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Local Public Goods and the Spatial Distribution of Economic Activity

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Local Public Goods and the Spatial Distribution

of Economic Activity[*]

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Abstract

Using French data, we provide: a) causal evidence that a drop in local public goods provision decreases private sector activity, and b) evidence consistent with monopsony power of the public sector in local labor markets. We introduce a public sector with these two key characteristics in an otherwise standard spatial equilibrium model, and show that it delivers the main stylized facts established in our data, in particular, that the share of the public sector relative to the private is independent of the productivity of the city. We emphasize the tradeoffs between allowing governments to freely choose local public employment and wages (as in most of the US public sector), versus imposing rules that constrain public sector pay with some indexation to the local cost of living (as in many European countries). We show that wage indexation limits monopsony power – leading to a larger public sector – and is optimal if the indexation is sufficiently strong.

1 Introduction

In most developed countries, a large share of employment belongs to the public sector, accounting for as much as 23% of total employment in France and 21% on average in the OECD. One of the main missions of the public sector is to produce local public goods, ranging from education, security, to public health. These local public goods are naturally valued by citizens and may also increase the productivity of firms. Thus, the public sector likely shapes local economic activity.

The public sector differs from the private in a number of dimensions. On the one hand, at least part of its objective is to maximize welfare, either of the general population or of the median voter, rather than

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profits. On the other hand, its size gives public administrations a dominant position in many local labor markets. Moreover, and perhaps as consequence of these special features, the public sector is regulated under particular rules. When it comes to the labor market, many countries impose fixed wage rules on public sector workers' pay, potentially with some compensation as a function of the local cost of living. This is the case in many countries in Europe and for some specific public sector workers in the US – although pay is much more flexible for the majority of public employees in the US.[1]

Despite these special features most of the spatial economics literature has either ignored the public sector or focused instead on the (optimal) allocation of political power across jurisdictions (following the tradition of Tiebout, 1956 and Oates, 1972). Several key features of the public sector have been ignored overall: the impact of its size, which grants market power in local labor markets, the effect of its organization, which often constrains local wage setting, and the impact of its production of local public goods, which can affect firm productivity and citizen welfare. This paper attempts to fill this gap.

In the first part of the paper, we provide empirical evidence on some key characteristics of the public sector that matter for local economic activity. The first fact that we establish is that a decrease in the size of the public sector producing local public goods leads to a decline in employment in the private sector at the local level. For identification, we leverage the rule that imposed to replace only one out of every two retirements in the public sector, in the context of the Révision Générale des Politiques Publiques (RGPP) reform in 2008, the overall effect of which was to cut employment in the public sector by 6-7%. In the cross-section, we exploit variation stemming from the fact that this general rule disproportionately affected local labor markets with public workers close to retirement age. We address potential concerns with this strategy by controlling for local Bartik shocks,[2] by allowing for broad geography flexible time trends and, perhaps most importantly, by building an exposure measure that focuses on workers close to retirement but only among older workers, which controls for potentially systematic differences in the age structure across different parts of the country.

Our results show that a decrease in public employment producing local public goods leads to a decline in private sector employment which concentrates among tradable sector jobs, with an elasticity of approximately 1. The fact that the reform affected public sector workers moving into retirement, that we do not observe large population responses, and that private sector employment losses were concentrated exclusively in tradable sectors, causes us to interpret the evidence of this policy change as suggesting that the provision of public goods directly affects private sector productivity. This effect is above and beyond local demand effects which have also been documented in prior literature (Faggio and Overman, 2014; Becker et al., 2021; Faggio et al., 2019), but that are probably much less important in our context for two reasons. First, our identification strategy uses shocks on retirees, who most likely continue living and consuming in the same location after

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[1]Elliott et al. (1999) ranked countries based on how decentralized pay determination is. They identified three groups among OECD countries: very centralized systems in some European countries (France, Germany, Italy, Spain), an intermediate system in Nordic European countries (Sweden, Denmark) and a more decentralized one in Anglo-Saxon countries (USA, Australia, Ireland).

[2]As for instance in Suárez Serrato and Zidar (2016).

the shock.[3] Second, the literature has focused on global public goods for which the only effects are local demand effects, while our focus is on the production of local public goods, which affect local productivity and amenities.

Next, we provide evidence consistent with local monopsony power of the public sector in the labor market. First, we show that in most employment zones, the public sector is the largest employer. We document that, in a large majority of local labor markets, the largest unit in the public sector (typically a hospital, a university or a city council) is bigger than the largest private sector employer, up to a factor of eight. Second, we document that employment flows from the public to the private sector are larger than flows in the other direction in most local markets. This finding is consistent with survey evidence (Ipsos 2012) showing that 73% of young French adults would like to work in the public sector, and that the main drawback that they see in joining is the salary level.

Finally, we document a striking regularity across local labor markets: the ratio of the number of public to private sector workers does not seem to be related to the productivity of firms in the area. We find that this pattern holds in both France, where wages are in general weakly indexed to the local cost of living, and the US, where wages in the public sector are more flexibly set and where location premia are similar between the two sectors. Moreover, in the French case, we can distinguish between two types of public sector employees. For public sector employees in the Fonction Publique de l'État and Hospitalière (FPE + FPH), we observe how public sector wages follow strict wage indexation rules, so that there are minimal wage differences across locations with different productivity levels and costs of living. Instead for public sector workers in the Fonction Publique Territoriale (FPT), where the local administration has more discretion to effectively change local wages through internal promotions, we observe that wages are strongly correlated with local productivity. In both cases, however, the share of public sector workers is uncorrelated with local productivity. This finding suggests that, independent of the wage setting mechanism, governments find it optimal to hire similar numbers of public sector workers relative to the size of the private sector in every location.

In the second part of the paper, we build on our empirical findings and introduce a public sector in an otherwise standard spatial equilibrium model with imperfect mobility across space and sectors (public and private). The public sector features two key characteristics. First, consistent with our first fact, *i.e.* that reductions in public sector employment lead to declines in private sector employment, we assume that local public goods provision influences both firms' productivity and local amenities. In other words, the public sector affects directly local economic activity, above and beyond the (more indirect) local demand effects of public sector workers who consume local non-tradable goods, something that we also incorporate into our model with a housing sector. Second, consistent with the evidence on monopsony power, we assume that governments are large local employers that face upward sloping labor supply curves. Depending on the institutional setting, governments can exert this monopsony power when deciding how many public sector

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[3]For instance, Abbas (2020) documents that the average income drop at the time of retirement is around 3% and concentrated on high income households.

employees to hire.

We use this model to compare two institutional settings. In the first one, which we label "flexible wages", we assume that the government chooses local public sector employment and that public sector wages are flexibly determined by the equilibrium in the market. In the second one, which we label "wage indexation", we assume that wages of public sector workers follow a common rule across locations. This common rule is either a fixed common wage across all locations, or a common wage indexed to the local cost of living. "Flexible wages" capture governments that operate in institutional settings such as the FPT in France or most of the public sector in the United States. In contrast, governments with "wage indexation" capture best the forces at play for the FPE and FPH public sector workers in France and many other public sector workers in other (mainly European) countries that also operate under wage indexation mechanisms.

We show that, irrespective of the institutional setting, governments optimally choose a similar relative size of the public sector across locations, thus reproducing our third stylized fact. This choice balances two forces. On the one hand, funding the public sector with local taxes is cheaper in more productive locations, where private firms can sustain higher wages. This is a force toward larger public sectors in more productive locations. On the other hand, having public sector workers in more productive locations is more difficult because these locations are also those in which higher housing prices are sustained in equilibrium. We show that, under the assumptions of the model, these two forces are of similar size irrespective of the wage setting mechanism. In particular, the model predicts that the ratio of public to private sector employment is unrelated to local productivity, something that we observe in the data.

We then use this framework to study the role of flexible versus indexed public sector wages in shaping economic activity within and across locations. We show that public sector wages that are indexed to local productivity limit the extent to which governments can exploit their power in the labor market – resulting in larger public sectors in each and every location – and, at the same time, "move" the allocation of economic activity across space toward more productive places. Intuitively, the "penalty" that the indexed wages in the public sector impose on labor demand in the private sector is larger in less productive locations, which are, in equilibrium, smaller with wage indexation. We show that wage indexation acts as a transfer of indirect utility from private sector workers to public sector ones.

We explore the welfare implications in the final part of the paper. We consider the solution of a local planner who maximizes a weighted average of indirect utility in the two sectors. The planner would choose a larger public sector than the government under flexible wages who exploits its monopsony power and is concerned only about the median voter. Wage indexation can solve this problem. Moreover, we show that there exists a level of wage indexation such that the government makes the same choice as the planner. This indexation must be sufficiently large because, while wage indexation solves monopsony power, it fails to internalize the existing link between the labor supply in the private and public sectors, something that disproportionately affects public sector workers competing in the housing market with high-paid private sector workers in the most productive locations.

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Our empirical results and the insights of the model can shed light on policy discussions about pay determination in the public sector. There have been many reforms regarding pay determination over the last 30 years, particularly in European countries. In the 1990s, Sweden moved from a centralized system, similar to the French one, to a decentralized system in which pay is determined by local administrations. In France, Spain and Italy, there has been gradual growth of the local public sector (FPT in France, regional and local public sectors in Spain), which have more flexibility in wage setting.[4] Our results suggest that introducing more flexible wages can have detrimental effects when governments have substantial market power in local labor markets. Using wage indexation may be a useful policy tool when governments put too much weight on the median voter compared to the average voter and when agglomeration externalities of concentrating population in more productive locations are large. Our work also shows the importance of finely adapting the wage indexation in the public sector, which is a public policy issue that is often discussed but rarely addressed.[5]

Related Literature

There is a growing body of literature examining the impact of public sector employment on private sector activity at the local level. A majority of papers have examined the relocation of the central administration, or, in other words, shifts in the part of the public sector producing global public goods, in settings such as the displacement of public workers away from London (Faggio and Overman, 2014; Faggio, 2019), the move of the capital city from Berlin to Bonn (Becker et al., 2021) or the move back to Berlin (Faggio et al., 2019).[6] This literature finds positive effects of public sector employment on private employment that are concentrated in the non tradable sector, with between 0.5 jobs (Faggio and Overman, 2014; Faggio et al., 2019) and 1 job (Becker et al., 2021; Faggio, 2019) created for every public position opened.[7] This prior literature, typically has found either no effect or a negative impact on employment in the tradable sector.

The empirical work in the first part of our paper has two main features that distinguish us from this literature. First, we emphasize the importance of differentiating local from global public goods, and we show that local public goods provision seems to lead to productivity gains in the private sector. Second, we exploit a reform that targeted potential retirees and show that they tended not to leave the commuting zone after retirement. We therefore exploit a shock that is unlikely to directly impact local demand, allowing us to isolate the impact of public sector workers through the production of local public goods. Instead, the results in prior work have seemed to stem from the effect of public employment on the demand for local

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[4]Elliott et al. (1999) in Chapter 6 indicated that in Spain, although the regional and local governments are tied to a national pay grid, they can use bonuses, resulting in large regional disparities in wages. This situation resembles the features of the FPT in France.

[5]For instance in France, despite repeated calls to reform the system, the indexation is still minimal (maximum 3%) and has barely been revised since 1962.

[6]Another interesting paper with similar results is Jofre-Monseny et al. (2020), which exploits differences between provincial capital and other cities suggests with regions in Spain.

[7]One exception is Auricchio et al. (2019) who examine variations in public sector employment in Italian municipalities and show that a drop in public employment increases employment in the private sector. They cannot however distinguish between local and global public goods and furthermore, because they observe public employment at large time intervals (10 years), they cannot rule out other type of compensations from the state over this time period.

non-tradables.

In the second part of the paper we propose a spatial model in the spirit of Rosen (1974) and Roback (1982), in which we add an active public sector. The model is closely related to the model in Becker et al. (2021), although Becker et al. (2021) considered only global public goods, not local ones. Moreover, we study different institutional settings, something not considered in Becker et al. (2021) – in which wages in the public sector are set as an equilibrium outcome of a perfectly competitive labor market. Hence, our paper derives insights into how *local* public good provision affects the spatial equilibrium while, at the same time, incorporating some key characteristics of the public sector that were not considered in this previous work. Instead Becker et al. (2021) focused on how a government producing *global* public goods affects the spatial distribution of economic activity through its effects on labor and housing markets.

Another contribution of the paper is also to provide evidence that the public sector has some degree of monopsony power in the labor market, and to introduce this feature of the public sector into the model. A recent literature, see for example Schubert et al. (2021) and Azar et al. (2020), has documented how concentration of employment in the private sector leads to private sector market power, which can explain phenomena such as wage inequality or wage stagnation. We complement this literature by documenting that, very often, the largest employer in a local labor market is the public sector. Hence, regulations on public sector employment can address inefficiencies that arise from this concentration of employment.

In some sense, our model is also closely related to Boeri et al. (forthcoming). Boeri et al. (forthcoming) consider the impact of collective bargaining that fixes wages across the territory. In their one-sector model, they perform a similar exercise of comparing a flexible-wage model with a model with wage rigidity. The authors assume that the fixed wage is set at the equilibrium wage of the most productive city, and workers queue for jobs in less productive cities. They use this framework to study how fixed nominal wages distort economic activity in the private sector. They do not consider a public sector, and hence, the types of questions that they address are different from those we address in our paper.

Finally, there is a small body of literature examining empirically how fixed wages in the public sector affect the quality of service in regions where the outside wage is higher. Propper and van Reenen (2010) used the regulation of nurses' wages to show that an increase in the outside wages worsens the hospital quality and increases deaths. Britton and Propper (2016) do a similar exercise for teachers. They find that a ten per cent shock to the gap between the local average outside wage and the teacher wage, results in an average loss of approximately 2% in test scores. Relative to this work, we analyze how public sector pay affects the overall distribution of economic activity across locations, rather than focusing on specific occupations.

2 Institutional setting and data

2.1 Institutional setting

The public sector in France employs more than 5 million people (i.e approximately 23% of total employment) and is divided into 3 categories: the Fonction Publique de l'État (national public servants, denoted as FPE), accounting for approximately 50% of the workforce, the Fonction Publique Territoriale (local civil servants, abbreviated FPT), representing approximately 30% and the Fonction Publique Hospitalière (workers in hospitals), which represents approximately 20% of the workforce.

The FPE provides a mix of local and global public goods. In terms of global public goods, some of the public servants in this category are in charge of the administration of the social security system, of foreign affairs or defense. However a large share also provides local public goods, such as teachers in elementary, primary, and secondary schools, as well as social workers, policemen and firefighters. Workers in the education sector are in fact the largest group, as shown in Figure 1.[8] The FPE also includes the army, which we ignore throughout the paper because it is absent from our data and since it is a clear case of a global public good.

Figure 1: Composition of the FPE
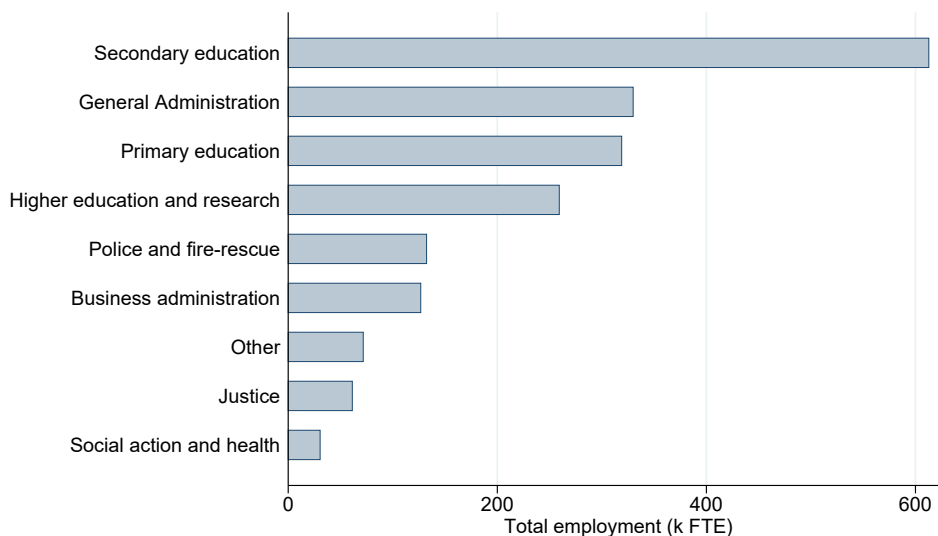
NOTES: This figure presents the number of workers (in thousands of full-time equivalent workers) within the FPE.

The FPT produces quasi-exclusively local public goods. Public servants in this category include schools' administrative and technical staff, town clerks, local police and workers in charge of social action or cultural activities. The workers can be recruited either at the level of the municipality or at higher administrative units (département or région).[9] Over time the share of the FPT in the public sector has been gradually

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[8]Figure A.1 in Appendix A presents the same population divided by type of occupation rather than by function. Figure A.2 reproduces Figure A.1 for the FPT.

[9]While some of the employees at the regional level (less than 25% of the FPT) provide what might be considered as more

growing from 26% in 1996 to more than 35% today, in an effort to decentralize public services. Finally the workers in the FPH exclusively work in hospitals.

Employees in these 3 categories of public services are employed either with a civil servant status or under a regular contract (similar to those in private firms), which can be either temporary or long term. Employees with a civil servant status represent approximately 80% of the workforce, a figure that has been decreasing over time and is slightly less prevalent in the FPT. Most workers with a civil servant status are recruited by a contest (except for positions with very low qualifications). They are divided in three categories A, B and C that correspond to different levels of pay and hierarchy.

A key feature of pay is that wages are determined centrally, according to a public pay grid, and only very mildly depend on local characteristics. There is a small bonus called "indemnité de résidence" that can range from 0 to 3%. The list of cities where workers can claim this bonus was established after the Second World War and has not been updated in depth since 1985.[10] Within a category (A, B or C) wages evolve as a function of time in the position. Wages can also change when one is promoted to a higher category, which can be achieved through participation in internal contests. The Fonction Publique Territoriale is subject to the same pay grid as the Fonction Publique d'Etat and the Fonction Publique Hospitalière, but the main difference is that promotions are determined locally, providing some flexibility in adjusting wages. The local administration can also influence the initial allocation in the pay grid at the time of the initial recruitment. We show later that, indeed, in the FPT, wages evolve with the productivity of the city in a similar way as in the private sector, something that does not occur with FPE and FPH workers.

Hiring procedures are specific to each type of public sector and to some extent for each occupation within them. For the FPE, a certain number of positions are opened per year to a contest (separate contests for teachers, policemen). The selected applicants are assigned to a particular city, based on priority criteria, and rotate throughout their career. The allocation of FPE workers to particular cities is determined by the relevant ministry, based on discussions about local needs. For the FPT, the city or the department can open a position, which will be filled either by a new entrant in the public sector or by a worker in a different office. In this case there is no requirement for a rotation, and promotions are decided at the local level.

In terms of retirement, which is an important element in our empirical analysis, civil servants are not all subject to the same rules. In general, the retirement pensions regime is different from that in the private sector. Additionally, certain professions such as policemen and firefighters can leave earlier with full rights due to the difficult work conditions. While we do not observe retirement age directly, we present in Table A.1 different percentiles of ages in different professions in the FPE from our employment data. The 95th percentile roughly presents the age of workers in a profession two years away from retirement. We see that this age varies significantly across occupations.

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global goods, it is natural to think that most of the activity is targeted towards the production of local public goods.

[10]The list of cities originally copied the list used to determine the minimum wage, when the minimum wage was still conditioned on local prices, which is no longer the case.

2.2 Data

2.2.1 Commuting zones

As is standard in studies interested in local labor markets, the spatial unit that we use throughout the paper is the commuting zone (CZ), in French *Zone d'Emploi*. These were established in 2010 by the French National Institute for Statistics and Economic Studies (Insee) based on daily commuting flows. We consider only mainland France (that is, excluding Corsica and the DOM-TOM). Moreover we omit Paris since it is an outlier in terms of public sector endowment.[11] We are left with a total of 296 commuting zones. We complement the basic information available on these CZ (population, area, etc.) with information on personal income taxpayers by municipality (IRCOM database) produced by DGFiP (French tax administration), which we aggregate to the CZ.[12]

2.2.2 Employment data

To measure private employment, we rely on information from the Déclarations Annuelles des Données Sociales (DADS Postes) over the period from 2006 to 2015. The DADS Postes are matched employer-employee data provided by Insee, built from mandatory social security contribution records reported by firms operating in France. For every year, we observe every job spell within France, which is defined at the worker-plant level. For every spell, we have some basic information on the employee's characteristics (such as age and gender), occupation, salary, and the number of hours worked. For every plant, we have information about the industry and municipality (*commune*) in which it operates. We aggregate this information at the CZ level. We also have information about the occupation held in the previous year. Finally, for every job spell we also have some limited information about the contract associated with the job, such as whether it is a part-time or full-time contract, and whether it has a fixed or unlimited duration.

To measure public sector activity, we build a novel dataset combining multiple sources. For the period 2009-2015 public sector employment was integrated into the DADS described above. For the period 2006-2008, we obtained a separate dataset, the Fichier Général de l'État (FGE) produced by Insee, which contains the information specific to public sector workers in the FPE. In contrast with the DADS Postes, this file is purely cross-sectional. Note that we exclude from the whole panel all the SIREN (legal unit identifiers) which are recorded as public companies at least once, because many of these companies are privatized over the period, and whether they produce public goods seems more questionable.

A key novelty of our paper is to distinguish local and global public goods. We construct our measure of global public goods using the activity code (5-digits NAF rev2 code),[13] in two distinct ways (given a definition of local public goods, global public goods are then defined as the complement):

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[11]Paris notably hosts all ministries' headquarters, the presidency of the republic, both chambers of the Parliament, the vast majority of state agencies, and it has a large concentration of universities.

[12]Data: https://www.data.gouv.fr/en/datasets/l-impot-sur-le-revenu-par-collectivite-territoriale/

[13]Note that in the FGE data (used for the period 2006-2008), the industry NAF code is not available. We apply a specific procedure to recover or impute the NAF code for this period, procedure described in Appendix C

- *local non-restricted*: we exclude activities related to foreign services and all activities recorded as administrative services.[14] These activities include services treating tax declarations or social security claims. Part of the services might involve local offices open to the public, but this part remains a very small proportion of the activity.

- *local restricted*: we exclude in addition justice and higher education sectors.[15] This exclusion is more contentious, thus we only use it to test the robustness of our results. Higher education can have localized spillovers and proximity to tribunals might matter. Nevertheless, these are not local public goods of the same nature as those produced by the local police force or primary school teachers, since they can also benefit citizens outside the commuting zones.

Using these definitions, 84% of the FPE produces local public goods (non-restricted) in the average CZ. This proportion decreases to 68% when we use the more restrictive definition. Table A.2 in Appendix displays summary statistics on the numbers of workers in each sector.

2.2.3 Wages

We obtain the information about wages (net of social security contributions) at the job spell level from the DADS Postes and the FGE (for the public sector from 2006 to 2008). To measure the local wage premium associated with each commuting zone in each sector (private or public), we regress individual log hourly wages on age, age squared, a gender dummy, as well as a full set of occupation, industry and contract dummies, and a commuting zone dummy.[16] We then recover these commuting zone fixed-effects, and normalize the minimum to zero. This sectoral local wage premium can be interpreted as the local percentage deviation from the minimum among all commuting zones.

2.2.4 Local productivity estimates

Financial information about private firms is contained in the FICUS and FARE balance-sheet datasets produced by the French tax administration (DGFiP) and Insee. They report accounting data at the firm level, such as gross value-added, sales, gross operating system, profits, employment and paid wages. Value-added is the excess value of the firm's production from the value of intermediate consumptions, excluding taxes and subsidies that firms must pay or might receive.

To measure productivity in each commuting zone, we aggregate gross value-added from firms in the area. To handle firms with plants in multiple commuting zones, we take the spatial distribution of their workforce from the DADS (i.e. the share of hours worked in each commuting zone), and split their total value-added

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[14]Specifically we exclude NAF codes 8411, 8412, 8413, 8421 and 8430.

[15]Specifically we also exclude NAF codes 8423 and 8542.

[16]The contract variable takes 14 distinct values, the occupation variable follows the 4 digits PCS-ESE classification and takes 429 different values (including 324 in the public sector), the industry variables follows the 5 digits NAF rev.2 classification and takes 723 values (including 124 in the public sector).

according to this share. We then divide by the number of full-time equivalent workers in the area to obtain a measure of value-added per worker. We use this measure as a proxy of local productivity.

2.2.5 Rents and housing prices

The main source that we use on rents throughout the paper originates from a large web-scraped database, which records all rental announcements posted in 2016 on the two main websites from rental adds in France. From this database, we use municipality-level fixed-effects from a standard regression of the proposed rent on the characteristics of the house.[17] We then take the mean of these fixed-effects weighted by population to obtain a measure of rents in the commuting zone.

3 Empirical evidence

In this first part of the paper, we document a number of novel facts about the role of the public sector. First, we provide in Section 3.1 causal evidence that local public goods positively affect employment in the private sector. Second, we show in Section 3.2 suggestive evidence that the public sector is likely to have monopsony power in local labor markets. Finally, we identify in Section 3.3, a number of stylized facts about the public sector, and in particular show that the ratio of public to private sector workers is constant across cities and does not depend on local productivities. Facts 1 and 2 are used as input in a spatial equilibrium model that yields Fact 3 as a prediction.

3.1 Fact 1: Local public goods positively affect local private employment

3.1.1 The RGPP reform

The Révision Générale des Politiques Publiques (RGPP) was launched in July 2007 under the presidency of Nicolas Sarkozy, with the aim of reforming in depth the Fonction Publique de l'État (it did not directly affect the FPT or FPH). The general publicized goal was to modernize the state, but one of the key purposes of the reform was a reduction in overall public employment. A target of not replacing one out of every two retirements was set by the government, and widely communicated. The reduction in the size of the FPE ended up being very large: from 2008 to 2012, the reduction was estimated at approximately 150,000 workers, representing a decrease in the order of 6-7% of the overall public sector employment. As quoted in the report by the French Sénat (de Legge, 2011), at the end of 2012, the number of workers in the FPE had returned to its pre-1990 level.[18]

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[17]These fixed-effects are extracted from a regression of the log of rents per square meter on powers of the log of surface, the floor, the date of construction of the building when available, whether it is a single unit, whether it is furnished. We warmly thank Guillaume Chapelle for giving us access to this data source.

[18]The implementation of the reform was not limited to the application of the non-replacement of one out of every two retirees. There was also a significant restructuring of services that led to closures of local administrations in certain municipalities. The idea was to regroup activities that were close in nature, so that after January 2010 public sector activity was organized into 8 services rather than the 20 that existed earlier. The list of 8 services is: directions régionales de l'alimentation, de l'agriculture et de la forêt (DRAAF), les directions régionales des affaires culturelles (DRAC), les directions régionales des entreprises,

A key feature of the reform was that it was centrally planned, without consideration for the heterogeneity of the local impacts (see the report by the French Parliament: Cornut-Gentille and Eckert, 2011).[19] The reform was never discussed before the Assemblée Nationale (French Parliament) and the government simply assigned objectives to the different ministries in order to achieve the overall goal of one out of every two retirements not being replaced.[20] There was a general sense that local needs were not considered (see de Legge, 2011). For instance M. Olivier Dussopt, vice-president of the association of small town mayors (APVF) complained that "the RGPP was imposed without discussion with either the locally elected officials or the unions, the cuts were decided without any coherence and have had an impact on the quality of the public service." Similarly, M. Vanik Berberian, president of the Association of Rural Mayors (AMRF), complaining that mayors in rural areas were not consulted, declared that "announcing in the media that one public servant retiring out of two will not be replaced without any other explanation, without concern for the role of those not replaced, without having thought about the way in which the tasks will be performed, it means throwing people into uncertainty."[21] There was an additional criticism that was often invoked: the fact that the different ministries did not coordinate their actions, potentially piling up employment cuts on the same areas.

That the reform, because of its centralized implementation, might have had very different consequences across the territory, was only acknowledged in 2011 (which explains why we later show estimates including or excluding the period from 2011 to 2015). In January 2011, the DATAR (délégué interministériel à la délégation à l'aménagement du territoire et à l'attractivité régionale) was placed in charge by the government of monitoring the local consequences of the reform. As the representative reported in de Legge (2011), "we are creating a geo-referenced database to track the towns piling up multiple closures of public services and identify the most vulnerable territories". It appears that the government gradually realized that the reform might have had very different impacts in different regions, and attempted to compensate for it without increasing public employment again.[22]

3.1.2 Identification strategy

Using the data introduced in Section 2.2, we exploit the RGPP reform to establish how a local shock in public sector employment affects the size of the private sector. We focus on workers employed in occupations

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de la concurrence, de la consommation, du travail et de l'emploi (Direccte), les directions régionales de l'environnement, de l'aménagement et du logement (DREAL), les directions régionales des finances publiques (DRFP), les directions régionales de la jeunesse, des sports et de la cohésion sociale (DRJSCS), les rectorats et l'Agence régionale de la santé (ARS). This restructuring mostly affected public servants producing global public goods, for which the exact location of work mattered less.

[19]They actually point out that this central planning without much discussion with local actors enabled the quick implementation of the reform.

[20]As reported in de Legge (2011), different goals were set for different ministries, with the justice ministry not impacted while the finance ministry went further than the 1 out of 2.

[21]Another example is the declaration by Alain Rousset president of the association of French regions (ARF) "The main problem of the RGPP is that it came from above, originating from an opaque dialogue between a few unions and one or two ministers".

[22]First, it could offer the possibility for the municipalities to buy at a preferential price the land liberated by the closure of certain services. Second, in certain occupations, like with teachers, the fall in employment could be partially compensated by overtime hours. Third the region or the state could support financially private activity in towns affected by the fall in public sector employment.

producing local public goods, following a methodology outlined in Section 2.2. We use the nonrestricted definition for our baseline results, and the restricted one as robustness. We aim to establish how a decrease in the number of workers producing local public goods affects local employment and city size.

We exploit two sources of variation. On the one hand, we exploit the variation over time generated by the RGPP reform. The reform was implemented in 2008, as confirmed in the aggregate data, in which we observe an overall drop in public sector employment starting in 2009. On the other hand, we exploit the fact that, based on the institutional details described in Section 3.1.1, the reform was based on the non-replacement of one out of every two retirees, with little consideration for the differential impact this rule would have on different locations. Thus we can measure the local exposure to the reform by examining the proportion of public sector employees close to retirement.

A key measurement issue is that the retirement age varies across professions as described in Section 2.2. Rather than trying to recover all of the specific retirement regimes, which involves conditioning on many variables that we do not observe, we estimate retirement ages in each occupation nationally using the data for 2008. More concretely, we determine in each occupation the 95th percentile of the age distribution (at the national level) and calculate the proportion of public workers in the commuting zone in that profession above this nationwide 95th percentile. Aggregating over professions, yields what we call retirement exposure R_i in commuting zone i, more formally defined as:

$$R_i = \sum_{j \in J} p_{ij}^{95}$$

where J refers to the set of professions in the public sector and p_{ij}^{95} the proportion of public workers of profession j in commuting zone i above the 95th percentile of the age distribution in that profession at the national level. We chose the 95th percentile since, if the age distribution is relatively uniform and the career of individuals is roughly 40 years, those above the 95% represent those 2 years away from retirement. Table A.1 provides different percentiles of the age distribution for the main professions in the public sector. We later provide robustness exercises using different thresholds.

It is natural to think that R_i will capture the local exposure to the reform given the rule of non-replacement of one out of every two retirees. However, R_i can also be correlated with unobserved characteristics of commuting zone i since having a large share of elderly workers in the locality could reflect the attractiveness of the place (at least to the elderly). To address this potential concern we construct a second measure determining those close to retirement among the older part of the workers in the public sector. Specifically, we propose what we call the adjusted retirement exposure $\tilde{R}_i$, where for each profession we calculate the proportion of workers in the FPE above the 95th percentile of the age distribution among those
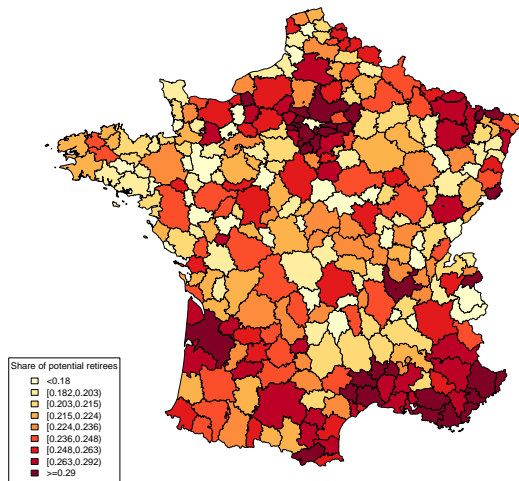
above the 85th percentile. This can be summarized in the following equation.

$$\tilde{R}_i = \sum_{j \in J} \frac{p_{ij}^{95}}{p_{ij}^{85}}$$

Figure 2 shows the map of the adjusted local exposure to the RGPP change. The map shows that this measure generates large local variations, with some concentration along the Mediterranean coast.[23]

Figure 2: Map of the adjusted retirement exposure $\tilde{R}_i$ by commuting zone

NOTES: This map represents the spatial distribution of the adjusted retirement exposure $\tilde{R}_i$ using the 95th age percentile relative to the 85th by commuting zone. Light yellow areas indicate low shares, while darker red areas indicate high shares.

With these local exposure measures we then run the following event-type, continuous difference-in-difference specification:

$$Y_{it} = \sum_{k=2006}^{2015} \alpha_k \mathbf{1}_{t=k} \tilde{R}_i + \beta X_{it} + \delta_i + \gamma_t + \varepsilon_{it}, \tag{3.1}$$

where δ_i and γ_t are commuting zone and year fixed effects and X_{it} are a set of controls, including Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles.[24] Table A.2 in the

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[23]We show in the Appendix Figure A.3, the same map for the non-adjusted measure.

[24]Bartik shocks are calculated using NAF 5-digits industry codes, calculating shares of private employment by commuting zone with the DADS. As has become common practice and is formally advised by Goldsmith-Pinkham et al. (2020), we use leave-one-out growth rates, meaning that the national trend in each industry for each commuting zone excludes its own contribution to that trend.

Appendix provides summary statistics from 2008 of the main variables of interest in our baseline regression sample.

3.1.3 Local effects of the reform

Using the identification strategy described in the previous subsection we can turn to the empirical results. Figure 3 shows the estimates of the interaction between the year fixed effects and the exposure to the policy (α_k in equation (3.1)). Panel (a) shows that public sector employment in occupations related to the provision of local public goods decreased significantly starting in 2009 in commuting zones with a larger share of workers close to retirement relative to older workers not as close to retirement (i.e. our adjusted measure $\tilde{R}_i$). The effect is large and persistent. A 1% higher number of potential retirees leads to a bit more than 0.5% decline in public sector employment. Panel (b) of Figure 3 shows the same as in panel (a) but using private employment as the dependent variable. The graph shows that commuting zones more exposed to the drop in employment providing local public goods experience a significant decline in private sector employment.

Figure 3: The effect of adjusted retirement exposure on local public goods employment and private employment
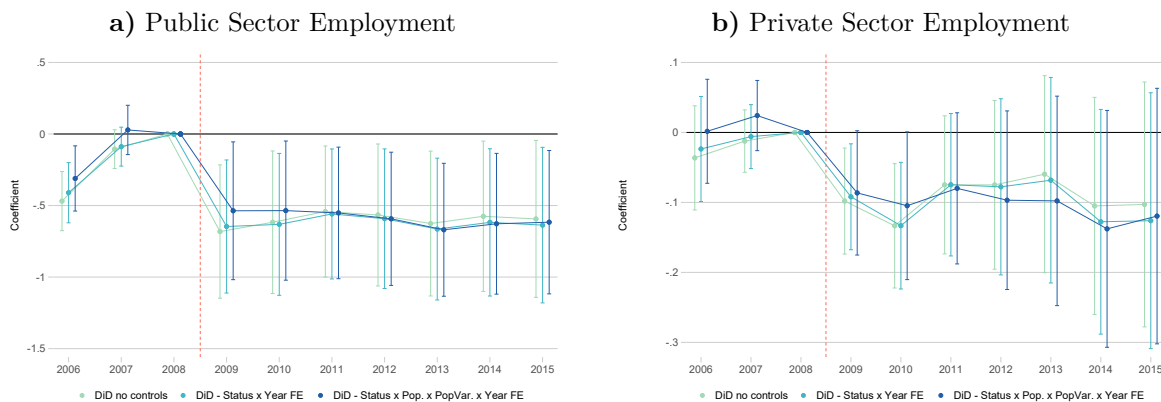
NOTES: These figures represent coefficients associated to our adjusted retirement exposure $\tilde{R}_i \times$ year calculated on local public good producers, on the log of FPE local public employment (panel a, first-stage regression) and the log of private employment (panel b, second stage regression).
SOURCES: DADS Postes, FGE.

Table 1 quantifies the effects controlling for broad geography flexible time trends.[25] In line with Figure 3, commuting zones with large proportions of public sector workers close to retirement age lost more public employment. This is true in the short-run, i.e. up to 2010, and in the longer-run, which includes the period from 2011 to 2015.

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[25]Specifically we control for Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles.

Table 1 also shows that exposure to the reform also leads to a decline in private sector employment, both in the short and in longer runs. This drop in private sector employment is smaller (in proportional terms) than that in the public sector, and is entirely concentrated among tradable sectors. The table reports no significant differences in population, wages, and non-tradable sector employment. This finding suggests that retirees stay in the CZ after retirement and continue consuming there, consistent with evidence on mobility.[26]

Table 1: The effect of adjusted retirement exposure

	(ln) Public Empl.		(ln) Private Empl.		(ln) Population	
$Post \times \tilde{R}_i$	-0.472**	-0.508**	-0.105**	-0.115*	-0.001	0.009
	(0.231)	(0.228)	(0.048)	(0.065)	(0.017)	(0.032)
N obs	1480	2960	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

	Private Wages		(ln) Non-Trad. Empl.		(ln) Tradable Empl.	
$Post \times \tilde{R}_i$	-0.001	0.005	-0.164	-0.114	-0.585***	-0.681***
	(0.012)	(0.013)	(0.129)	(0.140)	(0.205)	(0.237)
N obs	1475	2950	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

NOTES: This table presents coefficients associated to our adjusted retirement exposure $\tilde{R}_i$ calculated on local public good producers × a dummy indicating that year is greater than 2008, on – top table – the log of FPE local public employment, the log of private employment, the log of population (number of fiscal households), – bottom table – private wages (local wage premium), the log of non-tradable private employment, and the log of tradable private employment. All regressions include Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles. Regressions using as dependent variable tradable on non-tradable employment also include a Bartik shock calculated specifically on that part of private employment.

We provide a number of robustness checks and additional evidence in the Appendix. First, we reproduce the exercise for local public goods using the more restrictive definition (Figure A.4 and Table A.3). The results using the more restrictive definition of local public goods are broadly similar. Second, we also use alternative exposure measures. In Table A.4 we reproduce Table 1 using R_i rather than $\tilde{R}_i$. The results are also broadly similar, suggesting that the endogenous sorting close to retirement is not an important concern. In Figure A.5, we vary the definition of $\tilde{R}_i$ by choosing different percentiles of the age distribution for the numerator and the denominator. The results are also broadly consistent, except when those close to retirement (numerator) are defined by the 97% percentile, in which case private employment increases after 2011.

Overall, we provide novel findings showing that the provision of local public goods affects private sector employment. The focus on local rather than global public goods is a key distinctive feature compared to

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[26]We also note that the retirement regime in the public sector in France is very generous, and is calculated based on the salary over the last 6 months, so that there is very little fall in income at retirement.

the existing literature. Considering the direct effects of the local provision of public goods on private sector employment is the first novel new input that we include in the model presented in Section 4.

3.2 Fact 2: Monopsony power of the public sector

3.2.1 The size of the public sector

The first piece of evidence consistent with the idea that the public sector holds market power in labor markets, comes from comparing its size with that of private sector firms. Specifically, we study how total employment in the largest unit of either the national (FPE+FPH) or local (FPT) public sector compares to the largest private employer in each CZ.[27] The largest unit in a CZ for the FPE+FPH can be, for instance, a hospital or a university and for the FPT a townhall or a regional council. Figure 4 presents the ratio respectively of the largest unit in FPE+FPH (left panel) and in the FPT (right panel) to the largest private employer, plotted against local productivity. It shows that, for the FPE+FPH this ratio is greater than 1 in most CZ and can be as large as 8. The ratio appears particularly high for medium-sized cities. For the FPT, the ratio is less than 1 in many CZ, but even in these cases, the largest unit in the FPT is far from negligible compared to the largest private employer.

The split between (FPE+FPH) on the one hand, and FPT, on the other hand, which will be essential when we examine wage and size, shows that even more local administrations of smaller size, which constitute the FPT, are large compared to the largest private firm. In the Appendix, we perform the same exercise, but separately for large occupational categories (managers, intermediate professions, employees and workers). The evidence, presented in Figure A.6, shows that the pattern still holds when we perform the exercise separately for different occupational categories. Overall this is an indication that the public sector potentially has market power in the labor market.

3.2.2 Worker flows from the private to the public sector

The second piece of evidence is based on movements of workers between the public and the private sectors. Using the pseudo-panel feature of our data, we construct all transitions of workers across sectors over the period 2010–2015.[28] We then compute the ratio of worker flows, that is the sum of movements from the private to the public sector divided by the sum of movements from the public to the private. To avoid capturing reasons for movements other than the respective attractiveness of these sectors, such as changing jobs to follow a spouse, we restrict ourselves to movements occurring within the same CZ.

Figure 5 plots the ratio of movements plotted against local productivity. It shows that this ratio is greater than 1 in most CZs, indicating that more workers move from the private to the public sector than the reverse. This finding is particularly true for the FPT. We note that, because in the FPE and FPH, there

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[27]We define the largest private employer at the firm (Siren) level.
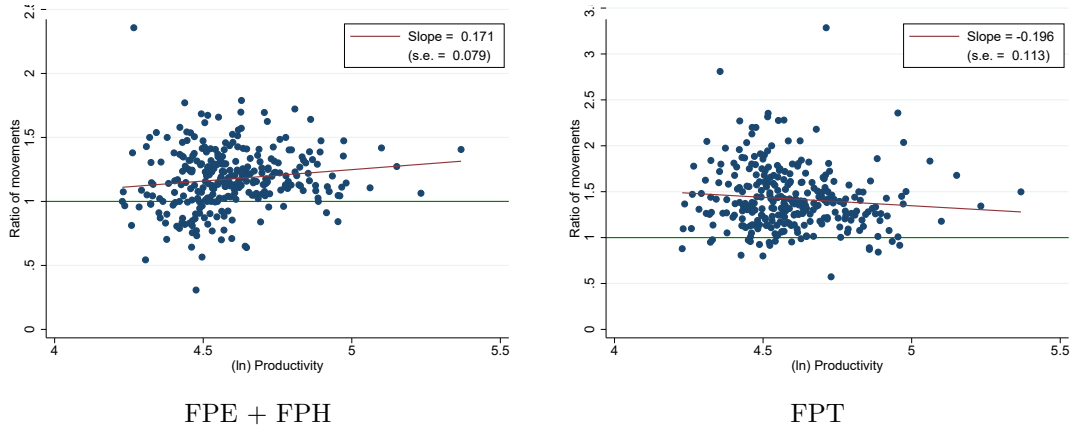
[28]Specifically, we consider as moving workers all workers who held their main (highest paying) job in year N-1 in one sector and hold their main job in year N in another sector.

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Figure 4: Size of the public sector relative to the largest private sector employer
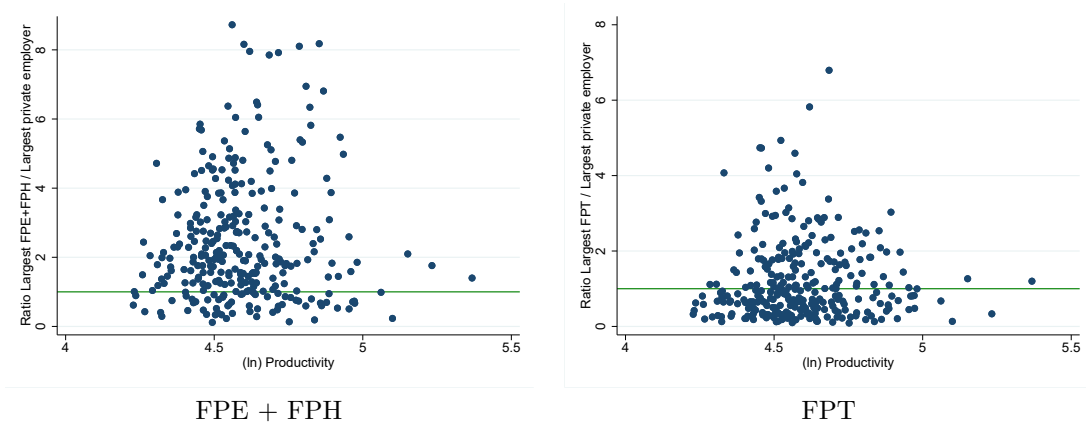
FPE + FPH   FPT

NOTES: This figure plots the ratio of number of workers in the largest public sector employer over the number of workers in the largest private sector employer (measured at the firm level) as a function of local productivity. Each dot represents a different commuting zone. The public sector is split between workers in the Fonction Publique de l'État (FPE) and Fonction Publique Hospitalière (FPH) in the left panel, and Fonction Publique Territoriale (FPT) in the right panel

Figure 5: Ratio of movements from the private to the public sector

FPE + FPH   FPT

NOTES: This figure plots the ratio of number of moves from the private to the public sector over the number of moves from the public to the private sector as a function of local productivity. We use all transitions of workers over the period 2010–2015 in the DADS Postes. We consider as moving workers all workers who held their main (highest paying) job in year N-1 in one sector and hold their main job in year N in another sector. Each dot represents a different commuting zone. The public sector is split between workers in the Fonction Publique de l'État (FPE) and Fonction Publique Hospitalière (FPH) in the left panel, and Fonction Publique Territoriale (FPT) in the right panel

are rotation requirements that induce workers to move across CZs, some of the movements from the FPE and FPH to the private sector capture individuals who do not want to switch commuting zones. We thus consider the evidence for the FPT more robust. The right panel for the FPT also shows a mild but negative slope as a function of productivity, suggesting that the attractiveness of the public sector grows when the

private sector pays lower wages.[29]

Overall, that the public sector appears attractive relative to the private sector provides additional evidence for the market power of the public sector in the labor market. These patterns of mobility are in fact consistent with survey evidence collected by Ipsos in partnership with the newspaper *Le Monde*.[30] This survey reports than, in a sample of young respondents (between the ages of 15 and 30), 73% expressed the desire to work in the public sector, particularly in the FPT. Moreover the largest drawback that young individuals see in joining (34% of them) is the salary level.

Overall, there is ample evidence based on size and labor movements, supporting the idea that the public sector has market power in local labor markets. We provide further evidence in the Appendix consistent with monopsony power, based on switches from private to public sector mayors and how they expand public sector employment once elected.

3.3   Fact 3: Public relative to private sector, size and wages

In this last subsection, we document aggregate facts about wages and the relative sizes of the public and private sectors. Figure 6 shows that France is similar to other countries in terms of the distribution of wages, employment, and rental prices across commuting zones as a function of local labor productivity. As predicted by the standard Rosen - Roback model, more productive locations can sustain higher wages, attracting more workers who can then afford to pay higher rents. Recent literature (see Davis and Dingel, 2020) has documented different population elasticities across sectors. As a result, some sectors are concentrated in large cities, while others are more spread across locations. Prior literature, however, has not documented how much the public sector concentrates across space relative to the private sector.

Figure 6: Distribution of wages, employment, and rents as a function of local productivity

NOTES: This figure shows the relationship between population, wages, and rents and local productivity. Each dot represents a different commuting zone.

Figure 7 relates wages and employment in the public and private sectors. Given the French institutional

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[29]We reproduce Figure 5 in the Appendix without imposing the restriction that movements must be within the same CZ. The evidence, presented in Figure A.7, shows a very similar pattern and the relationship with productivity for the FPE+FPH becomes negative.

[30]See https://www.ipsos.com/fr-fr/la-fonction-publique-un-choix-de-raison.

Figure 7: Relative wages and employment in the public sector

Panel A: Wages

FPE + FPH   FPT

Panel B: Employment

FPE + FPH   FPT
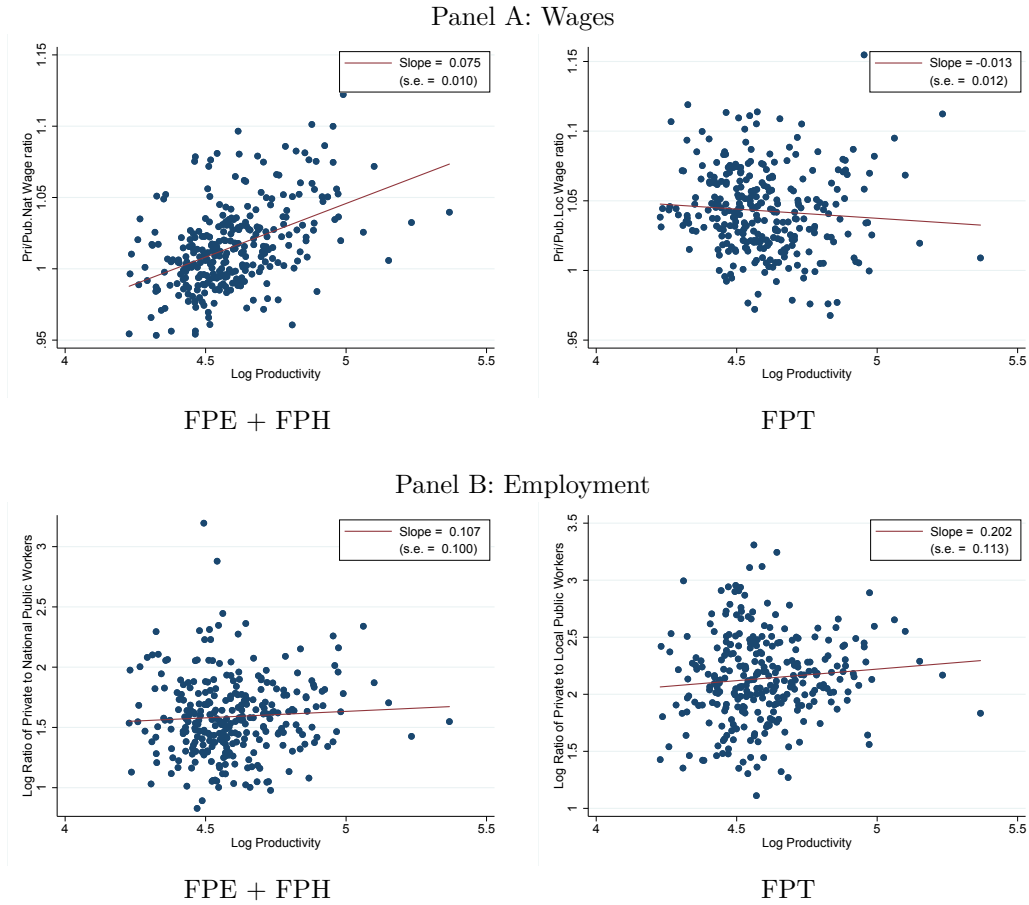
NOTES: This figure shows the relationship between the relative wages and employment in the private to public sector and local productivity. Each dot represents a different commuting zone. The public sector is split between workers in the Fonction Publique de l'État (FPE) and Fonction Publique Hospitalière (FPH), on the one hand, and onction Publique Territoriale (FPT) on the other. Given the institutional setting, wages can vary more flexibly across locations in the FPT category.

features that we describe in detail in Section 2.1, we divide the public sector into the FPE + PFH and the FPT. As explained before, local administrations do not have any ability to set wages or promote public sector workers in the FPE and FPH categories. As a result, their wages should follow the nationally set wage rule, which compensates mildly for the local cost of living. Moreover, given that the compensation for the local cost of living has not been revised much since the second World War, it should be, at best, modestly correlated with current productivity levels across locations. Conversely, local administrations have more power to set wages in the FPT, either through local promotions or through the initial allocation of workers in the pay grid.

Panel A of Figure 7 shows that the ratio of private sector wages to FPE + FPH public sector wages is strongly correlated with local productivity. The elasticity is almost the same as the overall wage to local productivity elasticity shown in Figure 6 which reflects the fact that wages in the FPE and FPH categories

barely change across locations. The graph in the right hand side of Panel A, shows that the wages paid in the public sector's FPT category are similar to private sector wages. This finding is consistent with the greater flexibility that local public administrations have in setting wages through internal promotions.

Since wages in the private sector are higher in more productive locations, while they are essentially flat for FPE and FPH public sector workers, one might expect to find more private sector workers in these more productive locations. Panel B of Figure 7 shows that this is not the case: the ratio of private to public sector workers is essentially flat. In other words, the size of the public sector relative to the private is somewhat unrelated to local productivity, and hence quite unrelated to private sector wages. This is also the case for the FPT as shown in the right panel of Figure 7.

We reproduce this exercise using US data. We show the results in Appendix B. The public sector in the US is similar to the French FPT in the flexibility that it grants for wage setting. We show that wages in the public sector are very similar to those in the private sector, reflecting the institutional setting in the US, where only a handful of public sector wages are fixed by the 'Locality Pay' scheme set by the Office of Personnel Management. However, as in France, the size of the public relative to the private sector does not vary systematically with city size (which is what we use in the US data to proxy for local productivity). Overall, the French and US data reveal an important stylized fact about the relative size of public and private sectors, a fact that is produced by the model that we present in the next section.

4 Model

In this section, we build on our empirical findings by introducing a local public sector in an otherwise standard spatial equilibrium model with imperfect mobility across locations and sectors (see the seminal contributions of Rosen, 1974 and Roback, 1982, and the review of the literature in Redding and Rossi-Hansberg, 2017). The local public sector features two key ingredients. First, consistent with the empirical finding that decreases in public sector employment lead to declines in private sector employment, we assume that local public goods provision influences both firms' productivity and local amenities. In other words, the public sector affects directly local economic activity, above and beyond the (more indirect) local demand effects of public sector workers who consume local non-tradable goods, something that we also incorporate into our model by considering a housing sector. Second, consistent with the evidence about monopsony power, we assume that governments are large local employers that face upward sloping labor supply curves. Depending on the institutional setting, governments can exert this monopsony power when deciding how many public sector employees to hire.

We assume that the hiring of local public sector workers is chosen to maximize the welfare of the local median voter, which we assume works in the private sector. This objective function could reflect the incentives of local authorities in local elections, or the incentives of MPs that represent particular regions in national parliaments. We ignore in the model features that have been the focus of past literature, such as spatial

spillovers, which matter for how to allocate power across different jurisdictions.

We use this model to compare two institutional settings. In the first one, which we label "flexible wages" and present in subsection 4.2, we assume that the government chooses local public sector employment and wages are flexibly set in equilibrium. The second institutional setting that we analyze, which we label as "wage indexation" and present in subsection 4.3, assumes that wages of public sector workers follow a common rule across locations. This common rule is either a fixed common wage across all locations, or a wage that is indexed to the local cost of living.[31]

4.1 Setup

Environment

Consider I cities indexed by $i \in \{1, 2, .., I\}$ and two sectors indexed by $j \in \{pub, pri\}$, the public and the private sectors. We denote the number of workers in sector j in city i by N_i^j and wages by w_i^j. The total amount of workers is given by L.

Public sector workers in city i produce a local public good Q_i^{pub} that can be freely consumed by all citizens of city i, but is not accessible to the citizens of other cities. The production technology is given by $Q_i^{pub} = N_i^{pub}$.[32] To keep the model simple, we do not include global public goods, since those would be available equally across cities and would not affect the results that we derive below. Also to maintain simplicity, we abstract from the potentially differential productivity of the public sector across locations – something that is notoriously difficult to measure. If such productivity differences exist, one should think of public sector employers in terms of efficiency units.

Public goods benefit the consumers, who enjoy local public amenities, as described below, but they also affect the productivity of firms. Indeed, the quantity of private goods produced in city i is given by $Q_i^{pri} = \tilde{A}_i F(N_i^{pri}, K_i)$ where the productivity $\tilde{A}_i$ can vary by city, where K_i denotes capital, which we assume is in perfectly elastic supply, and where $F(.,.)$ denotes the production function (net of Hicks neutral technology terms), which we assume is common across cities. We assume that $\tilde{A}_i = A_i(Q_i^{pub})^{\beta_1}$: local productivity has an exogenous component A_i and a component that depends on the amount of local public goods Q_i^{pub} available in city i. The parameter β_1 captures the extent to which public goods in a city affect productivity.

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[31]"Flexible wages" capture governments that operate in institutional settings such as the FPT in France or most of the public sector in the United States. In contrast, governments with "wage indexation" reflect best the forces at play with the FPE and FPH public sector workers in France and many other public sector workers in other (mainly European) countries that also operate under wage indexation mechanisms.

[32]This statement is without loss of generality, since, as we will see, the model easily accommodates log-linear relationships. Hence, one could think that the production function of local public goods also incorporates direct investments, and inputs other than labor, which are supplied to the public sector. We abstract from potentially dominant positions of the public sector on other inputs.

Preferences

Households value the consumption of the private good (which is freely traded and we take as the numeraire), the public good, and housing (or more broadly a local non-tradable good), the price of which we also refer to as the cost of living in each location. Thus, a worker k in sector j in location i maximizes:

$$U_i^j(Q^{pri}, Q^H, Q^{pub}, k) = (Q^{pri})^{1-\alpha}(Q^H)^{\alpha}(Q^{pub})^{\beta_2}e^{\varepsilon_i^j(k)},$$

subject to the budget constraint:

$$(1 - \tau_i)w_i = Q^{pri} + p_i Q^H,$$

where τ_i denotes taxes. We assume that workers' utility is Cobb-Douglas, and hence, they optimally decide to spend a fraction α of their after tax income on housing and a fraction $1 - \alpha$ on the private sector good. We denote by p_i the price of housing in city i. β_2 governs how much public goods affect local amenities, which are valued by consumers.

$\varepsilon_i^j(k)$ is an idiosyncratic taste shock that varies across both cities i and sectors j, and is drawn from a nested logit distribution with shape parameters in each nest governed by ϵ_B and ϵ_W respectively, as we make explicit below. From workers' direct utility maximization we obtain the following indirect utility function:

$$v_i^j + \varepsilon_i^j(k) = \ln V_i^j + \varepsilon_i^j(k) = \ln(1 - \tau_i) + \ln w_i^j - \alpha \ln p_i + \beta_2 \ln Q_i^{pub} + \varepsilon_i^j(k). \tag{4.1}$$

Workers decide where to live and where to work based on the maximum indirect utility that they obtain in each location and sector given their individual idiosyncratic taste shock. The solution to this discrete choice problem determines the probability that a sector and location are chosen by each worker. By the law of large numbers, it also defines the following aggregate labor supply schedule:

$$N_i^j = \left(\frac{V_i}{V}\right)^{1/\epsilon_B}\left(\frac{V_i^j}{V_i}\right)^{1/\epsilon_W} L, \tag{4.2}$$

where $V_i = (\sum_j (V_i^j)^{\frac{1}{\epsilon_w}})^{\epsilon_w}$ and $V = (\sum_i (V_i)^{\frac{1}{\epsilon_B}})^{\epsilon_B}$. For later derivations, it is useful to note that this implies that the relative labor supply to the public sector within a location is given by:

$$\ln N_i^{pub} = \ln N_i^{pri} + \frac{1}{\epsilon_W}\left[\ln w_i^{pub} - \ln w_i^{pri}\right]. \tag{4.3}$$

Private sector labor market

The private sector is competitive and the supply of capital is perfectly elastic. As a result, private sector workers are paid their marginal product of labor, so that wages are given by:

$$\ln w_i^{pri} = \ln \tilde{A}_i, \tag{4.4}$$

where, as defined above, $\tilde{A}_i = A_i(Q_i^{pub})^{\beta_1}$ is the local productivity which depends on local public goods production.

Public sector labor market

We assume that governments choose the size of the local public sector to maximize the indirect utility of the median voter, (potentially) internalizing the (relative) labor supply to this sector. Hence, governments exploit, whenever possible, their market power in the labor market.

We further assume that the median voter is a private sector worker. The model can be extended by assuming that the public sector's objective is to maximize the indirect utility of a weighted average between the indirect utility of private and public sector workers, and results are in general very similar.[33] Furthermore, we assume that local public good provision is funded through local (income) taxes.

In each location, the public sector faces a simple trade-off. Providing public goods is beneficial for both local productivity of private sector firms and for local amenities. However, to provide public goods, governments must raise taxes, which in turn decreases the income of private (and public) sector workers.

More explicitly, governments' maximization is given by:

$$\max_{N_i^{pub}} \ln(1 - \tau_i) + \ln w_i^{pri} - \alpha \ln p_i + \beta_2 \ln Q_i^{pub} \quad \text{subject to} \quad (4.3).$$

Note that governments take into account only the common component of indirect utility in each location, i.e., it ignores the idiosyncratic taste shocks.

Taxation

To fund the provision of local public goods, governments must raise revenues through taxation. We assume that local public goods are funded locally, meaning that the government budget constraint is given by the following equation:

$$\tau_i(w_i^{pub} N_i^{pub} + w_i^{pri} N_i^{pri}) = w_i^{pub} N_i^{pub}. \tag{4.5}$$

Housing market

Housing supply, denoted by H, is assumed inelastic and identical across cities. Aggregate housing demand, which is obtained from utility maximization, is equalized to aggregate housing supply in each location, as

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[33]This problem is similar to that which we analyze as long as weights are exogenous. The derivations are more complicated when the weights depend on the size of each sector.

expressed by the following equation:

$$\frac{\alpha}{p_i}(1 - \tau_i)(w_i^{pri} N_i^{pri} + w_i^{pub} N_i^{pub}) = H \tag{4.6}$$

This expression highlights that the share of income devoted to housing (α), multiplied by the after-tax total wage bill must be equal to the total housing stock.

Equilibrium

This setting allows us to define the spatial equilibrium of this economy as follows.

Definition I. *A spatial equilibrium in this economy is defined by:*

1. *Workers/consumers maximize direct utility subject to their budget constraint;*

2. *Workers decide where to supply their labor;*

3. *A representative firm in each location maximizes profits taking as given the price of labor;*

4. *Governments maximize the indirect utility of the local (private sector) median voter subject to the labor supply of workers.*

5. *Housing markets clear;*

6. *Local taxes fund local goods provision.*

In what follows we study two different situations. First, we study the "flexible wage" equilibrium, in which governments can freely set the wage of public sector workers. As a result of their local labor market power, the government acts as a local monopsonist. Second, we study the effect of a policy that imposes a common wage across locations in the public sector, potentially indexed to the local cost of living.

4.2 Flexible wages

We start by analyzing the predictions of the model where the government freely chooses how many workers to hire to maximize the utility of the local median voter, and where wages are determined flexibly in equilibrium in each location:

$$\max_{N_i^{pub}} \ln(1 - \tau_i) + \ln w_i^{pri} - \alpha \ln p_i + \beta_2 \ln Q_i^{pub} \text{ subject to (4.3)}$$

subject to the equilibrium conditions (4.4), (4.5), and (4.6).

It is useful to introduce some notation, to clarify the derivations that follow. We define the total wage bill expressed as a function of public wages, which we hereafter call the adjusted wage bill, as:

$$\widetilde{N}_i = \frac{N_i^{pub} w_i^{pub} + N_i^{pri} w_i^{pri}}{w_i^{pub}}.$$

This notation simplifies the equilibrium conditions (4.4), (4.5), and (4.6). For instance, the housing constraint writes $p_i = (1 - \tau_i) w_i^{pub} \widetilde{N}_i \frac{\alpha}{H}$ and local taxes as $(1 - \tau_i) = \frac{w_i^{pri}}{w_i^{pub}} \frac{N_i^{pri}}{\widetilde{N}_i}$. Using this notation, we can substitute housing prices, taxes, and the relative supply of labor (4.3), into the objective of the government. This objective can be reexpressed as:[34]

$$\max_{N_i^{pub}} \ (1 - \alpha + \epsilon_W) \ln N_i^{pri} + (1 - \alpha) \ln w_i^{pri} - \ln \widetilde{N}_i + (\beta_2 - \epsilon_W) \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha$$

Finally, we can use the expression for wages in the private sector $\ln w_i^{pri} = \ln \tilde{A}_i = \ln A_i + \beta_1 \ln N_i^{pub}$ to express the objective of the government as:

$$\max_{N_i^{pub}} \ ((1 - \alpha) + \epsilon_W) \ln(N_i - N_i^{pub}) + (\beta - \epsilon_W) \ln N_i^{pub} - \ln \widetilde{N}_i + \alpha \ln H - \alpha \ln \alpha + (1 - \alpha) \ln A_i$$

where $\beta = (1 - \alpha)\beta_1 + \beta_2$, depends both on the impact of public goods on productivity (β_1) and on the taste of citizens for amenities (β_2).

This expression shows the fundamental trade-off that the government faces when providing local public goods. On the one hand, if public goods provision is sufficiently valuable, i.e., if $\beta > \epsilon_W$, the presence of local public sector workers benefits private sector workers since they increase local productivity and amenities (β is a combination of β_1 and β_2). However, to do so, governments must raise resources, translating into higher taxes that reduce the income of the median voter whom they are attempting to please.

Under the simplifying assumption that the government takes as given the size of the location and the adjusted wage bill, we obtain that the solution to this maximization problem is as follows:

$$\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1 - \alpha) + \epsilon_W}{\beta - \epsilon_W} \ \text{or, alternatively,} \ N_i^{pub} = \frac{\beta - \epsilon_W}{\beta + (1 - \alpha)} N_i = \gamma N_i \tag{4.7}$$

Two properties emerge. First, the relative sizes of the private and public sectors (N_i^{pri}/N_i^{pub}) is constant across cities. In particular, this ratio is independent of the local productivity of each city, consistent with the third stylized fact that we uncovered. We denote the fraction of public sector workers in each location

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[34]The complete derivations can be found in the Appendix, and we provide here the main steps Incorporating first housing prices (condition (4.6)), the objective becomes.

$$\max_{N_i^{pub}} \ (1 - \alpha) \ln(1 - \tau_i) - \alpha \ln w_i^{pub} + \ln w_i^{pri} - \alpha \ln \widetilde{N}_i + \beta_2 \ln Q_i^{pub} + \alpha \ln H - \alpha \ln \alpha \ \text{subject to (4.3)}$$

The following step incorporates taxes (condition (4.5)). From this, we obtain:

$$\max_{N_i^{pub}} \ (1 - \alpha) \ln N_i^{pri} - \ln w_i^{pub} + (2 - \alpha) \ln w_i^{pri} - \ln \widetilde{N}_i + \beta_2 \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha \ \text{subject to} \ \text{subject to (4.3)}.$$

The final step is to integrate the constraint (4.3) to obtain an expression for $\ln w_i^{pub} = \ln w_i^{pri} + \epsilon_W [\ln N_i^{pub} - \ln N_i^{pri}]$, which we incorporate into the maximization.

by $\gamma = \frac{\beta - \epsilon_W}{\beta + (1-\alpha)}$. This fraction is increasing in β, indicating that the optimal size of the public sector is larger when amenities provided by the public sector are more valued by citizens or/and when they have a large impact on the productivity of the private sector.

Second, public sector employment is lower when the local power in the labor market (ϵ_W) is higher. Indeed, the government, concerned with the private sector electorate, exploits its market power to drive wages and employment down in the public sector.

That the size of the public sector relative to the private sector is equalized across locations results from two opposite forces. Firms in locations with higher baseline productivity (A_i) can more easily attract workers to the private sector, which is a force toward having a larger private sector in these locations. At the same time, funding of local public goods is easier in these more productive locations, hence, allowing for a larger public sector. Under the assumptions of the model, these two forces cancel each other out.

Government's market power in local labor markets: equilibrium implications

Using the optimality condition expressed in equation (4.7), we can show that the indirect utility in the private sector is linearly decreasing in the log population in city i and can be expressed as:[35]

$$v_i^{pri} = \ln V_i^{pri} = \theta^{pri}(\gamma, A_i) - \mu \ln N_i$$

with $\mu = (\alpha - \beta)$ and $\theta(\gamma, A_i) = ((1-\alpha) + \epsilon_W) \ln [1 - \gamma] + (\beta - \epsilon_W) \ln \gamma - \ln \left[\gamma + (1-\gamma)(\frac{1-\gamma}{\gamma})^{\epsilon_W}\right] + \alpha \ln H - \alpha \ln \alpha + (1-\alpha) \ln A_i$.

Indirect utility in each location depends on two factors: first, an intercept $\theta(\gamma, A_i)$ which increases with productivity and second, the indirect utility decreases in overall population, with an elasticity that is independent of the local market power.

Furthermore, we can use the fact that $V_i^{pub} = V_i^{pri} \frac{w_i^{pub}}{w_i^{pri}} = V_i^{pri}(\frac{\gamma}{1-\gamma})^{\epsilon_W}$, to obtain an expression for V_i which is the expected value of working in location i.[36]

$$\ln V_i = \theta(\gamma, A_i) - \mu \ln N_i \tag{4.8}$$

where $\theta(\gamma, A_i) = \theta^{pri}(\gamma, A_i) + \epsilon_W \ln(1 + \frac{\gamma}{1-\gamma})$. The expression for μ, naturally leads to the following result.

Proposition 1. *When the public sector wages can differ across locations, a spatial equilibrium involving an active public sector exists if and only if:*

$$\alpha > \beta > \epsilon_W \tag{4.9}$$

---

[35]Where we have used the fact that $\frac{w_i^{pub}}{w_i^{pri}} = (\frac{N_i^{pub}}{N_i^{pri}})^{\epsilon_W} = (\frac{\gamma}{1-\gamma})^{\epsilon_W}$.

[36]We have $V_i = (\sum_j (V_i^j)^{\frac{1}{\epsilon_w}})^{\epsilon_w}$ so that $\ln V_i = \epsilon_w \ln \left((V_i^{pri})^{\frac{1}{\epsilon_w}} + (V_i^{pub})^{\frac{1}{\epsilon_w}}\right)$

Proof. Given expression (4.8), $\mu > 0$, which is equivalent to $\alpha > \beta$, guarantees that the indirect utility decreases in population. Expression (4.7) implies that the condition $\beta > \epsilon_W$ is necessary for the government to hire public sector employees.

$\square$

Condition (4.9) reflects the role of the public sector. When β is too low, private sector workers are better off not paying for the production of public goods. In contrast, when β is too high, the benefits of the public sector, in terms of both amenities and productivity, are so high that population would concentrate in only one location.

Another interesting object is the average utility of each location. We define it as the population weighted average of indirect utilities in each sector, which can be expressed as:

$$\overline{v}_i = (1 - \gamma)v_i^{pri} + \gamma v_i^{pub} = -\mu \ln N_i + (1 - \alpha) \ln [1 - \gamma] + \beta \ln \gamma + cst_i \tag{4.10}$$

It is worth emphasizing that this average indirect utility captures the average of the common component of indirect utilities, which can be thought as the realized indirect utility once location choices have been made.

In this environment we can derive the following results.

Proposition 2. *With flexible wages, the equilibrium is such that:*

1. *The ratio of private to public sector workers (N_i^{pri}/N_i^{pub}) is constant across cities.*

2. *More productive cities:*

    a. *are more populated, and the slope is independent of ϵ_W: $(\ln N_i - \ln N_j) = \frac{1-\alpha}{\epsilon_B + \mu} (\ln A_i - \ln A_j)$,*

    b. *pay higher wages and are more expensive,*

    c. *the common component of indirect utility is higher, and the slope is independent of ϵ_W: $(\ln V_i - \ln V_j) = \frac{\epsilon_B(1-\alpha)}{\epsilon_B + \mu} (\ln A_i - \ln A_j)$.*

3. *Furthermore, as the local market power of the government (ϵ_W) increases:*

    a. *The public sector becomes smaller.*

    b. *Wages in the private and public sector decrease, but at a faster rate in the public sector.*

    c. *The average utility $\overline{v}_i$ in city i decreases.*

Results 1 and 2 of Proposition 2 echo the empirical facts presented in Section 3. Proposition 2.1 shows that across cities, the ratio of public to private sector workers is constant, in line with the evidence for France and the US. It also shows that, as seen in the data, more productive cities attract larger populations, pay higher wages and are more expensive, as is standard in spatial equilibrium models without a public sector.

Proposition 2.3 studies the consequences of a change in local market power of the government. As ϵ_W increases, governments concerned with private sector electors, attempt to decrease the tax burden by exploiting their monopsony power to decrease wages in the public sector. As a consequence, the private sector becomes less productive and wages also decrease in the private sector, but at a slower rate. Utility is transferred from public to private sector workers, but the second effect dominates and the average indirect utility decreases.

4.3 Wage indexation

A natural way to constrain the use of this market power is to restrict the freedom of governments to set public wages. In this section, we thus study the equilibrium when governments are constrained to set public sector wages equal to a common wage across locations, potentially with some local compensation indexed to local level conditions. More specifically, we assume in this case that wages in the public sector follow the rule given by:

$$\ln w_i^{pub} = \ln \bar{w} + \psi \ln w_i^{pri}$$

It is worth noting that this indexation covers a range of situations. First, whether the indexation is tied to local private wages or the local cost of living is equivalent in our model. Second, this indexation covers extreme cases, such as governments setting the same nominal wage in the public sector across locations ($\psi = 0$), or partial indexation to the local cost of living, as is the case in several European countries (Elliott et al., 1999).

We assume that this constraint is the only one imposed on governments. In particular, given this wage, the government decides how many public sector workers to employ locally under a balanced budget constraint.

Following similar derivations as before, the government maximization can be reexpressed in this case as:

$$\max_{N_i^{pub}} (1-\alpha)\ln(N_i - N_i^{pub}) - \ln \bar{w} + (2 - \alpha - \psi)\ln w_i^{pri} - \ln \widetilde{N}_i + \beta_2 \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha$$

where the main change relative to the flexible wage case is that the relative supply to the public sector is substituted by the wage indexation rule.

Similar steps as before, lead to the following optimality condition:[37]

$$\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1-\alpha)}{(2-\alpha-\psi)\beta_1 + \beta_2} = \frac{(1-\alpha)}{\beta + (1-\psi)\beta_1} = \frac{(1-\alpha)}{\tilde{\beta}}$$

The ratio of private to public workers is also constant under wage indexation, but is lower than when the government can freely set wages for two reasons. We explore this difference in the next section.

As in the case of flexible wages, everything can be written as a function of local population $N_i^{pub} = \gamma^I N_i$ and $N_i^{pri} = (1 - \gamma^I)N_i$ with

$$\gamma^I = \frac{\beta + (1-\psi)\beta_1}{\beta + (1-\psi)\beta_1 + (1-\alpha)} = \frac{\tilde{\beta}}{\tilde{\beta} + (1-\alpha)}$$

As a consequence, we can show that the indirect utility is linearly decreasing in the population in city i with the same slope as in the flexible wage case, but a different intercept:

$$\ln V_i^{pri} = \theta_I(\gamma^I, A_i) - \mu \ln N_i$$

with $\theta_I(\gamma, A_i) = (1-\alpha)\ln(1-\gamma) - \ln\left(1 + \gamma\frac{w_i^{pub} - w_i^{pri}}{w_i^{pri}}\right) + ((2-\alpha-\psi)\beta_1 + \beta_2)\ln\gamma + \alpha\ln H - \alpha\ln\alpha + (1-\alpha)\ln A_i$

Comparing city i and j, we obtain the following expression, in which the term in blue is the additional term compared to the case where wages can vary flexibly across locations.

$$
\begin{aligned}
\ln V_i^{pri} - \ln V_j^{pri} = {} & -\mu\left(\ln N_i - \ln N_j\right) + (1-\alpha)\left(\ln A_i - \ln A_j\right) \\
& - \left[\ln\left[1 + \gamma^I\frac{w_i^{pub} - w_i^{pri}}{w_i^{pri}}\right] - \ln\left[1 + \gamma^I\frac{w_j^{pub} - w_j^{pri}}{w_j^{pri}}\right]\right]
\end{aligned}
$$

Indexing wages in the public sector increases the gap in indirect utilities, and thus population, between the more and less productive cities, as illustrated in Figure A.10 in the Appendix. There are two main mechanisms that drive this result. First, funding public sector workers is more difficult in the less productive city since wages in the private sector are lower. To maintain the same ratio of public to private workers, the government is thus forced to raise taxes, decreasing the attractiveness of the least productive city. Second, high public sector wages raise housing prices, which is particularly true in the least productive city where

---

[37]Starting from:

$$\max_{N_i^{pub}} \ (1-\alpha)\ln(N_i^{pri}) - \ln w_i^{pub} + (2-\alpha)\ln w_i^{pri} - \ln\widetilde{N}_i + \beta_2\ln N_i^{pub} + \alpha\ln H - \alpha\ln\alpha$$

we obtain:

$$\max_{N_i^{pub}} \ (1-\alpha)\ln(N_i^{pri}) - \ln\bar{w} - \psi\ln w_i^{pri} + (2-\alpha)\ln w_i^{pri} - \ln\widetilde{N}_i + \beta_2\ln N_i^{pub} + \alpha\ln H - \alpha\ln\alpha$$

And using $\ln w_i^{pri} = \ln\tilde{A}_i = \ln A_i + \beta_1\ln N_i^{pub}$, the objective becomes

$$\max_{N_i^{pub}} \ (1-\alpha)\ln(N_i - N_i^{pub}) - \ln\bar{w} - \ln\widetilde{N}_i + ((2-\alpha-\psi)\beta_1 + \beta_2)\ln N_i^{pub} + \alpha\ln H - \alpha\ln\alpha + (2-\alpha-\psi)\ln A_i$$

housing prices are lower. The results are summarized below.

Proposition 3. *In the model with wage indexation:*

1. *The ratio of private to public sector size is constant across cities and smaller than when wages are flexible*

2. *The distribution of economic activity is more skewed towards productive locations than when wages are flexible.*

3. *Lower indexation to local conditions (i.e. lower ψ) magnifies the ratio of public to private sector size and the concentration of economic activity in the more productive locations.*

4.4   Local planner

The results in the previous sections show that, irrespective of the way in which wages are determined in the public sector, the ratio of private to public sector workers does not depend on the city's productivity, consistent with our empirical findings (Fact 3). However, the value of this ratio will be very different between the two cases. Under flexible wages we have

$$
\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1-\alpha) + \epsilon_W}{\beta - \epsilon_W},
$$

while under wage indexation,

$$
\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1-\alpha)}{\beta + (1-\psi)\beta_1}.
$$

The first reason for this difference is that with wage indexation governments are no longer in a position to exercise their local monopsony power, and hence, the size of the public sector is chosen as if ϵ_W were equal to zero in the unconstrained case. Even after accounting for this first effect, the number of public sector workers remains higher in the wage indexation case: there remains an additional term $(1-\psi)\beta_1$ in the denominator. The reason is the following. Consider the extreme case with no indexation ($\psi = 0$). When the government considers increasing the number of public workers N_i^{pub} locally, it takes into account the positive effect this will have on the productivity of firms and thus on wages of private sector workers (effect proportional to β_1). This consideration, however, has a negative impact on the utility of public sector workers, due to increased taxes and house prices, which are not compensated for by an increase in wages. The government does not internalize this effect, since it only considers the utility of private sector workers. Under wage flexibility, the government is forced to internalize this since it is bound by the labor supply equation ($\ln w_i^{pub} = \ln w_i^{pri} + \epsilon_W \left[\ln N_i^{pri} - \ln N_i^{pub} \right]$). The government thus takes into account that the increase in firm productivity will have a downside for private sector workers since it also raises public wages and thus

house prices and taxes. Under wage indexation, the extent to which the government internalizes this effect on public sector workers depends on the level of wage indexation, since it is bound by $\ln w_i^{pub} = \ln \bar{w} + \psi \ln w_i^{pri}$.

In this section, based on the analysis of these two forces, we compare the flexible wage and wage indexation institutional settings in terms of welfare. Specifically we consider a local planner who chooses the size of the public sector which maximizes a weighted average of the indirect utility of private and public sector workers and which internalizes that the labor supply to the public sector is upward sloping.

Hence, we assume that the planner maximizes:

$$\bar{v}_i^{LP} = \xi v_i^{pri} + (1 - \xi) v_i^{pub}$$

For simplicity, we assume that the weights ξ are fixed, potentially equal to the share of each group in the population.

The solution to this maximization problem is similar to what we derived earlier. In particular, we can rewrite:[38]

$$\bar{v}_i^{LP} = \max_{N_i^{pub}} \ ((1 - \alpha) + \xi \epsilon_W) \ln(N_i - N_i^{pub}) + (\beta - \xi \epsilon_W) \ln N_i^{pub} - \ln \widetilde{N}_i + \alpha \ln H - \alpha \ln \alpha + (1 - \alpha) \ln A_i.$$

Thus, the first order condition yields:

$$\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1 - \alpha) + \xi \epsilon_W}{\beta - \xi \epsilon_W} \tag{4.11}$$

It is clear that the size of the public sector is larger than under wage flexibility. For the planner, who puts weight on public sector workers, the role of monopsony power is dampened. However, we see that it does not fully disappear unless governments only care about public sector workers. Using wage indexation entirely removes the incentives for the government to exploit its market power in local labor markets. However, whether it brings it closer to the local planner solution depends on the value of ψ. We see that wage indexation can replicate the local planner allocation if

---

[38]We can rewrite:

$$\bar{v}_i^{LP} = \ln V_i^{pri} + (1 - \xi)(\ln V_i^{pub} - \ln V_i^{pri}) = \ln V_i^{pri} + (1 - \xi)(\ln w_i^{pub} - \ln w_i^{pri})$$

Then, we can use the expression for V_i^{pri} obtained in the proof of Proposition 2 so that:

$$\bar{v}_i^{LP} = (1 - \alpha) \ln N_i^{pri} - \xi \ln w_i^{pub} + (1 - \alpha + \xi) \ln w_i^{pri} - \ln \widetilde{N}_i + \beta_2 \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha.$$

We then integrate the constraint (4.3) to obtain an expression for $\ln w_i^{pub} = \ln w_i^{pri} + \epsilon_W[\ln N_i^{pub} - \ln N_i^{pri}]$, which we incorporate into the maximization.

$$\max_{N_i^{pub}} \ (1 - \alpha + \xi \epsilon_W) \ln N_i^{pri} + (1 - \alpha) \ln w_i^{pri} - \ln \widetilde{N}_i + (\beta_2 - \xi \epsilon_W) \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha.$$

Finally, we can use the expression for wages in the private sector $\ln w_i^{pri} = \ln \tilde{A}_i = \ln A_i + \beta_1 \ln N_i^{pub}$ to express the objective of the government.

$$\psi = 1 + \xi \epsilon_W \frac{1 - \alpha + \beta}{\beta_1 (1 - \alpha + \xi \epsilon_W)}$$

This expression shows that for wage indexation to replicate the local planner solution, indexation must over-compensate public sector wages, as long as governments have some monopsony power at the local level (i.e., $\epsilon_W > 0$) and as long as the local planner cares about private sector workers (i.e., $\xi > 0$). This finding reflects the planner's needs to correct for the second effect identified above and force the government to internalize the effect of an increase in private wages on the utility of public sector workers.

Overall, we find that the planner's objective can be achieved, but with stronger indexation on local prices than what is typically put in place, such as in France, where there is only a 3% difference between the highest and lowest wages in the public sector and where the list of cities receiving the high compensation has barely been revised since World War II.

5 Conclusion

In this paper, we provide empirical evidence on the role and characteristics of the public sector and propose a spatial equilibrium model incorporating the empirical findings. Using comprehensive administrative data from France and leveraging a large reform of the public sector for identification, we first show three empirical facts: (1) a decrease in the size of the public sector producing local public goods negatively affects the size of the private sector (2) the public sector has market power in local labor markets (3) the size of the public sector relative to the private sector does not vary with the size or productivity of the city.

Introducing in a standard spatial equilibrium model an active public sector that satisfies Facts 1 and 2, i.e affects the private sector and has market power, we make a number of predictions and are able to compare different institutional regimes that govern wage setting in the public sector. We show that Fact 3 naturally follows from the assumptions of the model. We also show that using wage indexation, a system adopted in many European countries, rather than letting the public sector freely adjust wages, has the benefit of preventing governments from exploiting their monopsony power, but at the cost of moving activity across space in favor of more productive places.

Our work shows that understanding the distribution of economic activity across space, a key concern for academics and policy makers alike, cannot be comprehensively done without considering the role of the public sector and the features of its organization. We have, in particular, focused on the role of wage setting regimes. Our results can inform policy debates over pay determination in the public sector. Finally, our results emphasize that any work of this nature should distinguish the part of the public sector producing local public goods from that producing global public goods, which has been the focus of most of the literature up until now.

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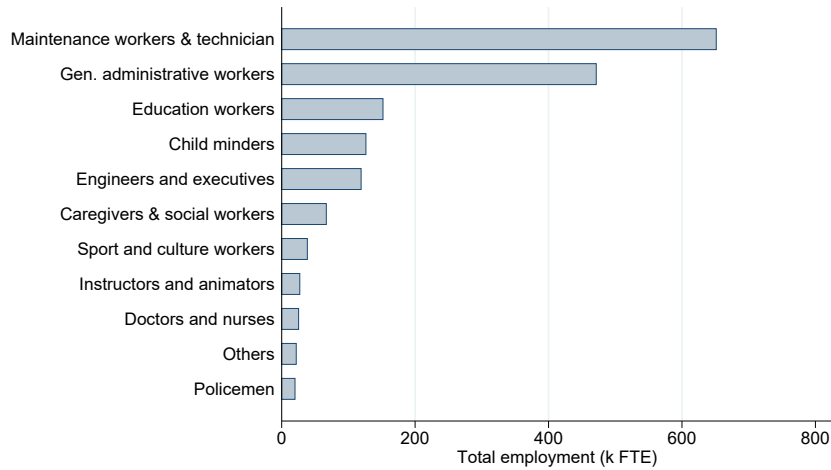
A   Appendix: additional evidence

A.1   Descriptive statistics

Figure A.1: Age composition of the national public sector
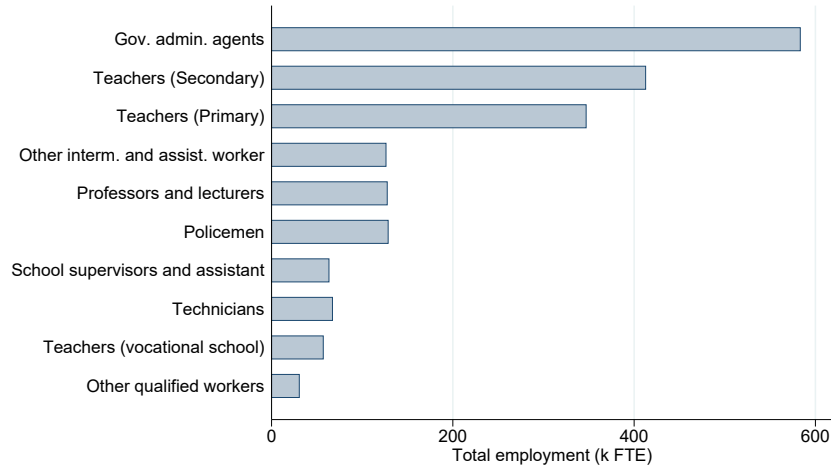
NOTES: This figure presents the number of workers (in 1000s) within the FPE, organized by occupation.

Figure A.2: Composition of the local public sector

NOTES: This figure presents the number of workers (in 1000s) within the FPT, organized by occupation.

Table A.1: Composition of the national public sector

Occupation	Mean	p75	p85	p95	p99
School supervisors and assistants	32.16	37	42	51	58
Policemen	36.08	43	47	52	54
Teachers (Primary)	39.77	48	51	55	59
Other interm. and assist. workers	44.17	52	55	59	62
Technicians	44.59	53	56	59	62
Teachers (vocational school)	44.57	53	56	59	61
Teachers (Secondary)	42.11	52	56	59	62
Gov. admin. agents	45.56	54	57	60	63
Other qualified workers	44.47	54	58	62	65
Professors in higher education	42.26	52	58	62	65

NOTES: This table presents statistics on the distribution of ages in the FPE in 2008 in our data.

Table A.2: Summary statistics

	Mean	Median	1st decile	9th decile
Private empl.	43.89	20.17	7.046	104.4
FPE public empl. (all)	5.344	2.297	0.708	13.33
FPE public empl. (local unrestricted)	4.440	1.934	0.633	10.90
FPE public empl. (local restricted)	3.638	1.829	0.618	8.517
FPH public empl.	3.208	1.842	0.556	7.556
FPT public empl.	4.768	2.365	0.682	11.79
Ratio FPE all / private empl.	0.114	0.110	0.0743	0.163
Ratio FPE local unrestr. / private empl.	0.0960	0.0940	0.0633	0.132
Ratio FPE local restr. / private empl.	0.0873	0.0855	0.0605	0.118
Ratio FPH / private empl.	0.0887	0.0815	0.0443	0.140
Ratio FPT / private empl.	0.113	0.105	0.0644	0.173
R_i	0.0294	0.0284	0.0189	0.0416
$\tilde{R}_i$	0.229	0.227	0.171	0.292
Population	191.5	106.7	39.36	420.5
Private empl.	43.89	20.17	7.046	104.4
Tradables private empl.	16.36	8.070	2.510	34.57
Non-tradables private empl.	27.32	12.63	4.041	65.09
Share Tradables in private empl.	0.383	0.341	0.228	0.624
Share Non-tradables in private empl.	0.610	0.653	0.371	0.764
Local wage premium (pri)	0.0277	0.0235	-0.00219	0.0643
Value-added (M€)	1772.4	802.7	262.9	3917.9
Nb firm creations	685.1	302.5	9.500	1587.5
Nb firm destructions	350.2	123	2	885
Nb CZ		296		

NOTES: This table presents summary statistics by commuting zone over the period 2006-2015. Employment is expressed in thousands of full-time equivalent employees, population is expressed in thousand inhabitants.

A.2 Robustness for Fact 1

Figure A.3: Map of the retirement exposure R_i by commuting zone
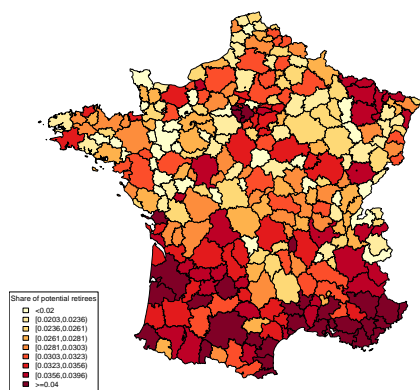
NOTES: This map represents the spatial distribution of the unadjusted retirement exposure R_i using the 95th age percentile relative to the 85th by commuting zone. Light yellow areas indicate low shares, while darker red areas indicate high shares.

Local public goods using restrictive definition

Figure A.4: Local good production (restrictive definition): variation in α_t for public and private employment
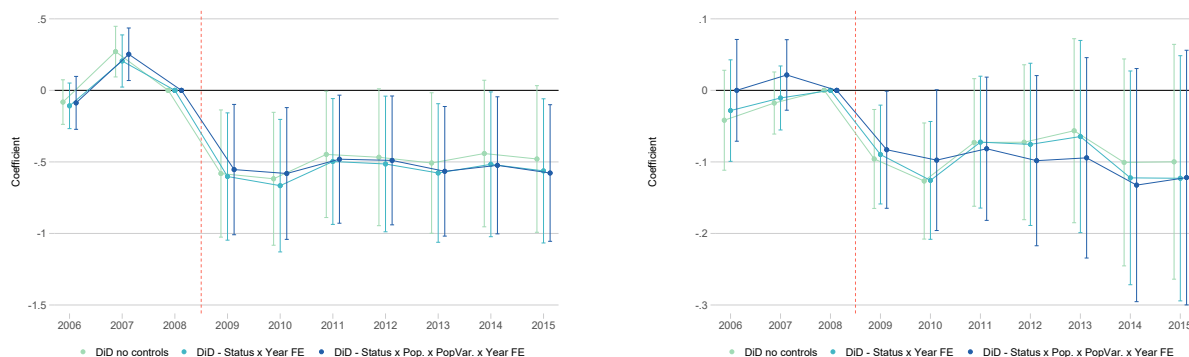
NOTES: These figures represent coefficients associated to our adjusted retirement exposure $\tilde{R}_i \times$ year calculated on local public good producers with the restrictive definition, on the log of FPE local public employment (panel a, first-stage regression) and the log of private employment (panel b, second stage regression).
SOURCES: DADS Postes, FGE.

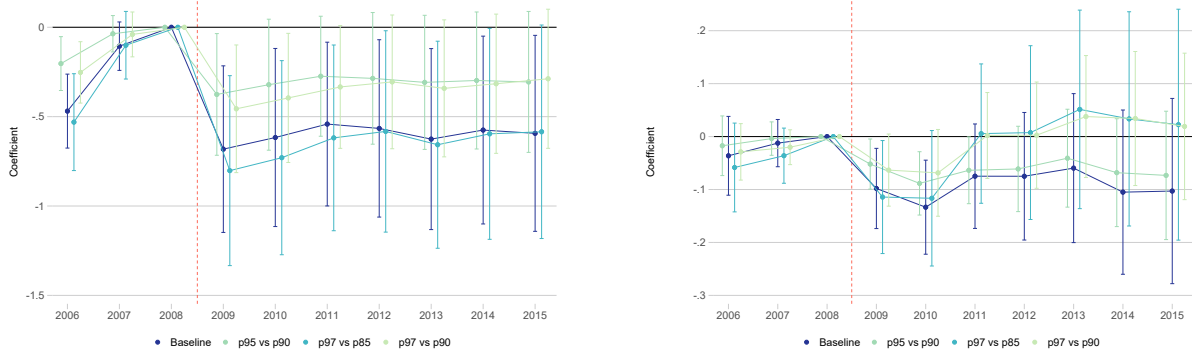**Table A.3:** The effect of adjusted retirement exposure using $\tilde{R}_i$ (restrictive definition)

	(ln) Public Empl.		(ln) Private Empl.		(ln) Population	
$Post \times \tilde{R}_i$	-0.599***	-0.593***	-0.097**	-0.115*	-0.005	0.00
	(0.215)	(0.212)	(0.045)	(0.061)	(0.017)	(0.031)
N obs	1480	2960	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

	Private Wages		(ln) Non-Trad. Empl.		(ln) Tradable Empl.	
$Post \times \tilde{R}_i$	-0.006	0.002	-0.243*	-0.206	-0.493**	-0.591**
	(0.012)	(0.013)	(0.136)	(0.149)	(0.211)	(0.240)
N obs	1475	2950	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

NOTES: This table presents coefficients associated to our adjusted retirement exposure $\tilde{R}_i$ calculated on the restrictive definition of local public good producers $\times$ a dummy indicating that year is greater than 2008, on – first table – the log of FPE local public employment, the log of private employment, the log of population (number of fiscal households), – second table – private wages (local wage premium), the log of non-tradable private employment, and the log of tradable private employment, – third table – the log of private sector value-added, the log number of firm creations, and the log number of firm destructions. All regressions include Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles. Regressions on tradable on non-tradable employment also include a Bartik shock calculated specifically on that part of private employment.

Figure A.5: Local good production (non-restrictive definition): variations in the percentiles used to build $\tilde{R}_i$

NOTES: These figures represent coefficients associated to our adjusted retirement exposure $\tilde{R}_i \times$ year calculated on local public good producers with different percentiles of the age distribution, on the log of FPE local public employment (panel a, first-stage regression) and the log of private employment (panel b, second stage regression).
SOURCES: DADS Postes, FGE.

Table A.4: The effect of adjusted retirement exposure using R_i

	(ln) Public Empl.		(ln) Private Empl.		(ln) Population	
$Post \times R_i$	-3.11**	-3.40***	-0.934***	-0.571	-0.106	-0.182
	(1.29)	(1.26)	(0.274)	(0.358)	(0.103)	(0.185)
N obs	1480	2960	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

	Private Wages		(ln) Non-Trad. Empl.		(ln) Tradable Empl.	
$Post \times R_i$	0.013	-0.017	-0.243	0.649	-4.85***	-5.63***
	(0.071)	(0.074)	(0.753)	(0.820)	(1.29)	(1.48)
N obs	1475	2950	1480	2960	1480	2960
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

NOTES: This table presents coefficients associated to our adjusted retirement exposure $\tilde{R}_i$ calculated on local public good producers $\times$ a dummy indicating that year is greater than 2008, on – first table – the log of FPE local public employment, the log of private employment, the log of population (number of fiscal households), – second table – private wages (local wage premium), the log of non-tradable private employment, and the log of tradable private employment, – third table – the log of private sector value-added, the log number of firm creations, and the log number of firm destructions. All regressions include Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles. Regressions on tradable on non-tradable employment also include a Bartik shock calculated specifically on that part of private employment.

Additional elements on local public goods using non-restrictive definition

Table A.5: The effect of adjusted retirement exposure on firm outcomes using $\tilde{R}_i$

|	(ln) Value-added		(ln) Nb Firm Crea.		(ln) Nb Firm Destr.	
$Post \times R_i$	-0.007	-0.138	0.033	-0.041	0.127	0.357
	(0.091)	(0.152)	(0.174)	(0.160)	(0.382)	(0.289)
N obs	1480	2960	1184	2664	1184	2664
Est. period	2006-2010	2006-2015	2006-2010	2006-2015	2006-2010	2006-2015

NOTES: This table presents coefficients associated to our adjusted retirement exposure $\tilde{R}_i$ calculated on local public good producers × a dummy indicating that year is greater than 2008, on the log of private sector value-added, the log number of firm creations, and the log number of firm destructions. All regressions include Bartik shocks, Commuting Zone fixed-effects, as well as year fixed-effects interacted with administrative status, wide geographic areas (5 areas in total), population quintiles and mean income quintiles.

A.3 Robustness for Fact 2

The size of the public sector

We reproduce Figure 4 from Section 3.2.1 separately for different occupational categories (1 digit occupation codes). We aggregate all categories of public sector (FPH, FPE and FPT), and select in each commuting zone the largest employer (Siren) of the selected category. The pattern identified in the main text, namely that the ratio of the largest unit in the public sector relative to the largest employer is high for most CZ, holds separately for the different types of occupations.

Figure A.6: Ratio of employment in public sector relative to the largest private sector employer by job type
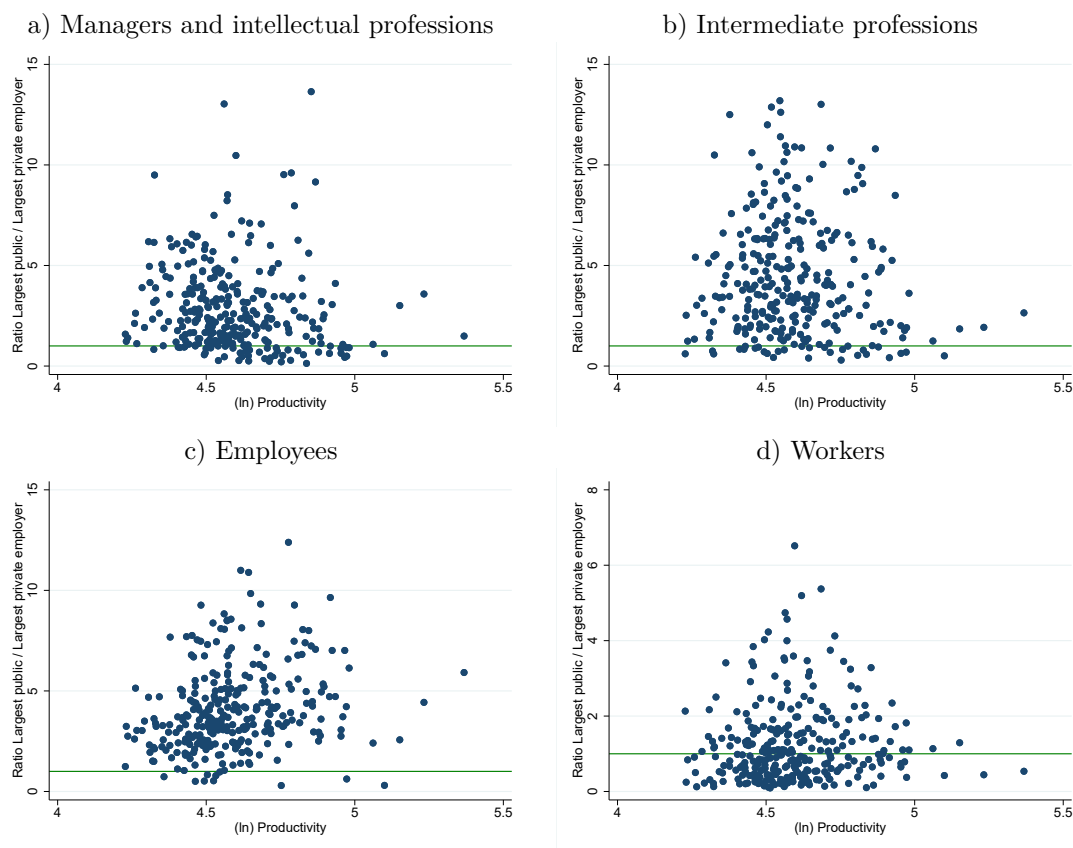
a) Managers and intellectual professions

b) Intermediate professions

c) Employees

d) Workers

NOTES: This figure plots the ratio of number of workers in the largest public sector employer over the number of workers in the largest private sector employer (measured at the firm level) as a function of local productivity. Each dot represents a different commuting zone. We perform the exercise separately for different occupation categories. Panel a corresponds to the PCS 3 in the DADS, panel b to PCS 4, panel c to PCS 5 and panel d to PCS 6. We do not report the other PCS, such as agricultural workers, who are unlikely to appear in the public sector.

Worker flows from the private to the public sector

We reproduce Figure 5 in the main text Section 3.2.2, but without restricting to movements within the same CZ. We find similar results.

Figure A.7: Ratio of movements from the private to the public sector all movements

FPE + FPH   FPT
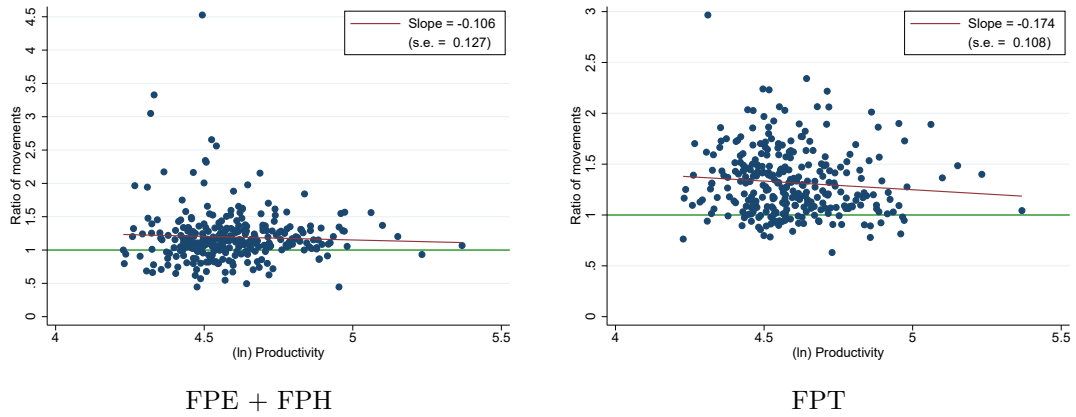
NOTES: This Figure reproduces Figure 5 in the main text, without restriting to movements within the same CZ.

Additional evidence: changes in mayors

We explore how turnover in mayors impacts wages and hours worked for FPT workers employed by the city. We collect information of the profession of mayors (for the vast majority of mayors this is a part-time job and they hold another profession). We use data on mayors from the RNE (*Répertoire national des élus*)[39] in 2008 and 2014 that reports the occupation and political party affiliation of all mayors and municipal council members. We code whether mayors belong to the public or private sector.

We examine whether a switch from a mayor working for the private sector to a mayor working for the public sector increases wages. The underlying assumption is that mayors working in the public sector will put a relatively larger weight in their objective function on public sector workers and will thus be less likely to exert their monopsony power (if it does exist as we claim). Table A.6 provides the evidence, where the dependent variable is the difference of the log of our variable of interest in a given year compared to the log of this variable in 2014, which is the year of the election. The results show that indeed a switch from having a private sector to a public sector worker is correlated with higher wages of the municipal staff, and with more hours worked (although not significantly). We interpret this with evidence consistent with the existence of monopsony power, although the evidence may also be compatible with public sector mayors having a taste for higher quality public goods and thus increasing wages of its employees.

Table A.6: Impact of mayors changes

	(dlog) wage bill	(dlog) Hours	(dlog) Hourly wage		
	(1)	(2)	(3) All	(4) Entrants	(5) Incumbents
Switch from pri. to pub. sector mayor in 2014	0.0205***	0.0131	0.0142***	0.0188**	0.00829*
	(0.00764)	(0.00806)	(0.00535)	(0.00741)	(0.00427)
Switch from pub. to pri. sector mayor in 2014	0.00269	-0.00582	0.00758	0.00806	0.00512
	(0.00693)	(0.00726)	(0.00487)	(0.00698)	(0.00396)
Observations	32860	32860	32860	27531	26403

NOTES: Coefficients and standard errors of regressions using respectively the log difference of the wage bill (total gross salaries) between 2017 and 2014, the log difference of hours worked, and the log difference of the mean hourly wage of workers with a permanent contract (all, entrants, and incumbents) over the same period. All regressions are conducted at the level of a municipality, and include a dummy variable indicating whether the mayor changed, fixed effects for *départements*, the status of the municipality (*Préfecture*, *chef-lieu*, none), the log of population and area, and the dlog of population and of total income over the last mandate (2008-2014) in the municipality. Standard errors are robust.

As a complement, we also use municipality accounts[40] data from 2012 to 2019 to test the effect of mayor switches on wage bill and on taxes.

In all our regressions, we use as dependent variable the difference of the log of our variable of interest in a given year compared to the log of this variable in 2014, which is the year of the election. We introduce a set of control variables that capture potential confounding factors for changes in wage bill and taxes: we

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[39]Available online at https://www.data.gouv.fr/fr/pages/donnees-des-elections
[40]Comptes des communes 2012 − 2019, available online from the website of Observatoire des Finances et de la Gestion publique Locales: https://data.ofgl.fr/pages/accueil/.

introduce *département* fixed-effects (96 *départements*), status (*préfecture*, *chef-lieu,...*) fixed-effect, as well as the log of population, the log of area, and the log difference in population and in total income over the last mandate.

Figure A.8 presents the results obtained on the municipal account variables for wage bill and taxes. We observe in Figure A.8a that a switch from a private to a public sector mayor in 2014 is associated with an increase in total municipal wage bill which is significant and equates a 2% increase. This effect can be observed 2 to 3 years after the election and persists over the mandate. A switch from the public to the private sector is, however, associated to no change in the wage bill. The opposite pattern can be observed for taxes in figure A.8b: while a switch to a public mayor does not changes the amount of taxes on average,

Figure A.8: Effect of public/private mayor switches in 2014

(a) dlog wage bill

(b) dlog Taxes
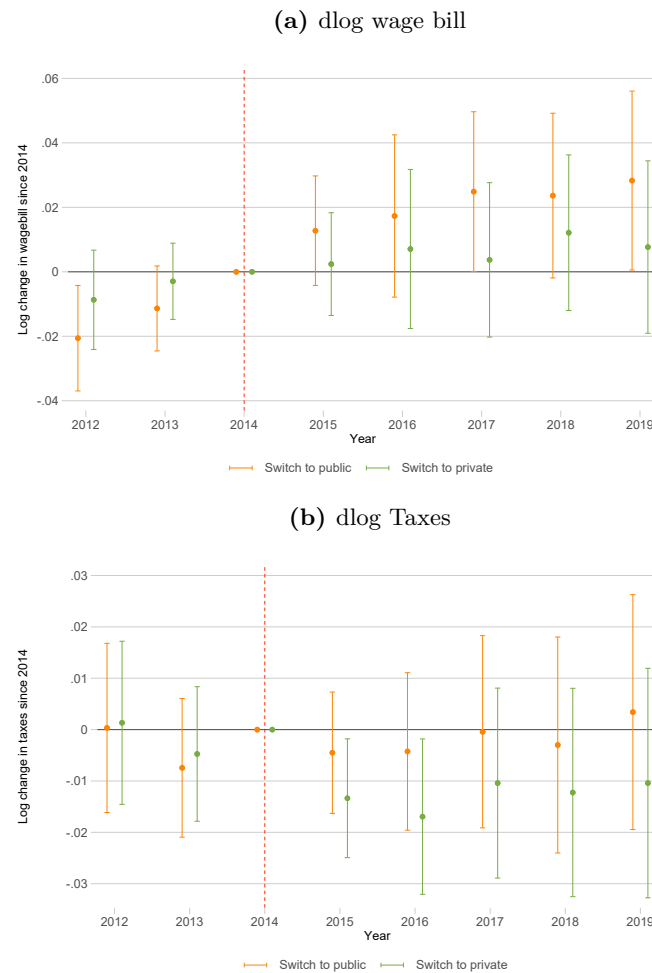
NOTES: Coefficients and 95% confidence intervals of regressions using respectively the dlog of the wage bill and the dlog of taxes between 2014 and the year specified on the x-axis. All regressions are conducted at the level of a municipality, and include a dummy variable indicating whether the mayor changed, fixed effects for *départements*, the status of the municipality (*Préfecture*, *chef-lieu*, none), the log of population and area, and the dlog of population and of total income over the last mandate (2008-2014) in the municipality. Regressions include 33891 municipalities. Standard errors are robust.

B   Appendix: International evidence

In this section we show whether in the US wages and employment in the public sector vary systematically across cities. Instead of using a measure of local productivity, we use local population as a proxy. Using this proxy we replicate Figure 7 using Census data for the year 2000, obtained from Ruggles et al. (2016). We use the variable 'ind1990' to classify private sector and public sector workers. We leave outside the computation (although this does not matter) industries that are (at least) partially public such as education and health care. Wages are measured as yearly income divided by weeks worked, and are adjusted for observable characteristics. We use metropolitan areas as our unit of local labor market.

Figure A.9 shows that on average wages in the private and public sector are very similar within locations (the dots in the figure cluster around one) and there there is no systematic variation across metropolitan areas. Similarly, the ratio of private to public sector workers is unrelated to city size. The overall size of the public sector is lower in the US than in France.

**Figure A.9:** Relative wages and employment in the public sector
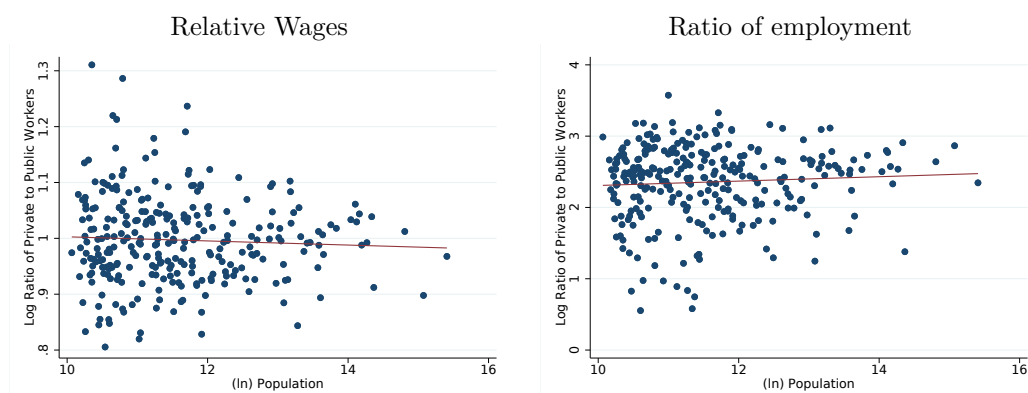
C Appendix: recovering the NAF code for FGE data

In the FGE data (used for the period 2006-2008), the industry NAF code is not directly available. We reconstruct it using the following procedure.

1. We first match the plants with the SIRENE database (historical inventory of firms and plants) and use the NAF recorded there. This steps recovers a NAF code for 82% of workers in the database.

2. Then, we match the plant identifier (SIRET) with the list of identifiers present in the DADS from the later periods. This step matches an additional 8% of workers.

3. For the remaining cases that do not match, we exploit the composition in terms of occupation of the firm to infer a NAF code. We consider plants including university professors to be universities, plants including a high share respectively of primary or secondary teachers to be primary or secondary schools, and plants with a large share of administrative workers to be administrations. This step allows reaching a total of 97% of workers matched with a NAF code.

D   Appendix: graph model

Figure A.10: Illustration of fixed wage effect on distribution of economic activity
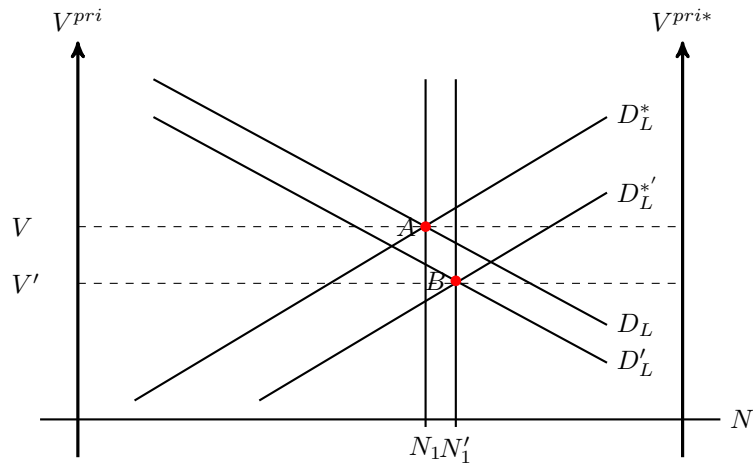
Notes: This graph illustrates the model with two regions, represented in the two y-axis. Wage indexation leads to a decline in the demand for labor in the private sector that is proportional to the difference between flexible and indexed wages. Hence, the decline in the demand is larger in less productive locations.

48

E   Appendix: proofs

Proposition 2

We first derive the results in the main text in more details.

The objective of the government is:

$$\max_{N_i^{pub}} \ln(1-\tau_i) + \ln w_i^{pri} - \alpha \ln p_i + \beta_2 \ln Q_i^{pub} \text{ subject to } (4.3), (4.4), (4.5), (4.6).$$

Incorporating first housing prices (condition (4.6)) $p_i = (1-\tau_i)w_i^{pub}\widetilde{N}_i\frac{\alpha}{H}$, the objective becomes:

$$\max_{N_i^{pub}} (1-\alpha)\ln(1-\tau_i) - \alpha \ln w_i^{pub} + \ln w_i^{pri} - \alpha \ln \widetilde{N}_i + \beta_2 \ln Q_i^{pub} + \alpha \ln H - \alpha \ln \alpha.$$

Incorporating taxes (condition (4.5)), $(1-\tau_i) = \frac{w_i^{pri}}{w_i^{pub}}\frac{N_i^{pri}}{\widetilde{N}_i}$, we obtain:

$$\max_{N_i^{pub}} (1-\alpha)\ln N_i^{pri} - \ln w_i^{pub} + (2-\alpha)\ln w_i^{pri} - \ln \widetilde{N}_i + \beta_2 \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha.$$

We then integrate the constraint (4.3) to obtain an expression for $\ln w_i^{pub} = \ln w_i^{pri} + \epsilon_W[\ln N_i^{pub} - \ln N_i^{pri}]$, which we incorporate into the maximization.

$$\max_{N_i^{pub}} (1-\alpha+\epsilon_W)\ln N_i^{pri} + (1-\alpha)\ln w_i^{pri} - \ln \widetilde{N}_i + (\beta_2 - \epsilon_W)\ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha.$$

Finally, we can use the expression for wages in the private sector $\ln w_i^{pri} = \ln \tilde{A}_i = \ln A_i + \beta_1 \ln N_i^{pub}$ to express the objective of the government as:

$$\max_{N_i^{pub}} ((1-\alpha)+\epsilon_W)\ln(N_i - N_i^{pub}) + (\beta-\epsilon_W)\ln N_i^{pub} - \ln \widetilde{N}_i + \alpha \ln H - \alpha \ln \alpha + (1-\alpha)\ln A_i.$$

Maximizing under the assumption that the government takes as given the size of the location N_i and the adjusted wage bill $\widetilde{N}_i$, the first order conditions yield:

$$\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1-\alpha)+\epsilon_W}{\beta-\epsilon_W}.$$

This proves Proposition 2.1.

To show Proposition 2.2, we exploit expression (4.8), and the fact that $\theta(\gamma, A_i)$ only varies across cities because of variation in productivity A_i:

$$(\ln V_i - \ln V_j) = (1-\alpha)(\ln A_i - \ln A_j) - \mu(\ln N_i - \ln N_j).$$

Since the choice of location implies that $\ln N_i - \ln N_j = \frac{1}{\epsilon_B} [\ln V_i - \ln V_j]$, we also have:

$$(\ln V_i - \ln V_j) = \frac{1 - \alpha}{1 + \frac{\mu}{\epsilon_B}} (\ln A_i - \ln A_j)$$

$$(\ln N_i - \ln N_j) = \frac{1 - \alpha}{\epsilon_B + \mu} (\ln A_i - \ln A_j)$$

Given expression (4.4) for private sector wages, we have

$$
\begin{aligned}
\ln w_i^{pri} - \ln w_j^{pri} &= (\ln A_i - \ln A_j) + \beta_1 (\ln N_i - \ln N_j) \\
&= \left(1 + \beta_1 \frac{1 - \alpha}{\epsilon_B + \mu}\right) (\ln A_i - \ln A_j)
\end{aligned}
$$

This proves results Proposition 2.2.(a) to (c)

We finally prove Proposition 2.3. Result (a) directly follows from expression (4.7).

To show result 2.3.(b), we use the expression for wages:

$$
\begin{aligned}
\ln w_i^{pri} &= \ln A_i + \beta_1 \ln N_i^{pub} \\
&= \ln A_i + \beta_1 \ln \gamma - \ln N_i
\end{aligned}
$$

Taking derivatives, and since N_i is independent of ϵ_W while γ decreases with ϵ_W, we have:

$$\frac{\partial \ln w_i^{pri}}{\partial \epsilon_W} = \frac{\partial \gamma}{\partial \epsilon_W} \left[\frac{\beta_1}{\gamma}\right] < 0.$$

Wages in the private sector go down because less public goods are provided and because more private sector workers are hired. However the decrease in public sector wages is faster. Since $\frac{w_i^{pub}}{w_i^{pri}} = (\frac{N_i^{pub}}{N_i^{pri}})^{\epsilon_W} = (\frac{\gamma}{1-\gamma})^{\epsilon_W}$.

$$\frac{\partial \ln w_i^{pub}}{\partial \epsilon_W} = \frac{\partial \ln w_i^{pri}}{\partial \epsilon_W} + \epsilon_w \frac{\partial \gamma}{\partial \epsilon_W} \left[\frac{1}{\gamma} + \frac{1}{1 - \gamma}\right] + [\ln \gamma - \ln(1 - \gamma)] < \frac{\partial \ln w_i^{pri}}{\partial \epsilon_W}$$

We turn to result 2.3.(d).

The average indirect utility is given by:

$$\ln \overline{V}_i = (1 - \gamma) \ln V_i^{pri} + \gamma \ln V_i^{pub} = -\mu \ln N_i + (1 - \alpha) \ln [1 - \gamma] + \beta \ln \gamma + cst_i \qquad (E.1)$$

Taking derivatives with respect to ϵ_W, using the fact that N_i does not vary with ϵ_W, we have

$$\frac{\partial \ln \overline{V}_i}{\partial \epsilon_W} = \frac{\partial \gamma}{\partial \epsilon_W} \left[-\frac{1 - \alpha}{1 - \gamma} + \frac{\beta}{\gamma}\right]$$

50

Using the expression for γ, this can be expressed as

$$\frac{\partial \ln \overline{V}_i}{\partial \epsilon_W} = \frac{\partial \gamma}{\partial \epsilon_W} \frac{\beta}{\gamma} \left[1 - \frac{1-\alpha}{1-\alpha+\epsilon_W} \frac{\beta-\epsilon_W}{\beta} \right] < 0$$

which is negative.

Proposition 3

$$\max_{N_i^{pub}} \; (1-\alpha) \ln(N_i - N_i^{pub}) - \ln \bar{w} + (2-\alpha-\psi) \ln w_i^{pri} - \ln \widetilde{N}_i + \beta_2 \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha$$

Using $\ln w_i^{pri} = \ln \tilde{A}_i = \ln A_i + \beta_1 \ln N_i^{pub}$, the objective becomes

$$\max_{N_i^{pub}} \; (1-\alpha) \ln(N_i - N_i^{pub}) - \ln \bar{w} - \ln \widetilde{N}_i + ((2-\alpha-\psi)\beta_1 + \beta_2) \ln N_i^{pub} + \alpha \ln H - \alpha \ln \alpha + (2-\alpha-\psi) \ln A_i \quad \text{(E.2)}$$

Foc yield as derived in the main text

$$\frac{N_i^{pri}}{N_i^{pub}} = \frac{(1-\alpha)}{(2-\alpha-\psi)\beta_1 + \beta_2} = \frac{(1-\alpha)}{\beta + (1-\psi)\beta_1} = \frac{(1-\alpha)}{\tilde{\beta}}$$

This establishes result 1. by directly comparing with the ratio $\frac{N_i^{pri}}{N_i^{pub}}$ in the flexible wage case. Given that this ratio is increasing in Ψ, result 3 follows.

We also have that: $N_i^{pri} = (1 - \gamma^I) N_i$ with

$$\gamma^I = \frac{\beta + (1-\psi)\beta_1}{\beta + (1-\psi)\beta_1 + (1-\alpha)} = \frac{\tilde{\beta}}{\tilde{\beta} + (1-\alpha)}$$

Replacing in the objective (E.2), we have

$$
\begin{aligned}
\ln V_i^{pri} &= (-\alpha + (2-\alpha-\psi)\beta_1 + \beta_2) \ln N_i + (1-\alpha) \ln(1 - \gamma^I) \\
&\quad - \ln \bar{w} - \ln \left(\gamma^I + (1 - \gamma^I) \frac{w_i^{pri}}{w_i^{pub}} \right) + ((2-\alpha-\psi)\beta_1 + \beta_2) \ln \gamma + \alpha \ln H - \alpha \ln \alpha + (2-\alpha-\psi) \ln A_i
\end{aligned}
$$

Using the fact that: $\ln w_i^{pub} - \ln w_i^{pri} = \ln \bar{w} - (1-\psi) \ln w_i^{pri}$, we can rewrite the expression above as:

$$
\begin{aligned}
\ln V_i^{pri} &= (-\alpha + (1-\alpha)\beta_1 + \beta_2) \ln N_i + (1-\alpha) \ln(1 - \gamma^I) \\
&\quad - \ln \left(\gamma^I + (1 - \gamma^I) \frac{w_i^{pri}}{w_i^{pub}} \right) + ((2-\alpha-\psi)\beta_1 + \beta_2) \ln \gamma^I + \alpha \ln H - \alpha \ln \alpha + (1-\alpha) \ln A_i - (\ln w_i^{pub} - \ln w_i^{pri})
\end{aligned}
$$

This can be reexpressed as

$$
\begin{aligned}
\ln V_i^{pri} &= (-\alpha + (1-\alpha)\beta_1 + \beta_2)\ln N_i + (1-\alpha)\ln(1-\gamma^I) \\
&\quad - \ln\left(1 + \gamma^I \frac{w_i^{pub} - w_i^{pri}}{w_i^{pri}}\right) + ((2-\alpha-\psi)\beta_1 + \beta_2)\ln\gamma^I + \alpha\ln H - \alpha\ln\alpha + (1-\alpha)\ln A_i
\end{aligned}
$$

This implies the expression shown in the main text:

$$
\begin{aligned}
\ln V_i^{pri} - \ln V_j^{pri} &= -\mu\left(\ln N_i - \ln N_j\right) + (1-\alpha)\left(\ln A_i - \ln A_j\right) \\
&\quad - \textcolor{blue}{\left[\ln\left[1 + \gamma^I \frac{w_i^{pub} - w_i^{pri}}{w_i^{pri}}\right] - \ln\left[1 + \gamma^I \frac{w_j^{pub} - w_j^{pri}}{w_j^{pri}}\right]\right]}
\end{aligned}
$$

The blue terms are the extra term that appear compared to the case of flexible wage. Because $\frac{w_i^{pub} - w_i^{pri}}{w_i^{pri}} < \frac{w_j^{pub} - w_j^{pri}}{w_j^{pri}}$, $\ln V_i^{pri} - \ln V_j^{pri}$ will be larger than in the flexible wage case and thus the more productive city i will attract more population, as expressed in result 2.