde{n} = -\frac{H'}{H} \cdot \widetilde{\Pi} = -\left(\frac{\gamma \cdot \Pi}{\overline{\ell} \cdot r^{1+\delta} - \gamma \cdot \Pi}\right) \cdot \widetilde{\Pi}$$
(28)

The size of impact, given by  $\left(\frac{\gamma \cdot \Pi}{\overline{\ell} \cdot r^{1+\delta} - \gamma \cdot \Pi}\right)$ , can be either larger or smaller than one.

Case 2. Only the unskilled bear mobility costs:  $\rho^s = 0, \rho^u > 0$ . In this case, the rent expression (27) reduces to:

$$\widetilde{r} = \left\{ 1 - \frac{\left(1 + (1 - \theta)\frac{\rho^{u}}{2}\right) \cdot \gamma \cdot H}{\gamma \cdot H + \frac{\rho^{u}}{2} \left[1 - \theta(1 - \gamma \cdot H)\right]} \right\} \cdot H' \cdot \widetilde{\Pi}$$
(29)

The quantity in braces from expression (29) is now positive: thus, an increase in local public employment will exert a positive (but moderate, since the size of  $\rho^{u}$  is bound to one) impact on local rents.

The expressions for private employment are as follows:

$$\widetilde{N} = \frac{-\gamma \cdot H' \cdot \left(1 + \frac{\rho^u}{2}\right) \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho^u}{2} \left[1 - \theta(1 - \gamma \cdot H)\right]}$$
(30)

and

$$\widetilde{n} = \frac{-\gamma \cdot H' \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho^{u}}{2} \left[ 1 - \theta (1 - \gamma \cdot H) \right]}$$
(31)

Public employment still displaces skilled and unskilled private employment, but to a lesser extent: the size of the impact is decreasing in  $\rho^{u}$  in both (30) and (31). However, since the size of displacement is relatively larger for skilled workers, who are perfectly mobile in this case, more local public employment will *worsen* the local skill mix, measured by  $\tilde{N} - \tilde{n}$ .

Case 3. The skilled and the unskilled bear the same mobility cost:  $\rho^s = \rho^u = \rho > 0$ . Now, the rent expression (27) reduces to:

$$\widetilde{r} = \left\{ 1 - \frac{\left(1 + \frac{\rho}{2}\right) \cdot \gamma \cdot H}{\gamma \cdot H + \frac{\rho}{2} \left[1 + \gamma \cdot H + \frac{\rho}{2}\right]} \right\} \cdot H' \cdot \widetilde{\Pi}$$
(32)

Again, an increase in local public employment induces a (moderate) increase in local rents. Private employment displacement is given by:

$$\widetilde{N} = \widetilde{n} = \frac{-\gamma \cdot H' \cdot \left(1 + \frac{\rho}{2}\right) \cdot \widetilde{\Pi}}{\gamma \cdot H + \frac{\rho}{2} \left[1 + \gamma \cdot H + \frac{\rho}{2}\right]}$$
(33)

Again, mobility costs reduce the impact of public employment on private employment, that is, the size of the impact is decreasing in  $\rho$ . However, since the skilled and the unskilled are assumed to have the same measure of mobility costs, the local skill mix is unaffected.

# **Appendix B: Data Appendix**

### B.1 Census data and the economic activity classification

In 1991 the ISTAT standard for economic activity classification was set to ATECO 1991, than it was changed to get to ATECO 2002. ISTAT, following Eurostat requirement, in 2007 released the new ATECO 2007 that implements a quite radical change with respect to ATECO 2002. The ISTAT release for the 1991 and 2001 Census data are classified using the ATECO 5-Digit 1991, while the 2011 Census data is distributed with the ATECO 5-Digit 2007 classification. There is no official transition matrix from the ATECO 1991 classification to the ATECO 2007. There are, however, two different transition matrices, one from ATECO 1991 to ATECO 2002 and the other from ATECO 2002 to ATECO 2007 (both available on the ISTAT web site). Since for our purpose we can work with a less detailed classification, we approximated the 3-digit level classification in both matrices. The main problem is that, even at this level, each ATECO 2007 may correspond to multiple ATECO 2002 (and similarly for ATECO 1991). To solve this issue we use an aggregative mechanism method to build an univocal relationship. We started with the second and more critical transition matrix. We first removed those multiple correspondences that, at a close inspection, resulted to be less relevant. We then aggregated the 3-digit ATECO 2002 codes so that each ATECO 2007 was mapped into only one ATECO 2002 code. We then applied the same aggregation of the 3-digit ATECO 2002 codes to the 1991-2002 matrix. In very few cases this was not sufficient to have each ATECO 1991 code to be mapped to a single ATECO 2002 (re-aggregated) code. After careful inspection, these were marginal cases that we corrected by choosing the most relevant mapping. The do-file aggregating the codes is available with the replication material. However, since that public employment is concentrated in a few specific ATECO codes, and those are only marginally affected by our aggregation method, the reclassification process has no effect on our results.

## B.2 House Prices from Osservatorio del mercato immobiliare

The time series of housing prices at local level is based on the data released by the "Osservatorio del mercato immobiliare" (OMI) from 2003 onwards. The OMI data base contains semi-annual reports from approximately 8,100 Italian municipalities, in turn divided into about 31,000 homogeneous zones (whose identification is based on socio-economic and urban characteristics). The main sources are private real estate agencies, with a specific collaboration agreements; residually also administrative data on the transactions are considered. For each area and type of

building (flats, villas and cottages) a minimum and maximum price are given. First the average is taken as the mid-point and then the price is further averaged across different buildings (with weights that do not vary across different municipalities). Finally the average price at the municipality level is calculated by weighting the different areas (center, semi center and periphery), with municipality-specific weights calculated by Cannari and Faiella (2008) trough information collected in the Bank of Italy surveys of Household Income and Wealth of Italian families (SHIW).