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THE EFFECT OF PUBLIC SECTOR EMPLOYMENT ON LOCAL LABOUR MARKETS[1]

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Abstract

This paper considers the impact of public sector employment on local labour markets. Using English data at the Local Authority level for 2003 to 2007 we find that public sector employment has no identifiable effect on total private sector employment. However, public sector employment does affect the sectoral composition of the private sector. Specifically, each additional public sector job creates 0.5 jobs in the nontradable sector (construction and services) while crowding out 0.4 jobs in the tradable sector (manufacturing). When using data for a longer time period (1999 to 2007) we find no multiplier effect for nontradables, stronger crowding out for tradables and, consistent with this, crowding out for total private sector employment.

Keywords

Local labour markets; public and private sector employment; wages

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1. Introduction

This paper considers the impact of public sector employment on local labour markets. When a new job is created in an area, additional jobs may be generated as a result of increased demand for locally produced goods and services. This positive effect on employment may be offset by general equilibrium effects induced by changing local wages or prices (Moretti, 2010). In other words, the 'multiplier effect' of the additional jobs may be offset by 'displacement' or 'crowding out' elsewhere in the local economy. For public sector employment these effects may be complicated by the existence of a private-public pay differential and the fact that the increase in employment may be funded through additional local taxes.

In this paper we clarify some of the conceptual issues concerning the impact of public sector employment on local labour markets. However, our main focus is on obtaining empirical estimates of the effects using data on employment for English Local Authorities. We consider the impact of public sector employment growth on private sector employment growth as well as other labour market indicators (unemployment, participation and working age population). Our preferred specification using changes from 2003-2007 implies a short run overall multiplier that is insignificantly different from zero. Public sector employment has little effect on total private sector employment in the short run. In contrast, in line with predictions from a basic conceptual framework, we find evidence of a multiplier effect for non-tradable sectors and a displacement effect for tradable sectors. Our preferred specification implies that each additional public sector job creates 0.5 jobs in the nontradable sector (construction and services) while crowding out 0.4 jobs in the tradable sector (manufacturing). For a longer time period (1999 to 2007) we find no multiplier effect for nontradables, stronger crowding out for tradables and, consistent with this, crowding out for total private sector employment.

These effects are of considerable policy interest. The relocation of public sector employment is sometimes suggested as a tool for helping address employment problems in declining areas. Offsetting this, it is argued that public sector employment (and associated private-public pay differentials) may crowd out the private sector. In the UK, these issues have recently been considered in two government-sponsored reviews (Lyons, 2004; Smith, 2010). They have also provided the background to a series of relocation exercises since World War 2 (Jefferson and Trainor, 1996). Notwithstanding the attention given by successive UK governments to the subject, no robust evidence of the empirical effects are available. In the UK, continued interest in these issues partly reflects concerns over the uneven spatial impact of public sector job cuts (Larkin, 2009, Webber and Swinney, 2010) but also interest in the wider impacts of moving from national to local (or 'market facing') pay.[2]

Surprisingly, to the best of our knowledge, this issue has been the subject of little (if any) systematic analysis. Since the late 1960s, a series of studies for both the UK and other (mostly European) countries have assessed the case for public sector relocation from capital cities to less-developed areas.[3] However, these studies focus on the financial costs and

[2] See the December 2011 letters from the UK Chancellor to the Pay Review Bodies available from http://www.ome.uk.com/Article/Detail.aspx?ArticleUid=dfd0267d-9c7d-421b-80ba-71db9232f4b9.

[3] See, among others, Hammond (1967), Jefferson and Trainor (1996), Marshall et al. (2005a, 2005b), Marshall (2007) for the UK; Daniels (1985), Clark (1998), and Guyomarch (1999) for France; Cochrane and Passmore (2001), Haeussermann and Kapphen (2003) for Germany; Myung-Jin Jun (2007) for Korea.

benefits of relocation and provide little empirical evidence on impacts on local labour markets. Indeed, descriptive evidence on the impact of past relocations is usually restricted to discussion of secondary data on overall public sector employment rather than actual data on government office relocations. This broadly descriptive literature incorporates academic papers (see, e.g., Marshall et al. 1991); government sponsored reviews (see, Lyons 2004, Smith 2010) and a small number of consultancy studies (see, e.g., Experian, 2004; Deloitte, 2004). BIS (2010) does consider the impact of public sector employment on private sector employment using a panel of data for English NUTS 3 regions from 2003-2008. We improve on those estimates by focusing on differences (i.e. changes over time), adopting an appropriate functional form and instrumenting to deal with the problems of endogeneity and reverse causality. As we show below dealing appropriately with the latter problem is crucial for understanding the impact of higher public sector employment.

Ex-ante *predictions* of the impact of public sector employment can be constructed using methods developed in the extensive literature on regional input-output models. These models use input-output tables to trace through the way in which local supply is likely to respond to an increase in economic activity. Such models usually provide a range of different multipliers but because they assume prices are fixed ignore any general equilibrium constraints that might lead to crowding out. Miller and Blair (2009) provide a classic textbook treatment. The US Bureau of Economic Analysis RIMS II is one of the best known and most widely used applications. [4] Regional computable general equilibrium (CGE) models impose more theoretical structure to try to address the problems arising from the fixed-price assumption inherent in input-output models. Such regional CGE models are fitted to data that has been adjusted so as to be consistent with the underlying theoretical model (a process known as calibration). See Partridge and Rickman (2010) for a recent survey. Input-output and CGE models have been widely used to *predict* the impact of local demand shocks but neither approach provides estimates of the actual impact of such changes.[5]

In the macro-economic literature, a limited number of studies have looked at the potential impact of public sector employment on labour market outcomes (e.g., unemployment and private employment). Using data for 22 OECD countries from the end of the 1960s to 1990, Edin and Holmlund (1997) find that a rise in public sector employment reduces unemployment by about 0.3% in the short-run, whereas there is no significant long-run effect.[6] When looking at the Swedish experience (with longer time series data), they find that the rapid growth in public sector employment in Sweden over the 1960s and the 1970s contributed to the low Swedish unemployment rate during those years. Their estimates indicate that the effect was at most one percentage point of unemployment during the booming years and much smaller after that.

Boeri, Nicoletti and Scarpetta (2000) estimate that 10 additional public jobs crowd out 3 private jobs using a sample of 19 industrialized OECD countries over the period 1985-1992. Algan, Cahuc and Zylberberg (2002) focus instead on the long-run effects of public sector

[4] See http://www.bea.gov/regional/rims/

[5] In the UK, such IO/CGE approaches have been used to predict the impact of government relocations. Ashcroft and Swales (1982a and 1982b) predict the impact of two relocations to Cleveland and to South Glamorgan, while Ashcroft et al. (1988) consider a further dispersal to East Kilbride. The latter predicts an employment multiplier of 1.14 in the short-run with the long-run impact predicted to be 10% higher.

[6] Edin and Holmlund (1997) argue that as wages and prices adjust, public sector employment would crowd out private sector employment with no impact on equilibrium long-term unemployment.

employment on both unemployment and private sector employment using a panel of 17 OECD countries between 1960-2000. They find that a rise in a country's public sector employment increases that country's unemployment. Furthermore, they find that public sector employment had, on average, a strong crowding out effect on private employment: creation of 10 public sector jobs tend to destroy 15 private sector jobs.[7] Although interesting, these estimates do not take into account, or do not solve in a satisfactory manner, possible problems arising from reverse causality or endogeneity.

Moretti (2010) does attempt to isolate the causal impact of local employment changes and is the paper most closely related to our own work. Using US Census of Population data for 1980, 1990 and 2000, he looks at the long-term change in the number of jobs in a city's tradable and non-tradable sectors caused by a permanent shock in the tradable sector. Results suggest a positive local multiplier of tradables on nontradables (of about 1.6), but no impact of employment changes in one part of the tradable sector on the rest of the tradable sector. In contrast to our focus here, Moretti's definition of the non-tradable sector specifically excludes government jobs (along with those in agriculture, mining and the military). Thus, his paper is only concerned with multiplier effects between tradable and non-tradable components of the private sector.

Our work is also closely related to the migration literature, a popular strand of which considers the possible displacement effect of immigrants on natives using cross-regional (city or census track) data.[8] As we are also interested in the possibility of displacement (or a crowding-out effect) – but of public sector employment on private sector activity – it is possible to draw a parallel between the two approaches: one linking immigrants and natives, the other linking public and private sector employment. Indeed, our methodology uses an adapted version of that commonly found in the migration literature (specifically we use a version of Card (2007)'s model adjusted to take into account improvements as suggested by Peri and Sparber, 2011).

Other related research documents the large share of public sector workers in the economy (ranging from 17% of total employment in the US to about 22% in Western Europe); the sorting and substantial movement of workers between the private and public sector (see Borjas, 2002); the existence of a public-private wage differential and its evolution over time (see, among others, Nickell and Quintini, 2002; Disney and Gosling, 2008 for the UK); and the impact of public investment on local employment and wages (Pissarides and Wasmer, 1999)

Theoretical work considering the interaction between public and private sectors within a local labor market is scarce. To the best of our knowledge, Burdett (2012) is the only study that presents an equilibrium search model of the labor market where a public sector is explicitly

7 This crowding out effect of public employment on private jobs depends importantly on the degree of public/private production substitutability (i.e., both public and private sectors competing in education, health and transport services) and on the size of job rents in the public sector (i.e., the potential misuse of public power for private benefits). Only for countries with a higher level of substitutability and/or higher public rents are the crowding-out effects significant and public sector employment significantly increases unemployment.

8 See, among others, Borjas (2006); Card (2001, 2007); Card and DiNardo (2000); Cortes (2008); and Peri (2010).

modeled. [9] Under a reasonable set of assumptions, Burdett (2012) shows that public sector employment crowds out private sector employment in regions where public pay is higher than the outside private option. In contrast, in regions where private employers offer a wage at least as large as the public sector, an increase in public sector workers would raise total employment leading to a multiplier effect. Available evidence for the UK (Emmerson, Johnson and Miller, 2012) suggests that most regions of the UK pay a substantial public sector premium so we should expect displacement to dominate. Explicitly considering heterogeneity in response as a function of the pay differential would require Local Authority level estimates of the public-private pay differential which are not readily available and so this question is left for further work.[10]

The rest of the paper is structured as follows. The next section sets out a simple conceptual framework. Section 3 describes the data while section 4 reports results on the impact of public sector employment on total private sector employment and other labour market indicators. Section 5 reports results once we split private sector employment by broad industrial sector, while section 6 reports results when we consider changes over a longer time period. Section 7 discusses the role of the elasticity of labour supply in explaining our results. Section 8 concludes.

2. Conceptual Framework

Our work is most closely related to Moretti (2010) who estimates local multipliers for the impact of tradable private sector employment on the tradable and nontradable sectors. We use his conceptual framework, modified to incorporate a public sector, to help develop intuition on the local labour market impact of public sector employment.

Assume that each local authority area is a competitive economy using labour to produce a nationally traded good x whose price is exogenous, a non-traded good z whose price is determined locally and a public sector good v. To keep things simple, we assume that the public sector good is funded from national taxation and provides a public good that is nontradable.[11] Labour is assumed mobile across sectors within a local authority. We assume that wages in the tradable and nontradable sectors are determined locally, but that public sector wages are determined nationally. Consistent with empirical evidence from the UK

[9] In the macro-economic literature, Holmlund (1997) presents a model where the size of the public sector matters for equilibrium unemployment. In his model, a rise in public sector employment reduces unemployment only if unions have weaker bargaining power in the public sector than in the private sector.

[10] Looking at the impact of outside wages for UK NHS nurses on hospital quality, Propper and Van Reenen (2010) also find that the estimated effect varies depending on whether the nurses' pay at the NHS hospital is higher or lower than the outside option. In particular, it is larger for hospitals located in higher outside wage regions (like London and surrounding areas) while they find no impact of outside wages on hospital performance in lower outside wage region. For medium wage region, the impact lays in the middle.

[11] In the UK, only about 25% of local government revenue expenditure is funded from local taxes with the remainder funded from government grants (56%) or redistributed non-domestic rates (19%). Approximately 50% of total Local Authority expenditure is spent on employment and local governmentemployment accounts for approximately 50% of total public sector employment. See Department of Communities and Local Government (2011). Using these averages, *doubling* public sector employment in a Local Authority would require a 6.25% increase in local taxes (25% share of local taxes in total Local Authority expenditure x 50% share Local Authority employment in total expenditure x 50% share of Local Authority employment in total public sector employment).

(Emmerson, Johnson and Miller, 2012) we assume that public sector pay is higher than private sector pay. The mobility assumption means that marginal products and wages are equalised across the tradable and nontradable sectors within a local authority. The existence of a positive public-private sector wage differential requires some mechanism for rationing jobs in the public sector. To keep things simple, we assume that workers choose either to work in the private sector for certain wage w or else to enter a lottery for a job in the public sector. Workers entering the public sector lottery end up unemployed with probability u or employed with probability $(1-u)$. If they are unemployed they earn a reservation wage (normalised to zero), while if they are employed they earn the national public sector wage $\bar{w}$. We assume workers are risk neutral so that expected wages are equalised across public and private sectors (i.e. $(1-u)\bar{w} = w$).

Local labour supply is upward sloping and depends on local preferences, the degree of labour mobility across cities and the responsiveness of local housing supply. The more mobile are workers and the more responsive is local housing supply the more elastic is local labour supply.

Moretti (2010) considers the case of a permanent increase in local labour demand for traded good x. In contrast, our interest is in a permanent increase in the local production of the public sector good v. Note that it is the presence of a positive public-private sector wage differential that makes this distinction conceptually interesting. The direct effect of this increased production is to increase local employment in the public sector. Employment in the other sectors, unemployment, local prices (wages, non-traded goods and house prices), labour and housing supply must then adjust to re-establish equilibrium.

2.1 Impact on the Nontradable Sector

Assuming that local labour supply is neither perfectly elastic nor perfectly inelastic, increased local labour demand must increase both local wages and local employment. The resulting increase in local income increases demand for nontradable services (restaurants, retail etc). The nontradable sector may also supply intermediate goods and services to the public sector so that increased public sector employment directly increases demand. Finally, some nontradable sector activity (e.g. health care and education) may provide goods and services that are substitutes for public sector provision. To the extent that the first two income effects, dominate any negative substitution effect, there are three possible sources of new workers to meet the net increase in demand: the local unemployed, existing residents employed in the tradable sector and new residents who move from elsewhere. Several general equilibrium effects work to offset this increase in employment in the nontradable sector. The citywide increase in labour costs partially offsets the demand effect, while increased prices (of nontradables and housing) partially offsets the supply effects. However, unless labour supply is perfectly inelastic these offsetting factors will only be partial and employment in the nontradable sector must increase. The more elastic is labour supply, the larger will be the multiplier effect on the nontradable sector.

2.2 Impact on the Tradable Sector

Assume that local demand is a negligible component of total demand for the tradable sector. Under that assumption neither the increase in local income nor the increase in intermediate demand from the public sector will have a significant impact on demand for the tradable sector. In the absence of any demand effects, the general equilibrium effects (the citywide increases in wages, house prices and the price of nontradables) all work to decrease employment in the tradable sector. As with nontradables, the more elastic is labour supply,

the smaller are these general equilibrium effects and the lower is crowding out from the tradable sector.

2.3 Impact on Unemployment and the Wage Premium

In this framework, increased public sector employment changes the structure of local employment towards the public and non-tradable sector and away from the tradable sector. Because we assume that public sector wages are set nationally, the net increase in local wage must reduce the positive public-private sector wage differential. This in turn implies that the unemployment rate should fall to re-establish the equilibrium between expected wages in the public sector and the now higher wages in the private sector. That is, when w increases, with $\bar{w}$ constant, u must fall to ensure that $(1-u)\bar{w} = w$. While the unemployment rate should fall, the overall impact on the number of unemployed depends on the extent to which the labour force increases as a result of migration from elsewhere. Under reasonable assumptions on the elasticity of labour and housing supplies we should expect some of the supply response to come in the form of lower total unemployment and some in the form of migration from elsewhere.

2.4 Empirical predictions

We begin by estimating the response of total private sector employment to increases in public sector employment. Our conceptual framework tells us that a number of factors will determine the size of the resulting multiplier and so the overall impact is an empirical matter. For our data, results suggest that the multiplier of public sector on private sector employment is zero in the short run but closer to minus one in the long run. This suggests, in the short run at least, that total local employment will increase one-for-one with public sector employment. Our conceptual framework suggests that the resulting labour supply response should come from some combination of lower unemployment or larger population. In practice, as we will show, our empirical results do not allow us to distinguish which of these channels is in operation. In contrast, our empirical results do support one clear prediction from the conceptual framework – while we find a multiplier effect for nontradables, increased public sector employment crowds out employment in the tradable sector.

3. Data

We use data for Local Authorities (LAs) in England derived from the Annual Business Inquiry (ABI) employee job estimates.[12] We restrict our geographical focus to England only. The exclusion of Scotland and Wales from the analysis is partly due to the fact that both countries have devolved administrations and have seen significantly larger public sector employment increases during the decade 1998-2008. In addition, LAs in England are substantially smaller than most unitary authorities in Scotland and Wales so restricting our focus gives more comparable spatial units. We focus on LAs, rather than broader labour market areas (i.e. Travel to Work Areas), because of data availability. Where this has implications for our results, we discuss the issues arising further below.

[12] ABI provides estimates of employee, rather than workforce, jobs. That is, it excludes self-employed jobs, HM Forces and government supported trainees. While the distribution of these excluded jobs may differ somewhat between areas it is unclear why this should bias our results in any particular direction. The National Statistics Public Sector Employment series provides an alternative data source, based on public sector returns, but is only reported for ten regional government offices (a spatial scale that is too large for our purposes).

The ABI is a comprehensive employer survey of the number of jobs held by employees broken down by sex, full-time/part-time and detailed industry (down to 4-digit SIC2003 level). The survey records a job at the location of an employee workplace. The original ABI data do not contain a measure of public sector employment. Fortunately, however, in 2010 the UK Department for Business, Innovation and Skills (BIS) released an improved version of the ABI which provides a more accurate definition of public/private sector jobs.[13] This is our main source of employment data.

We provide some additional analysis using the original ABI retrieved from the NOMIS website. For this data we construct measures of public sector employment using the standard, but somewhat crude, method of aggregating employment in three sectors: SIC75 (public administration & defence; compulsory social security); SIC80 (education); and SIC85 (health and social work). This classification ignores the fact that a proportion of the services in division 80 and 85 are actually provided by the private sector (e.g. private schools, hospitals) and that, importantly in our context, this proportion can change over time and space.

We make a number of other adjustments to the data as detailed in Appendix 1. These manipulations leave us with two data sets. We will refer to the first of these as the BIS data (ABI, adjusted by ONS, provided by BIS) and the second of these as the ABI data (ABI, scale factor adjusted and classified by the authors). The BIS data provide an accurate and consistent public/private split, but are available only for the period 2003-2008. The ABI data provide a less accurate public/private split but for a longer period from 1997-2008.

Given our focus, our preferred data source is the BIS data available for 2003-2008. We further limit our sample period by dropping data for 2008, for two reasons. First, because of the direct impact of the global recession in 2008. Second, because public sector employment figures increase substantially in 2008 as a result of the reclassification of jobs for workers employed in several large financial institutions nationalised by the UK government. For ABI, we drop 2008 for the same reason and in addition drop observations pre-1999 because some control variables are not available. This gives us data for 352 LAs for two sample periods: BIS data for 2003-2007 (our main focus) and the ABI data for 1999-2007 (used to extend the time period of our analysis).

In our preferred empirical specification, we control for initial LA size. We measure initial size as the log of total employment in year *s* (either 2003 or 1999 depending on the sample period used). If city growth is correlated with city size, controlling for initial employment size will be important in order to avoid misleading inference about the true impact of public sector employment on private sector employment growth. In the context of cities, the existence of a correlation between city growth and city size remains highly contentious (see Gabaix and Ioannides, 2004). But some authors (e.g. Wright, Ellis and Reibel, 1997 and Card, 2007) find evidence of a correlation which is sufficient to warrant inclusion in our case.

A second set of controls includes the initial LA shares of working age population with the following education qualifications: college degree and above; A-level; apprenticeship; O-

[13] Constructed by the Office for National Statistics using the Inter-Departmental Business Register to add a public/private sector identifier to the microdata underlying the ABI. The data classifies jobs according to which of seven categories their employer's organisation falls into. Employees in companies, sole proprietors, partnerships and non-profit body or mutual associations are classified as private sector. Public sector jobs are those in public corporations, nationalised bodies, central government and local authority.

level, foundation diploma, other lower qualifications and no qualifications. To construct these, we use annual data on the population aged 16-64 with the relevant education qualification from the Local Area Labour Force Survey (LFS) for the years 1999-2003. We also use equivalent local shares from the Annual Population Survey (APS), which replaced the Local Area LFS from 2004 onwards. Both the Local Area LFS and the APS data are from the NOMIS website. These are residence-based surveys, appropriately weighted by the ONS to be representative of local area geographies. Finally, we include the initial local unemployment rate. We use the model based estimates of unemployment at the Local Authority level as developed by the ONS. The method improves the APS estimates on unemployment by using supplementary information from the claimant account (specifically, the number of people claiming UK Jobseeker's Allowance).

4. The impact of public sector employment

In this section we look at the relationship between growth in public sector employment and growth in total private sector employment and other aggregate local labour market indicators. To do this we adapt Card's (2007) approach for investigating the impact of immigrant inflows on population growth for US cities.

Total employment in an LA at a point in time *t*, E_t, is equal to the sum of private sector employment, R_t, and public sector employment, B_t. That is, $E_t = R_t + B_t$. The proportional change in total employment between period *s* and period *t* can be expressed as:

$$\frac{E_t - E_s}{E_s} = \frac{R_t - R_s}{E_s} + \frac{B_t - B_s}{E_s} \qquad (1)$$

which decomposes total employment growth into the sum of the contributions from private sector and public sector employment between period *s* and period *t*.

The decomposition in equation (1) does not help answer the key question of whether public sector employment growth *causes* changes in private sector employment. To consider this, we use a simple model for private sector employment growth, adapted from Card (2007):

$$\frac{R_t - R_s}{E_s} = \alpha + \beta\left(\frac{B_t - B_s}{E_s}\right) + \gamma X + \varepsilon \qquad (2)$$

Where $(R_t - R_s)/E_s$ is the contribution of private sector employment to total employment growth from equation (1) and $(B_t - B_s)/E_s$ is the contribution of public sector employment. The vector *X* is a set of LA characteristics that affect private sector employment growth and ε is an error term. If β=0, each additional public sector worker has no effect on private sector employment (and so simply adds 1 to total area employment). If β>0, for each additional worker employed in the public sector, private sector employment *increases* by β. That is, the increase in public sector employment has a multiplier effect on the private sector (resulting in a more than proportionate increase in total employment). Finally, if β<0, for each additional worker employed in the public sector, private sector employment falls by β. That is, public sector employment crowds out private sector employment.

Specification (2) takes into account criticisms of immigration research which uses similar approaches (Peri and Sparber, 2011). Relative to Card (2007) we use the change in private sector, rather than total employment as the dependent variable. This provides a direct test of

displacement and, more importantly, removes any artificial correlation between the dependent variable and explanatory variables (since public sector employment growth no longer appears on both sides of the estimating equation).[14]

As discussed by Card (2007), the central problem with estimating β in equation (2) is that the unobserved determinants of private sector employment growth (the factors omitted by the model captured in ε) are likely to be correlated with growth in public sector employment. For example, in relatively successful LAs, private sector employment growth will tend to be positively correlated with public sector employment growth if population increases as the private sector grows (because many public services are non-traded and so respond to local population growth). Alternatively, public sector employment may be negatively correlated with private sector employment growth if government attempts to offset negative shocks to the private sector by expanding the public sector (e.g. through relocation of public sector workers across LAs). The former effect will bias the estimate of β upwards, the latter will bias the estimate downwards. In order to isolate exogenous shifts in public sector employment we use instrumental variables estimation which requires a suitable instrument correlated with, but not directly related to, changes in local private sector employment.

We construct our instrument using the "shift-share" approach associated with Bartik (1991) and used by Card (2007) and Moretti (2010). This instrument uses initial shares of public sector employment and the national growth in public sector employment to predict LA changes in public sector employment. That is, we assume that in the absence of area specific shocks, each LA would have received a share of the (considerable) increase in national public sector employment that occurred during our study period in proportion to its initial share of public sector employment. Specifically, we construct our instrument as:

$$\frac{B_s}{E_s} \times \frac{B_t^{ENG} - B_s^{ENG}}{B_s^{ENG}} \qquad (3)$$

where B_s / E_s is the initial share of public sector employment in the LA and $(B_t^{ENG} - B_s^{ENG}) / B_s^{ENG}$ captures the overall growth rate of public sector employment in England (which varies across each LA because we exclude own LA employment when calculating overall growth). Excluding own LA helps address the concern that changes in private sector employment in any given LA may drive national changes in public sector employment (which would invalidate our identification strategy given we rely on the national change being exogenous). This still leaves the concern that initial shares may be correlated with unobserved characteristics of LAs which in turn drive private sector employment. We address this concern by showing that our results are broadly unchanged when subjected to a number of robustness checks discussed further below. In short, this instrument works well and is the one that we use throughout the paper.[15]

[14] As a robust check, we have run regressions based on specification (2) expressing all variables in logs. Results essentially do not change and are available upon request.

[15] In addition to our instrument constructed using this shift-share approach, we also considered alternative instruments based on a data set of government office relocations and another set of instruments based on local government seats won by the labour party at the 1983, 1997 and 2005 elections. None of these alternatives

Table 1: Descriptive statistics

	BIS data, 2003-2007		ABI data, 2003-2007	
	Mean	Standard Deviation	Mean	Standard Deviation
Total employment 2003	61,045	55,688	57,089	52,218
Private sector employment 2003	48,972	44,629	41,230	38,196
Private sector share 2003	80.6	6.3	72.6	6.9
Public sector employment 2003	12,073	12,008	15,859	15,201
Public sector share 2003	19.4	6.3	27.4	6.9
Total employment growth 2003-2007	5.5	6.5	4.8	6.5
Private sector employment growth	5.8	7.1	3.4	7.4
Contribution Private	4.7	5.7	2.5	5.4
Public sector employment growth	5.8	17.8	9.6	13.0
Contribution Public	0.8	3.2	2.3	3.5
Control variables				
Population 2003	141,632	94,683	141,632	94,683
Population growth 2003-2007	2.4	2.1	2.4	2.1
Contribution Population	6.0	5.2	6.4	5.6
College graduates and above	24.9	7.5	24.9	7.5
A-level	14.9	2.9	14.9	2.9
Apprenticeship	6.5	2.4	6.5	2.4
GCSEs and O-level	15.8	3.1	15.8	3.1
Foundation	15.3	3.6	15.3	3.6
Other qualifications	8.4	3.7	8.4	3.7
No qualifications	14.1	5.2	14.1	5.2
Model-based unemployment rate	4.4	1.8	4.4	1.8

Note: Education variables are expressed as the 2003 local share of working age population (16-64 years old) with the relevant education qualification. The 2003 local unemployment rate refers to the model-based unemployment rate derived by the ONS which combines unemployment information from the Annual Population Survey and the number of beneficiaries of Jobseeker's Allowance.

Source: BIS Local Authority data (2003-2007); ABI Local Authority data (2003-2007); Local Area Labour Force Survey (1999-2003); Annual Population Survey (2004-2007); ONS Model-based Estimates of Unemployment (1999-2007); mid-year LA population estimates derived from the 2001 UK Census of Population (1999-2007). Because of missing data we exclude two LAs: City of London and Isles of Scilly.

Table 1 provides descriptive statistics for LA employment growth rates, the contributions and shares of public and private sector (as defined in equations 1, 2 and 3) and our control variables. The first two columns provide statistics for the BIS data, the second two columns for ABI. The first thing to note is that our ABI data has smaller total employment because we

turned out to provide sufficiently strong instruments, hence our decision to focus solely on the shift-share instrument described in the text.

drop several sectors (agriculture and fishing; mining and quarrying; electricity, gas and water supply; transport and communication; and extra-territorial organisations and bodies).[16]

In the BIS data around 80% of 2003 employment is in the private sector. The share is smaller in the ABI data because, as discussed above, the private-public sector split relies on sectoral classifications and some jobs in SIC80 (education) and SIC85 (health and social work) are private sector jobs that incorrectly get classified as public sector. In the BIS data, average LA public and private sector employment growth are equal (at a little under 6%).[17] In contrast, public sector employment growth is considerably higher in the ABI data, suggesting that the private sector share of education, health and social work jobs has been growing over time (because these are the jobs that are incorrectly classified as public sector jobs in the ABI data). This misclassification problem for ABI data carries over to the contribution of public and private sector growth (as defined in equation 1). As a result, the contribution of private sector employment growth is considerably larger in the BIS data than it is in the ABI. These issues also arise when looking at the national growth in public sector employment. According to the BIS data, public sector employment grew by 4.3% between 2003 and 2007. The ABI data gives a higher growth rate, 8.3%, over the same time period (reflecting the classification issues just discussed). Over the longer time period, 1999-2007 the ABI data record an even larger 20.6% increase. Note, however, that our analysis identifies the effects on labour markets from variation in the contribution of public sector employment *across LAs* which is roughly similar in both the BIS and ABI data sets. This suggests that the measurement error driven by the growing private sector share of education, health and social work jobs does not have a strong spatial component so that overall the cross LA variation in the contribution is largely unaffected.

The final rows of the table report summary statistics for our control variables which are identical regardless of whether we use BIS or ABI data. In our empirical specification, identification comes from cross-LA variation in the contribution of public-sector employment growth. This raises the concern that LAs with higher public sector growth rate may differ systematically from LAs with low public sector employment growth. Clearly, controlling for observable characteristics and instrumenting help mitigate these concerns, but it is also reassuring to note that high and low public sector growth areas appear to be quite similar in terms of their observable characteristics. As evidence of this, Table 2 provides further descriptive statistics for our control variables for different groups of LAs classified by quartiles of public sector growth observed in the sample. The table shows that these groups are similar in terms of both industrial and educational composition. The final two rows of the table show that they are also very similar in terms of their proximity to London (and Inner London).

[16] We exclude farm agriculture because of missing data for some LAs (for the same reason BIS data exclude farm agriculture) and utilities because categorizing employment in those divisions is complicated by a number of factors. See Appendix 1 for more details.

[17] Note that the LA average total employment growth is actually lower than either the average public or private sector employment growth because we are presenting simple unweighted LA means.

Table 2: Descriptive statistics broken down by quartile of population growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quartile	0-25%	25-50%	50-75%	75-100%	0-25%	25-50%	50-75%	75-100%
	ABI 2003-2007				ABI 1999-2007			
Agriculture	0.37	0.46	0.30	0.40	0.36	0.29	0.43	0.34
Fishing	0.02	0.02	0.02	0.04	0.05	0.02	0.04	0.05
Mining	0.26	0.19	0.29	0.16	0.31	0.20	0.37	0.27
Manufacturing	13.48	15.40	14.89	14.63	15.91	18.28	18.80	18.94
Construction	4.49	4.97	5.19	5.33	4.73	4.74	5.38	5.52
Trade	17.73	18.14	18.97	18.57	17.12	18.16	18.14	18.81
Hotels & Rest.	7.55	7.35	7.09	7.49	7.16	6.80	7.02	6.95
Transport	5.45	5.80	6.09	5.96	5.28	5.71	6.01	6.29
Finance	2.43	2.86	3.01	2.87	3.06	3.46	2.87	2.57
Real estate	14.40	14.88	14.11	13.70	14.44	14.54	12.50	11.70
Public Admin.	6.58	4.63	4.81	4.87	6.73	4.42	4.47	4.93
Education	9.99	8.75	9.16	9.07	8.70	8.58	8.44	7.86
Health	11.53	10.77	10.77	11.38	10.64	9.35	10.11	10.81
Other	5.31	5.30	4.86	5.16	5.07	4.99	4.99	4.54
College degree	25.47	25.92	24.06	24.14	23.50	23.87	21.67	20.73
Apprenticeship	6.85	6.45	6.47	6.37	8.16	7.67	8.39	8.58
A-level	14.45	14.79	15.02	15.20	13.72	12.87	13.35	13.07
O-level	15.76	15.33	16.21	16.02	15.68	14.89	15.35	15.53
Foundation	15.20	14.87	15.67	15.55	15.40	15.46	16.79	17.17
Other quals.	8.71	8.78	7.84	8.30	9.53	9.52	9.46	9.21
No qualifications	13.56	13.87	14.73	14.41	15.17	15.93	15.84	16.78
Unemp. rate	4.24	4.45	4.35	4.40	4.94	4.97	5.27	5.69
Proximity Inner London (km)	170.24	167.66	168.90	155.37	159.55	146.97	176.93	178.71
Proximity London (km)	169.88	167.31	168.57	155.21	159.22	146.57	176.63	178.55

Note: Industry variables are expressed as the initial (2003 or 1999) local share of working age population (16-64 years old) working in a given industry; educational variables are also expressed as the initial (2003 or 1999) local share of working age population (16-64 years old) with the relevant education qualification. The initial (2003 or 1999) local unemployment rate refers to the model-based unemployment rate as described in the note to table 1. Distance variables (both proximity to Inner London and proximity to London) are expressed in kilometres. They refer to the distance between each LA centroid and the London centroid, constructed either by aggregated all LAs that belong to Inner London (14 LAs used for proximity to Inner London) or by aggregated all LAs that belong to Inner London and Outer London (33 LAs used for proximity to London).

We now turn to estimation results and begin with those for equation (2) using BIS data. Our dependent variable is the change in private sector employment 2003-2007 divided by total employment in 2003 (defined in equation 2 and referred to as the contribution of private sector employment). Our main regressor, similarly defined, is the contribution of public sector employment over the same period. Column (1) in Table 3 reports OLS estimates with no additional controls. Column (2) reports results when we control for total local employment and qualification shares in 2003. The specification in column (3) adds initial unemployment rate in 2003 as an additional control. As is clear from the table, the OLS estimate of β (the coefficient on the public sector growth) is roughly stable and just below 0. All of these

estimates are statistically insignificantly different from zero, although taken literally the point estimate of -0.02 in column OLS(3) implies that each additional 100 public sector jobs in a LA decreases private sector employment by 2.

Table 3: Impact of public sector on private sector employment, BIS data 2003-2007

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Contribution$_{2003\text{-}07}$ (public sector)	-0.043	-0.027	-0.022	0.565	0.306	0.214
	(0.100)	(0.100)	(0.101)	(0.382)	(0.348)	(0.343)
ln(total employment$_{2003}$)		-1.88***	-1.71***		-1.97***	-1.74***
		(0.43)	(0.52)		(0.42)	(0.51)
College degree$_{2003}$		0.02	-0.01		0.02	-0.02
		(0.06)	(0.07)		(0.06)	(0.07)
A-level$_{2003}$		0.27**	0.23**		0.25*	0.21*
		(0.13)	(0.12)		(0.14)	(0.12)
O-level$_{2003}$		-0.10	-0.14		-0.10	-0.15
		(0.14)	(0.13)		(0.14)	(0.13)
Apprenticeship$_{2003}$		-0.08	-0.10		-0.07	-0.10
		(0.17)	(0.16)		(0.17)	(0.16)
Foundation$_{2003}$		-0.12	-0.15		-0.14	-0.17
		(0.13)	(0.12)		(0.13)	(0.13)
Other qualifications$_{2003}$		-0.06	-0.06		-0.06	-0.06
		(0.12)	(0.12)		(0.12)	(0.12)
Unemployment rate$_{2003}$			-0.20			-0.25
			(0.38)			(0.35)
Constant	4.75***	12.07*	14.90**	4.27***	12.63*	16.02**
	(0.31)	(7.26)	(6.21)	(0.44)	(7.24)	(6.43)
Observations	352	352	352	352	352	352
Adj. R-squared	0.001	0.075	0.077			
First-stage statistic				11.53	12.68	15.54

Note: Robust standard errors reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. The dependent variable is the contribution of private sector to total employment growth (as defined in the text). Contribution$_{2003\text{-}07}$ (public sector) denotes the contribution of public sector to total employment growth (as defined in the text). The instrumental variable is equal to the 2003 share in public sector employment for a given LA multiplied by the 2003-2007 increase in public sector employment for England as a whole (excluding own LA). All included controls are as defined in Table 1 and measured as of 2003. Corresponding first-stage estimates for column IV(3) are reported in Appendix 2, Table A1, column BIS(1).

Source: BIS Local Authority data (2003-2007); Local Area Labour Force Survey (1999-2003); Annual Population Survey (2004-2007); ONS Model-based Estimates of Unemployment (1999-2007) Because of missing data we exclude two LAs: City of London and Isles of Scilly.

The right hand side panel reports instrumental variable estimations for the same three specifications where we use the shift-share instrument defined in equation 3. Instrumenting for the share of public sector employment gives a higher estimate for β. As discussed above, there are two opposite sources of bias at work when estimating β. The coefficient is biased upwards if increases in private sector employment *cause* increases in public sector employment (not vice-versa). The coefficient is biased downwards if public sector

employment growth is used to offset negative shocks to the private sector. The IV results reported in columns IV(1)-IV(3) suggest that the latter effect dominates. Taken literally the point estimate of 0.21 in column IV(3) implies that each additional 100 public sector jobs in a local district increases private sector employment by 21. However, as with OLS, all of these IV estimates are statistically insignificantly different from zero. The first stage results reported in Appendix 2 suggest that the instrument performs reasonably well, so this lack of statistical significance is not the result of a weak instrument problem. Instead, the most appropriate interpretation is that results in Table 3 provide little evidence of either a multiplier or displacement effect from public sector employment on total private sector employment.

We might still worry that unobserved area specific factors are driving both the original public sector employment shares and private sector employment growth. Introducing geographical dummies provides a way of further controlling for these unobserved omitted variables, although the number of LAs limits the number of dummies that we can include. Results for our coefficient of interest when including four regional dummies for the North, the Midlands, the South and London are reported in column (2) of Table 4.[18] Comparison with column (1), which simply replicates the final column of Table 3, suggests that there are broad regional factors which drive both private and public sector employment and that controlling for these reduces our estimates of the impact of public sector employment on private sector employment growth (although the differences in point estimates are not significant). To further address concerns about some omitted factor driving both private and public sector employment, we can include the change in private sector growth in an earlier time period as an additional control. Data availability prevents us from including such 'pre-trends' calculated from the BIS data, but we can use changes between 1999-2002 from the ABI data. Results, reported in column (3), show that our coefficient of interest is essentially unchanged.

[18] The broad area dummies are based on the government regions. North includes the North West, the North East and Yorkshire and the Humber; the Midlands the East and West Midlands; the South combines the South-East, the South West, the East of England; London is based on the Greater Metropolitan area. Results for the other characteristics are unchanged and available on request.

Table 4: Impact of public sector on private sector employment growth, additional controls and alternative instruments, BIS data 2003-2007

	(1)	(2)	(3)	(4)	(5)
$Contribution_{2003-07}$ (public sector)	0.214	0.085	0.112	0.065	0.863
	(0.343)	(0.325)	(0.320)	(0.325)	(0.707)
Pre-trends: $Contribution_{1999-02}$ (private sector)			0.11**	0.10*	0.11*
			(0.05)	(0.05)	(0.06)
$Contribution_{2003-07}$ (population)				0.12*	0.07
				(0.06)	(0.08)
Instrument	2003	2003	2003	2003	1999
Controls					
Employment; Education	√	√	√	√	√
Unemployment rate	√	√	√	√	√
Broad area dummies		√	√	√	√
Observations	352	352	352	352	352
First-stage statistic	15.54	14.01	13.87	13.60	4.70

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. The dependent variable is the contribution of private sector to total employment growth (as defined in the text). The pre-trend variable, $Contribution_{1999-02}$ (private sector), is the contribution of private sector employment 1999-2002 (defined as for the contribution of public sector employment, see equation (2) in the text). The population variable, $Contribution_{2003-07}$ (population) is the contribution of population 2003-2007 (defined as for the contribution of public sector employment). All specifications estimated using IV, with the row labeled instrument indicating the year for which initial shares are used to construct the instrument. Broad geographical areas are the Midlands, the South and London, with the excluded category being the North. All other regressors and controls are as in Table 3. Corresponding first-stage estimates for specifications (1) and (2) are reported in Appendix 2, Table A1, columns BIS(1) and BIS(2), respectively. Other first stage estimates for columns (3) to (5) are available on request.
Source: See Table 3. Mid-year LA population estimates derived from the 2001 UK Census of Population (2003-2007).

In addition to using pre-trends, we can also try including contemporaneous changes that might be driving both changing public and private sector employment. The obvious choice is to include the contemporaneous change in population as we know that this partly drives public sector employment and is likely to be correlated with private sector employment growth. For consistency with the other variables, we use the change in population 2003-2007 normalised by total employment (i.e. the 'contribution' of population growth). Results when including both the pre-trend for employment and contemporaneous changes in population are reported in column (4) and show little difference.

In addition to concerns about unobserved trends, we might also worry that serially correlated shocks are driving both the *initial share* of public sector employment and subsequent changes in private sector employment. This would invalidate our instrument which is constructed using initial shares combined with (arguably exogenous) changes in national public sector employment. To address this concern we use longer lags of initial shares - specifically initial public sector shares from 1999 taken from the ABI data - to construct an alternative instrument. Results are shown in column (5) for a specification including both the pre-trend and contemporaneous changes in population. Again, our results are broadly unchanged.

Results reported so far show an average effect across all LAs. One final possibility is that results may vary depending on LAs initial conditions. To consider this possibility we tried two alternative specifications. In one, we interacted the broad regional dummies with public sector contribution to allow the coefficient to differ across broad regions. In the other, we interacted public sector contribution with LA unemployment to allow for the effects to be different between higher and lower unemployment LAs. For both specifications, coefficients

on the interaction terms were very imprecisely estimated suggesting little strong evidence that effects are heterogeneous. Results are available on request.

Given that zero point estimates are still interesting in our conceptual framework we interpret these results as providing an estimate of the likely range of effects. Based on a coefficient estimate of 0.08 and a standard error of 0.33 (see column (2), Table 3), the 95% confidence interval for the effect of public sector employment on private sector employment is (-0.58, 0.74). That is, we can rule out complete crowding out (the coefficient on public sector employment would be minus 1) and we can rule out multipliers as high as 2 (as assumed in some reports on public sector relocation – see Lyons (2004) and Smith (2010)).

Given that we can rule out complete crowding out, increased public sector employment must imply some increase in total employment. Our conceptual framework suggested that labour supply responses to this increase in total employment could come from local residents or from new residents who move from elsewhere. The data we have available allows us to consider three possible supply responses. First, increased public sector employment could increase working age population if people move to the area. Second, it could increase labour force if some previously inactive people become active. Third, it could reduce unemployment. The fourth possibility (that we ignored for simplicity in our conceptual framework) is that the increase in employment is met by commuting of workers from some wider labour market. Given that we have no time series data on commuting patterns, we are unable to assess this explanation directly. Instead, we treat commuting as the 'residual' adjustment that occurs if changes in our observable labour force variables do not (fully) capture the labour supply response. Table 5 reports IV results for each of the three variables for which we have data for a specification including broad area dummies plus controls (i.e. the same specification as in column (2) of Table 4). We find no evidence that increased public sector employment increases working age population, reduces inactivity or unemployment. Taken literally, this suggests that all of the adjustment comes through commuting. However, given the imprecision of our estimates, we think a more appropriate interpretation is that we are unable to identify the relative importance of the different channels through which labour supply adjusts to the increase in total employment.

Table 5: Impact of public sector on local labour market indicators, BIS data 2003-2007

	Working Age Pop	Worklessness	Unemployment
$Contribution_{2003-07}$ (public sector)	-0.015	0.229	-0.019
	(0.282)	(0.438)	(0.043)
Controls			
Broad areas	√	√	√
Employment; Education	√	√	√
Unemployment rate	√	√	√
Observations	352	352	352
First-stage statistic	14.01	14.01	14.01

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. The dependent variables are Working Age Population: the change in working age population 2003-2007 normalized by total LA employment in 2003; Worklessness: the change in the number of inactive and unemployed over the same period, similarly normalized; Unemployment: the change in the number of unemployed over the same period, similarly normalized. All controls are as in Table 4. All specifications estimated using IV, with initial shares from 2003 used to construct the instrument. Corresponding first-stage estimates are reported in Appendix 2, Table A1, column BIS(2).
Source: See Table 3.

5. The impact on tradable versus non-tradable sectors

In this section we consider a central prediction from the conceptual framework: while public sector employment could have a multiplier effect for non-tradable sectors it should crowd out employment in the tradable sector. To consider this we start by simply assuming that manufacturing output is tradable, while service and construction outputs are non-tradable and re-run our analysis separately for each group.

One complication arises because the BIS data that we use to classify employment in to public and private does not provide further detail on sector. This leaves us with two ways to construct tradable and non-tradable employment. One possibility is to switch to ABI, subject to the caveats regarding problems with the public versus private classification discussed above. The other is to use the BIS data to classify employment in to private or public sector and then to use the ABI employment share in each LA to divide private sector employment in to tradable versus nontradable sectors. For consistency with our earlier results, the second of these is our preferred option for which we report results (although in practice it makes little difference). Further details on how we construct the data are provided in Appendix 1.

Results are reported in Table 6, first for employment in the tradable sector (manufacturing) then for employment in the non-tradable sector (construction plus services). We report results for specifications including the broad regional dummies and the three sets of controls as used in Tables 4 and 5. The OLS results, column (1), suggest a coefficient of around 0.02 for tradables, 0.09 for non-tradables. While the point estimates are consistent with our conceptual framework the coefficients are not significantly different from one another (or from zero). Of course, just as before there are two possible sources of bias in these OLS estimates. To reiterate, our estimates will be upward biased if private sector employment growth is positively correlated with public sector employment growth because population increases as the private sector grows (as many public services are non-traded and so respond to local population growth). Alternatively, our estimates will be downward biased if public sector employment is negatively correlated with private sector employment growth because, say, government attempts to offset negative shocks to the private sector by expanding the public sector.

To deal with this problem we use the same shift-share instrument as we did above which uses initial shares of public sector employment, combined with the national growth in public sector employment to predict local increases in public sector employment. The IV results are reported in column (2) of Table 6. In line with our conceptual framework, public sector employment crowds out private sector employment in the tradable sector, but has a multiplier effect on employment in the non-tradable sector. The point estimates suggest that 100 additional jobs in the public sector reduce manufacturing employment by a little over 40 jobs while increasing service and construction employment by a little over 50 jobs. Our earlier results, reported in Tables 3 and 4, suggest that these two offsetting 'structural' effects combine to leave total private sector employment unchanged.

The IV results suggest that the direction of bias in the OLS estimates differs depending on whether we are considering the tradable or non-tradable sector. For the tradable sector, OLS coefficients are upward biased suggesting the existence of a positive multiplier from private sector tradable employment to public sector employment. For the non-tradable sector, OLS coefficients are downward biased suggesting that public sector employment tends to expand in response to reductions in employment in the non-tradable sector. Interestingly, if we assume much public sector employment is itself non-tradable, the first of these effects is

consistent with results from Moretti (2010) for the US who finds that increases in tradable employment have a positive multiplier on non-tradable employment.

Columns (3)-(5) report results for a range of robustness checks (identical to those reported for total employment in Table 4). Column (3) introduces pre-trends in private sector employment (split in to tradable/non-tradable). Column (4) adds contemporaneous changes in population. Results for both tradable and non-tradable sectors are unchanged. Column (5) instruments using longer lags of initial shares. Here the results for tradable sector employment are robust, but those for non-tradable sector become insignificant. Recall, however, that constructing the instrument using longer lags requires us to shift to using ABI data where the misclassification problem in the service sector is more pronounced. In keeping with this, results available on request show that the coefficient for non-tradable sector becomes insignificant when the instrument is constructed using 2003 shares but taken from the ABI rather than the BIS data. It appears, therefore, that the lack of significance for the non-tradable sector when using long lags of shares to construct the instrument is more likely to reflect measurement error than a fundamental problem with our underlying identifying assumptions.

To reiterate, our main substantive conclusion: Consistent with our conceptual framework public sector employment crowds out private sector employment in the tradable sector, but has a multiplier effect on employment in the non-tradable sector.

Table 6: Impact of public sector on private sector employment splitting by tradable and non-tradable sectors, combined BIS and ABI data 2003-2007

	(1)	(2)	(3)	(4)	(5)
Tradable (Manufacturing)					
$Contribution_{2003-07}$ (public sector)	0.023	-0.441**	-0.441**	-0.464**	-0.807**
	(0.037)	(0.173)	(0.173)	(0.178)	(0.377)
First-stage statistic		14.01	13.96	13.78	5.52
Nontradable (Const. plus services)					
$Contribution_{2003-07}$ (public sector)	0.096	0.518*	0.519*	0.486*	0.943
	(0.077)	(0.278)	(0.283)	(0.282)	(0.631)
First-stage statistic		14.01	13.69	13.43	4.53
Instrument	OLS	2003	2003	2003	1999
Controls					
Broad areas	√	√	√	√	√
Employment; Education	√	√	√	√	√
Unemp rate	√	√	√	√	√
Pre-trends			√	√	√
Population change				√	√
Observations	352	352	352	352	352

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. The dependent variables are: Tradable (Manufacturing) defined as the change in manufacturing employment 2003-2007 normalised by total 2003 LA employment. Nontradable (Construction plus services) similarly defined using the change in construction and services employment. All controls are as in Table 4. Specification (1) estimated using OLS, with the remaining specifications estimated using IV with the row labeled instruments indicating the year for which initial shares are used to construct the instrument. Corresponding first-stage estimates for column (2) are reported in Appendix 2, Table A1, column BIS(2). Other first stage estimates for columns (3) to (5) are available on request.
Source: BIS data for public sector employment and ABI data for private sector employment split between tradable and non-tradable sectors across 352 English LAs over 2003-2007 (see Table 3 for sample restrictions). Mid-year LA population estimates are based on results from the 2001 UK Census of Population (2003-2007).

In order to better understand the impact of public sector employment on tradable/non-tradable sectors, we focus on services and investigate whether the impact varies by the degree of

service 'tradability'. Our prior, consistent with the conceptual framework, is that the less tradable is the service, the larger should be any positive impact of public sector employment on employment in that type of service. We look to the international economics literature to provide us with a suitable classification. A review of the literature suggests there is no standard way of splitting services between tradable and non-tradable. We draw on a recent contribution (Jensen and Kletzer, 2006) in the services offshoring literature that identifies services activities that are potentially exposed to international trade.

Jensen and Kletzer (2006) use the geographical concentration of service activities within the United States to identify those activities which are traded domestically. They assume that geographically concentrated activities are more tradable (which they verify by looking at manufacturing industries). Applying their geographical concentration index (an augmented GINI coefficient), they classify service activities into three classes according to their degree of tradability. Based on an industry correspondence table downloadable from the US Census Bureau webpage, we map their industrial classification (the North American Industrial Classification System) into the UK 4-digit SIC classification and classify LA service employment accordingly (see Appendix 3). The correspondence table maps 2002 NAICS (6 digit code) to NACE Rev. 1.1 (4 digit code) which is almost equivalent to the UK 2003 SIC classification. Together with the code, the correspondence table also provides a brief description of the industry. The Jensen-Kletzer (2006) list of tradable/nontradable service activities uses the NAICS classification, but it does not provide a full code or description of the activity – only a title and a 2-digit industry code. Therefore, we combine information on the industry code and description to match the NAICS and the UK SIC classifications.[19]

Results using this classification are presented in Table 7 (where, once again, we only report coefficients on the public sector variable). As expected, we find that the impact of public sector employment is positive and significant for non-tradable services activities; but insignificant for medium and tradable services (with the point estimates lower for the latter, then the former). It is interesting to note that the impact on tradable services is *insignificant*, while the impact on manufacturing was negative and significant. The most likely explanation is that even for these tradable services, local demand is a higher proportion of total demand, although data is not available for us to check the validity of this explanation. Once again, these results are robust to the inclusion of pre-trends and contemporaneous population change.[20] Looking at the composition of service employment, we see that non-tradables dominate within total service employment explaining why we find a positive coefficient when we run the regression for totals as reported in Table 6.

[19] Furthermore, Jensen and Kletzer (2006) do not report Gini coefficients for wholesale and retail trade activities (see Table 2 in Jensen and Kletzer, 2006), even though they compute them. We classify those activities into the three Gini classes combining the discussion that Jensen and Kletzer (2006) provide in the text with the results they report in Figure 1 of their paper.

[20] See table A3 in the appendix. As with the specifications reported in Table 6, results are not robust to switching to ABI data to construct the instrument using either long lags (1999) or initial share (2003).

Table 7: Impact of public sector on private sector employment splitting services by tradability, combined BIS and ABI data 2003-2007

	OLS			IV		
	(1)	(2)	(3)	(1)	(2)	(3)
Nontradable Contribution$_{2003\text{-}07}$ (public sector)	0.029 (0.043)	0.033 (0.043)	0.026 (0.043)	0.313* (0.171)	0.321* (0.167)	0.355** (0.171)
Medium Tradable Contribution$_{2003\text{-}07}$ (public sector)	0.079 (0.073)	0.078 (0.074)	0.088 (0.075)	0.367* (0.208)	0.257 (0.171)	0.167 (0.153)
Tradable Contribution$_{2003\text{-}07}$ (public sector)	-0.015 (0.014)	-0.015 (0.013)	-0.018 (0.013)	-0.012 (0.064)	-0.029 (0.061)	-0.003 (0.060)
Controls						
Broad areas	√	√	√	√	√	√
Employment; Education		√	√		√	√
Unemp rate			√			√
Observations	352	352	352	352	352	352
First-stage statistic				9.95	11.09	14.01

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. The dependent variables are: Nontradable defined as the change in employment 2003-2007 for services in Gini class 1, normalised by total 2003 LA employment; Medium Tradable and Tradable similarly defined for Gini class 2 and 3, respectively. Services sectors are classified according to the Jensen-Kletzer (2006) classification as described in the text: Gini class 1 (least geographically concentrated) when the Gini index < 0.1; Gini class 2 when the Gini index is between 0.1 and 0.3; Gini class 3 (most geographically concentrated) when the Gini index is ≥ 0.3. All controls are as in Table 4. Corresponding first-stage estimates for IV(3) are reported in Appendix 2, Table A1, column BIS(2).
Source: See Table 6.

6. The impact of public sector employment: long differences

The BIS data that we have used so far constrains the period of analysis to 2003-2007. Using the ABI data would allow us to consider longer periods, but we know from Table 1 and the discussion surrounding it, that this data is subject to greater measurement error in terms of the public/private split. To assess the degree to which this affects our results, we replicate the 2003-2007 analysis using the ABI data. Results reported below show that estimates on the impact of public sector employment for 2003-2007 are broadly similar whether we use ABI or BIS data. This gives us some confidence in using the ABI data to study the impact of public sector employment over a longer time period 1999-2007. Over this longer time period, we find stronger evidence of crowding out on overall private sector employment which appears to arise because of stronger crowding out for manufacturing coupled with weaker multiplier effects on local services.

We start with the issue of the comparability of results using BIS and ABI data for the period 2003-2007. Columns (1) and (2) of Table 8 report IV results for the impact of public sector on private sector employment using the BIS and ABI data for the period 2003-2007. The first column simply replicates the results for total employment and for tradables and non-tradables as reported in the final column of Table 4 and column (2) of Table 6, respectively. The second column shows the same results when using ABI. As is immediately apparent, for total employment the results are broadly similar whether we use BIS or ABI data for 2003-2007.

Turning to the differential impact on tradables versus nontradables results are, again, broadly similar. We continue to find significant displacement effects on manufacturing employment and evidence of a multiplier effect on services and construction, although the second of these estimates is marginally insignificant for the ABI data.[21] Remember, however, that it is the public-private split in service sector employment that represents the main classification problem with the ABI data so the (marginal) lack of significance for the coefficient on nontradables may simply reflect an attrition bias due to measurement error. Once again, results for tradables are robust to the inclusion of pre-trends, contemporaneous changes in population or using longer lags to construct the instruments. None of these robustness checks makes any difference to the coefficients on either total or service sector employment (both remain insignificant for all robustness specifications). Results are available on request.

Table 8: Impact of public sector on total private sector employment, and splitting by tradable and non-tradable sectors, comparing BIS data 2003-2007, ABI data 2003-2007 and ABI data 1999-2007

	(1)	(2)	(3)	(4)	(5)
Contribution (public sector)	0.085	0.075	0.229**	-1.00*	-0.727*
	(0.325)	(0.326)	(0.098)	(0.529)	(0.386)
Tradable (Manufacturing)					
Contribution (public sector)	-0.441**	-0.384***	-0.035	-0.784***	-0.667***
	(0.173)	(0.140)	(0.041)	(0.271)	(0.205)
Nontradable (Construction plus services)					
Contribution (public sector)	0.518*	0.458	0.264***	-0.218	-0.060
	(0.278)	(0.310)	(0.085)	(0.332)	(0.269)
Data	BIS	ABI	ABI	ABI	ABI
Time period	2003-07	2003-07	1999-07	1999-07	1999-07
Estimation	IV	IV	OLS	IV	IV
Controls					
Broad areas	√	√	√	√	√
Employment; Education	√	√	√	√	√
Unemployment rate	√	√	√	√	√
Population change					√
Observations	352	352	352	352	352
First-stage statistic	14.01	14.32		13.28	16.89

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. Column (1) use BIS data to construct contribution of public sector, columns (2)-(5) use ABI data. See text and note to Table 6 for further details. All variables defined as long-differences between either 2003-2007 (columns 1 and 2) or 1999-2007 (columns 3 to 5). All controls are measured as of 2003 (columns 1 and 2) or 1999 (columns 3 to 5). England area dummies include the Midlands, the South and London, the benchmark being the North. Because of missing reporting of some educational variables, columns 3 to 5 use a simpler education classification. Education variables use the local share of working age population with the relevant education qualifications: O-level and above, Foundation diploma, the benchmark being 'other and no qualifications'. Corresponding first-stage IV estimates for specifications (1) and (2) are reported in Appendix 2, Table A1, columns BIS(2) and ABI(2), respectively. Corresponding first-stage IV estimates for specifications (4) and (5) are reported in Appendix 2, Table A2, column ABI(2).
Source: BIS Local Authority data (2003-2007) and ABI Local Authority data (1999-2007). See Table 3 for sample restrictions. Mid-year LA population estimates are based on results from the 2001 UK Census of Population (1999-2007).

[21] It is significant if we exclude unemployment from the set of controls.

On balance this comparison of results using BIS and ABI data suggests that we should be reasonably confident in using the ABI data although the results for the service sector might marginally underestimate any multiplier effect. This also suggests that estimates of the coefficient on overall private sector employment could be somewhat downward biased when using the ABI data, although this effect is not particularly marked in the 2003-2007 period (compare the column (1) point estimate of 0.085 for BIS to that of the column (2) estimate of 0.074 for ABI).

With these caveats in mind, we now turn to results using long differences of ABI data for changes over the period 1999-2007. Aside from the change in timing, the estimating equation is exactly as before. The 1999 data provide a slightly less detailed set of educational variables and so we report results using three educational categories rather than six. Replicating the 2003-2007 analysis using the ABI data and these three educational categories suggests that this makes no substantive difference to our results.[22] Estimates for the impact of public sector employment on total private sector employment are reported in the first rows of columns (3) and (4) of Table 8. In contrast to our earlier results, we now find evidence of significant crowding out of private sector employment. Indeed, taking the point estimates literally suggests that over this longer time period crowding out is complete. Each additional public sector job leads to one less private sector job.

As just discussed, however, it is possible that the ABI data may somewhat underestimate any positive demand effect on the local service sector which would downward bias our estimates of the total employment effect. Results reported in the second and third rows of Table 8 suggest that this may be an issue. The big difference between results reported in Table 6 for BIS data 2003-2007 and those for ABI data 1999-2007 reported in Table 8 is the absence of any positive multiplier on local services. That said, the results on manufacturing employment, which we have argued are less likely to be affected by measurement error do suggest a stronger negative displacement effect over this longer time period. Column (5) shows that these results are robust to the inclusion of contemporaneous population change. Other robustness checks using pre-trends or earlier initial shares to construct the instrument are not possible given the period for which data are available.

A strict interpretation of our findings for changes over 1999-2007 are that they are no different from those for the shorter time period. The coefficient for manufacturing employment -0.78 (with a standard error of 0.27) is not significantly different from that over a shorter time period of -0.44 (with a standard error of 0.17). Similarly, the coefficient on overall private sector employment for the longer time period of -1.00 (s.e. 0.53) is also not significantly different from that of the shorter time period of 0.08 (s.e. 0.33), with the same holding for nontradables. That said, the direction of change on all three coefficients does point to stronger crowding out over the longer time period and the differences are economically important.

7. Channels

Our conceptual framework tells us that a number of factors will determine the nature of the impact of public sector employment on private sector employment. Considering all of these channels is beyond the scope of the paper. But using the data that we have available we can

[22] Results available on request.

consider the role of the elasticity of labour supply in explaining our results. In our conceptual framework, the more elastic is labour supply, the larger will be the multiplier effect on the nontradable sector and the lower is crowding out for the tradable sector. We do not have LA specific measures of labour supply, so cannot test this prediction directly. We can make some progress, however, by comparing our results to those available from Moretti (2010) as we know that labour supply is considerably more elastic in the US than in Britain.

Unfortunately, Moretti (2010) does not consider the impact of public sector employment, focusing instead on the impact of the tradable private sector on the non-tradable private sector. To allow comparison, therefore, we first need to replicate his analysis using our British data. Results reported in each of the panels of Table 9 do this for three of his central specifications: the impact of all tradable, tradable-durable and tradable-non-durable on non-tradable. Columns (1) and (2) use 2003 to 2007 BIS and ABI data, respectively, with the instrument constructed using our standard shift-share instrument as used in our preceding analysis. Column (3) continues to use the ABI data for 2003 to 2007, but now uses a shift-share instrument based on 22 2-digit sectors, which is closer to the instrument used by Moretti (2010). Columns (4) and (5) replicate the ABI analysis (first using our instrument, then using the 2-digit version). Finally, column (6) provides Moretti (2010)'s estimates for ease of comparison.

Looking first at the impact of tradable on non-tradable we see clear evidence that, at least in the short run, increases in tradable employment in the UK have the *opposite* effect to that identified by Moretti (2010) for the US. Results from the contribution of durables appear roughly comparable, while results for the impact of non-durables once again show the opposite pattern to that of the US. Consistent with our conceptual framework (and with our priors) this suggests that a much lower elasticity of labour supply in Britain has important implications for the multiplier effect from tradable employment. In Britain, when tradable private sector employment increases, low labour supply elasticity means that this increase in employment tends to crowd out other local private sector employment. In the US, in contrast, expanding tradable private sector employment also expands non-tradable private sector employment. We can identify two plausible candidates that may explain this lower elasticity of labour supply. The first is that labour market rigidities (e.g. a more generous benefit system) may directly lower the elasticity. The second is that Britain's highly restrictive planning system indirectly lowers labour elasticity by preventing the building of new homes which would allow the overall size of the labour force to respond to positive labour demand shocks (see Hilber and Vermeulen, 2012). Distinguishing between these two explanations on the basis of the data we have available to us is not possible and is left for further work.

Table 9: Impact of tradable on nontradable, and splitting by durable and nondurable goods industries, comparing BIS data 2003-2007, ABI data 2003-2007 and ABI data 1999-2007

	(1)	(2)	(3)	(4)	(5)	(6)
Contribution (Manufacturing)	-0.783**	-0.962**	-0.582**	-0.403*	-0.159	0.355***
	(0.365)	(0.400)	(0.278)	(0.212)	(0.178)	(0.055)
First-stage	23.44	23.83	45.16	101.2	165.7	
Contribution (Durables)	-0.090	-0.212	0.144	-0.170	0.133	0.006
	(0.494)	(0.519)	(0.410)	(0.236)	(0.210)	(0.138)
First-stage	19.64	20.04	35.19	94.89	162.9	
Contribution (Non-Durables)	-1.337***	-1.464***	-1.107***	-0.682*	-0.449*	0.250**

	(0.508)	(0.523)	(0.361)	(0.370)	(0.268)	(0.072)
	9.906	11.45	41.95	25.76	73.03	
Data	BIS	ABI	ABI	ABI	ABI	
Time period	2003-07	2003-07	2003-07	1999-07	1999-07	
Estimation	IV	IV	IV	IV	IV	
Controls						
Broad Areas	√	√	√	√	√	
Employment; Education	√	√	√	√	√	
Unemp rate	√	√	√	√	√	
Observations	352	352	352	352	352	

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. Corresponding first-stage IV estimates are reported below standard errors. Column (1) uses BIS data to construct contribution of Tradable (Manufacturing) sector, which is also split between Durable and Non-durable goods. Columns (2) to (5) use ABI data. The dependent- variable is non-tradable (Construction plus Services) defined as the change in non-tradable employment 2003-2007 (1999-2007) normalised by total 2003 (1999) LA employment. All variables defined as long-differences between either 2003-2007 (columns 1 to 3) or 1999-2007 (columns 4 and 5). All controls are measured as of 2003 (columns 1 to 3) or 1999 (columns 4 and 5). See Table 8 for details. Specifications (1), (2) and (4) use a shift-share instrument as defined in the text (applied to total manufacturing, durable and non-durable, respectively). Specifications (3) and (5) use a shift-share instrument based on 22 2-digit manufacturing industries for total manufacturing (SIC15 to SIC37); 12 2-digit industries for durable goods (SIC20 and SIC26 to SIC37); and 10 2-digit industries for non-durable goods (SIC15 to SIC19 and SIC21 to SIC25).
Source: BIS Local Authority data (2003-2007) and ABI Local Authority data (1999-2007). U.S. Census Bureau for the split between durable and non-durable industries. See Table 3 for sample restrictions.

8. Conclusions

We have examined the impact of public sector employment on private sector employment. Our results suggest that over the period 2003-2007 additional public sector employment had no impact on overall private sector employment. As a result, increases in public sector employment tended to increase total employment one-for-one. Adjustment to this increase in total sector employment can occur through some combination of lower unemployment, greater participation, more commuting and an increase in working age population. With the data available, however, we are unable to distinguish between these different adjustment mechanisms.

When we separate private sector employment in to tradable (manufacturing) and non-tradable (services and construction) we find a differential effect of increases in public sector employment. Consistent with our conceptual framework, public sector employment has a multiplier effect on employment in the non-tradable sector, but crowds out employment in the tradable sector.

Over a longer time period 1999-2007 we find evidence of a stronger displacement effect for the tradable sector and a weaker multiplier effect for the non-tradable sector. Consistent with this, we also find evidence of crowding out of overall employment over the longer time period. The differences are not statistically significant, but are certainly important economically. During the shorter time period point estimates from our preferred specification suggest that 100 extra public sector jobs increased employment in the non-tradable sector by 50 jobs while reducing employment in the tradable sector by 40 jobs leaving overall employment unchanged. In contrast, over the longer time period 100 extra public sector jobs crowd out jobs in the tradable sector, leaving non-tradable employment and total employment unchanged.

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Appendix 1: Data

Regardless of which data source we use (either BIS or ABI data), there is a discontinuity in the data between 2005 and 2006 due to methodological improvements. In order to provide a comparable series over time, the data have been adjusted using scaling factors provided by the Office for National Statistics. These scaling factors were computed for the total number of employee jobs in each LA at the 2-digit SIC2003 level. We have adjusted the original ABI data using these scaling factors, while the BIS version of the data is provided with figures already adjusted.

When constructing the public/private split for the ABI data, we exclude from the private sector the following divisions: agriculture and fishing (from SIC01 to SIC05 as defined by the SIC2003 classification); mining and quarrying (SIC10-SIC14); electricity, gas and water supply (SIC40-SIC41); transport and communication (SIC60-SIC64); and extra-territorial organisations and bodies (SIC95-SIC99). We exclude agriculture because of data issues (both the BIS and the ABI do not report jobs in farm agriculture for all Local Authorities) and utilities because some share of employment in these sectors is likely to be public rather than private sector (and private sector decisions in those divisions are complicated by a number of factors including the fact that they provide public goods and are heavily regulated).

We also restrict our geographical focus to England only. The exclusion of Scotland and Wales from the analysis is partly due to the fact that both countries have devolved administrations and have seen significantly larger public sector employment increases during the decade 1998-2008. In addition, Local Authority districts in England are substantially smaller than most unitary authorities in Scotland and Wales so restricting our focus gives more comparable spatial units.

Because of missing data, we are forced to exclude two English local authorities: the City of London and Isles of Scilly. Our final sample consists of 352 English local authorities over two time periods: 2003-2007 (for both BIS and ABI data) and 1999-2007 (for ABI data only).

In part of the analysis (see Tables 5 and 6), we split private sector employment between tradable and non-tradable sectors. Since the BIS data does not provide further detail on industries, we use the ABI employment share in each LA to divide private sector employment from the BIS data in to tradable and non-tradable sectors. The tradable sector includes all manufacturing industries (SIC15-SIC37). The non-tradable sector consists of construction (SIC45); retail and wholesale trade (SIC50-SIC52; SIC55); financial, professional and retail estate services (SIC65-SIC67; SIC70-SIC74); and personal services (SIC90-SIC93). When we exclude construction from our definition of non-tradable employment, results do not change. When we restrict our definition of non-tradable sector to include either FIRE services or trade and personal services only, results had the expected sign but they were less significant.

We use two skill classifications. The first includes the initial local shares of working age population with the following education qualifications: college degree and above; A-level; apprenticeship; O-level, foundation diploma, other lower qualifications and no qualifications. The second simply reorganizes the seven skill categories into three skill groups: O-level and above, Foundation diploma, the benchmark being other and no qualifications. In order to construct these, we retrieve annual data on the total number of working-age population (men and women aged 16-64) with the relevant education qualification from the Local Area Labour Force Survey (LFS) for the years 1999-2003 and the Annual Population Survey

(APS) for the subsequent years 2004-2007 (as the APS replaced the Local Area LFS from 2004 onwards). Both the Local Area LFS and the APS data are residence-based labor market surveys whose figures have been appropriately weighted by the ONS to be representative of local area geographies. Both datasets are available on the NOMIS website.

Even though we would have preferred to use the more detailed skill classification throughout the analysis, we were forced to adopt the simpler classification when looking at the sample 1999-2007 because of missing information on education in early years of the sample. We are confident that the use of either classification does not make much difference. As a robustness check, we apply the simpler skill classification to the sample 2003-2007 (for both BIS and ABI data), results for the variable of interest (i.e., the β coefficient in equation 2) were very similar to those obtained using the more detailed classification. As a further robustness check, we also ran the 1999-2007 regressions including the more detailed education classification by replacing missing information in 1999 with the first year (or an average of the first three years) for which education shares are available. Results did not change and are available upon request.

Appendix 2: First stage Regressions

Results for a number of first stage regressions are reported in Tables A1 to A2. The first column of Table A1 provides first stage estimates for the specifications reported in column 6 (labeled IV(3)) of Table 3 and also reported in column (1) of Table 4. The second column shows what happens when we include broad regional dummies and corresponds to the first stage regressions for the results reported in column (2) of Table 4. These are also the relevant first stage estimates for results reported in columns (1) to (3) of Table 5, column (2) of Table 6, column (6) of Table 7 and column (1) of Table 8. All of the coefficients are negative and significant and pass weak instrument tests. The negative coefficients imply that (conditional on other controls) actual public sector employment growth was negatively correlated with that which would have been predicted on the basis of initial employment share (consistent with a situation where public sector employment increased considerably for reasons that were unrelated with local economic conditions). The second set of columns in Table A1 present results for the ABI data over the same time period. The descriptive statistics suggested somewhat higher overall public sector employment growth in the ABI data, but Table A1 (columns 3 and 4) suggests somewhat lower coefficients on the shift-share instruments - in terms of magnitude, not statistical significance (F-tests for weak instruments remain satisfactory). This is perfectly consistent with the fact that the ABI data record higher overall public sector employment growth in this period. This effect is reinforced when we look at ABI data over the longer time period as shown in Table A2. Once again, the coefficient on the instrument is lower in terms of magnitude but not significance and the F-tests for weak instruments are, once again, satisfactory.

Table A1: Instrumental Variable Estimation: First Stage Results, BIS and ABI data 2003-2007

Dep. Var.:	$\Delta_{2003\text{-}07}$ (Public sector employment)		$\Delta_{2003\text{-}07}$ (Public sector employment)	
	BIS	BIS	ABI	ABI
	(1)	(2)	(1)	(2)
Instrumental variable	-4.36***	-4.27***	-1.99***	-1.96***
	(1.11)	(1.14)	(0.52)	(0.52)
ln(total employment$_{2003}$)	-0.06	0.04	-0.21	-0.20
	(0.26)	(0.30)	(0.34)	(0.34)
College degree$_{2003}$	0.05	0.04	-0.01	-0.03
	(0.04)	(0.04)	(0.04)	(0.05)
A-level$_{2003}$	0.08	0.07	0.11	0.10
	(0.07)	(0.07)	(0.07)	(0.07)
O-level$_{2003}$	0.05	0.02	-0.01	-0.05
	(0.07)	(0.08)	(0.08)	(0.08)
Apprenticeship$_{2003}$	0.06	0.07	-0.15*	-0.13
	(0.09)	(0.09)	(0.09)	(0.09)
Foundation$_{2003}$	0.11	0.08	0.02	-0.02
	(0.07)	(0.07)	(0.08)	(0.08)
Other qualifications$_{2003}$	-0.02	-0.02	-0.14**	-0.20**
	(0.06)	(0.07)	(0.06)	(0.08)
Unemployment rate$_{2003}$	0.53***	0.60***	0.38**	0.40**
	(0.15)	(0.16)	(0.17)	(0.17)
the Midlands		0.06		0.30
		(0.59)		(0.59)
the South		0.63		0.92*
		(0.40)		(0.48)
London		-0.42		0.98
		(0.84)		(0.94)
Constant	-3.10	-2.55	6.55	7.94*
	(3.51)	(3.91)	(4.39)	(4.66)
Observations	352	352	352	352
F-test of excluded instruments	15.54	14.01	14.73	14.32
	(0.0001)	(0.0002)	(0.0001)	(0.0002)
Centered R-squared	0.11	0.11	0.1173	0.1265

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. In all columns, the dependent variable is the (2003-2007) contribution of public sector as defined in the text. The instrumental variable is equal to the 2003 share in public sector employment for a given local authority multiplied by the 2003-2007 increase in public sector employment for England as a whole (excluding own LA). All other controls are measured as of 2003. See Table 1 for details.

Source: BIS Local Authority data (2003-2007) and ABI Local Authority data (2003-2007). See Table 3 for sample restrictions.

Table A2: Instrumental Variable Estimation: First Stage Results, ABI data 1999-2007

Dep. Var.:	$\Delta_{1999\text{-}07}$ (Public sector employment)	
	ABI	ABI
	(1)	(2)
Instrumental variable	-1.01***	-1.06***
	(0.29)	(0.29)
ln(total employment$_{1999}$)	-0.88**	-0.82**
	(0.40)	(0.41)
O-level$_{1999}$ and above	0.07	0.06
	(0.05)	(0.06)
Foundation$_{1999}$	0.16*	0.11
	(0.09)	(0.10)
Unemployment rate$_{1999}$	0.60***	0.68***
	(0.18)	(0.19)
the Midlands		0.19
		(0.85)
the South		0.77
		(0.84)
London		-0.81
		(0.99)
Constant	4.11	5.03
	(4.45)	(4.58)
Observations	352	352
F-test of excluded instruments	12.25	13.28
	(0.0005)	(0.0003)
Centered R-squared	0.0936	0.099

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels respectively. In all columns, the dependent variable is the (1999-2007) contribution of public sector as defined in the text. The instrumental variable is equal to the 1999 share in public sector employment for a given local authority multiplied by the 1999-2007 increase in public sector employment for England as a whole (excluding own LA). All other controls are measured as of 1999. England area dummies include the Midlands, the South and London, the benchmark being the North. Because of missing reporting of some educational variables, we adopt a simpler education classification. Education variables use the local share of working age population with the relevant education qualifications: O-level and above, Foundation diploma, the benchmark being 'other and no qualifications'.

Source: ABI Local Authority data (1999-2007). See Table 3 for sample restrictions.

Table A3: Impact of public sector on private sector employment splitting services by tradability, combined BIS and ABI data 2003-2007

	(1)	(2)	(3)	(4)
Nontradable (Const. plus services)				
$Contribution_{2003-07}$ (public sector)	0.027	0.019	0.358**	0.343**
	(0.043)	(0.044)	(0.171)	(0.172)
First-stage statistic			14.00	13.81
Medium Tradable (Const. plus services)				
$Contribution_{2003-07}$ (public sector)	0.084	0.076	0.151	0.131
	(0.073)	(0.075)	(0.152)	(0.153)
First-stage statistic			13.27	12.98
Tradable (Const. plus services)				
$Contribution_{2003-07}$ (public sector)	-0.011	-0.012	0.002	0.000
	(0.014)	(0.014)	(0.058)	(0.058)
First-stage statistic			13.46	13.32
Estimation	OLS	OLS	IV	IV
Controls				
Broad areas	√	√	√	√
Employment; Education	√	√	√	√
Unemp rate	√	√	√	√
Pre-trends	√	√	√	√
Population change		√		√
Observations	352	352	352	352

Note: Robust standard errors are reported in parentheses; *, **, *** indicate significance at the 10%, 5% and 1% levels, respectively. The dependent variables are: Nontradable defined as the change in employment 2003-2007 for services in Gini class 1, normalised by total 2003 LA employment; Medium Tradable and Tradable similarly defined for Gini class 2 and 3, respectively. Services sectors are classified according to the Jensen-Kletzer (2006) classification as described in the text: Gini class 1 (least geographically concentrated) when the Gini index < 0.1; Gini class 2 when the Gini index is between 0.1 and 0.3; Gini class 3 (most geographically concentrated) when the Gini index is ≥ 0.3. All controls are as in Table 3 plus pre-trends (1999-02 changes) in each Gini class and population 2003-07 changes.
Source: See Table 6.

Appendix 3

List of UK SIC 2003 services activities classified by tradability

Gini class 1 (least geographically concentrated)

Construction: demolition and wrecking of buildings; earth moving; test drilling and boring; general construction; erection of roof covering and frames; construction of motorways, roads; construction of water projects; other construction work involving special trades; installation of electrical wiring and fittings; insulation work activities; plumbing; other building installation; plastering; joinery installation; floor or wall covering; painting and glazing; other building completion; renting of construction or demolition equipment.

Sale and repair of motor vehicles: sale of mother vehicles; maintenance and repair of motor vehicles; sale of motor vehicles parts and accessories; sale, maintenance and repair of motorcycles and related parts and accessories; retail sale of automotive fuel.

Retail trade: retail sale in non-specialised stores; other retail sale in non-specialised stores; retail sale of fruit and veg; retail sale of meat and meat products; retail sale of fish, crustaceans and molluscs; retail sale of bread and cakes; retail sale of alcoholic and other beverages; retail sale of tobacco products; other retail sale of food, beverages and tobacco in specialised stores; dispensing chemists; retail sale of medical and orthopedic goods; retail sale of cosmetics and toilet articles; retail sale of textiles; retail sale of clothing; retail sale of footwear; retail sale of furniture; retail sale of electrical household appliances; retail sale of hardware, paints and glass; retail sale of books and stationary; other retail sale in specialised stores; retail sale of second-hand goods in stores; retail sale via stalls and markets.

Hotels and restaurants: youth hostels; camping sites; other provision of lodgings; restaurants; bars; canteens; catering.

Financial intermediation: other monetary intermediation; financial leasing.

Real estate, renting and business activities: renting of personal and household goods nec; maintenance and repair of office, accounting and computing machinery; accounting, book-keeping and auditing activities; tax consultancy; industrial cleaning; photographic activities; packaging activities; secretarial and translation activities; call centre activities.

Other community, social and personal services: collection and treatment of sewage; collection and treatment of other waste; sanitation, remediation and similar activities; activities of religious organisations; activities of other membership organisations nec; library and archive activities; sporting activities; gambling and betting activities; motion picture, television and other theatrical casting; washing and dry-cleaning.

Gini class 2

Wholesale trade: agents involved in the sale of agricultural raw materials, live animals, textile raw materials and semi-finished goods; agents involved in the sale of fuels, ores, metals and industrial chemicals; agents involved in the sale of timber and building materials; agents involved in the sale of machinery, industrial equipment, ships and aircraft; agents involved in the sale of furniture, household goods; agents involved in the sale of textiles, clothing, footwear and leather goods; agents involved in the sale of food, beverages and tobacco; agents specialising in the sale of products nec; agents involved in the sale of a variety of goods; wholesale of fruit and veg; wholesale of meat and meat products; wholesale of dairy produce , eggs and edible oils and fats; wholesale of alcoholic and other beverages; wholesale of tobacco products; wholesale of sugar and chocolate; wholesale of coffee, tea, cocoa and spices; wholesale of other food including fish, crustaceans and molluscs; non-specialised wholesale of food, beverages and tobacco; wholesale of textiles; wholesale of clothing and footwear; wholesale of electrical household appliances; wholesale of china and glassware; wholesale of perfume and cosmetics; wholesale of pharmaceutical goods; wholesale of other household goods; wholesale of machine tools; wholesale of mining, construction and civil engineering; wholesale of machinery for the textile industry; wholesale of computers and software; wholesale of other office machinery; wholesale of other electronic parts; wholesale of other machinery; wholesale of agricultural machinery; other wholesale.

Retail trade: retail sale via mail order house; other non-store retail sale; repair of electrical household goods; repair of watches and jewellery; repair non elsewhere classified.

Hotels and restaurants: hotels.

Financial intermediation: central banking; other credit granting; life insurance; pension funding; non-life insurance; activities auxiliary to insurance and funding.

Real estate, renting and business activities: development and selling of real estate; buying and selling of own real estate; letting of own property; real estate agencies; management of real estate on a fee or contract basis; renting of automobiles; renting of other land transport equipment; renting of water transport equipment; renting of air transport equipment; renting of agricultural machinery and equipment; renting of construction and civil engineering; renting of office machinery and equipment; hardware consultancy; other software consultancy and supply; data processing; database activities; other computer related activities; legal activities; market research

and public opinion polling; business and management consultancy activities; management activities of holding companies; architectural and engineering activities and related technical consultancy; technical testing and analysis; advertising; labor recruitment and provision of personnel; investigation and security activities.
Other community, social and personal services: activities of business and employers organisations; activities of professional organisations; activities of political organisations; artistic and literary creation and interpretation; operation of arts facilities; fair and amusement park activities; other entertainment activities nec; news agency activities; museum activities; botanical and zoological gardens and nature reserve activities; other sporting activities; hairdressing and other beauty treatment; funeral and related activities; physical well-being activities; other service activities nec.

Gini class 3 (most geographically concentrated)

Wholesale trade: wholesale of grain, seeds and animal feeds; wholesale of flowers and plants; wholesale of live animals; wholesale of hides, skins and leather; wholesale of unmanufactured tobacco; wholesale of solid, liquid and gaseous fuels; wholesale of metals and ores; wholesale of wood, construction materials; wholesale of hardware, plumbing and heating supplies; wholesale of chemical products; wholesale of other intermediate products; wholesale of waste and scrap.
Retail trade: repair of boots and shoes.
Financial intermediation: other financial intermediation nec; administration of financial markets; security broking and fund management; activities auxiliary to financial intermediation nec.
Real estate, renting and business activities: publishing of software; research and experimental development on natural science and engineering; research and experimental development on social science and humanities; architectural and engineering activities and related technical consultancy; other business activities nec.
Other community, social and personal services: activities of trade unions; motion picture and video production; motion picture and video distribution; motion picture projection; radio and television activities.

Note: Services sectors are classified according to the Jensen-Kletzer (2006) classification as described in the text: Gini class 1 (least geographically concentrated) when the Gini index < 0.1; Gini class 2 when the Gini index is between 0.1 and 0.3; Gini class 3 (most geographically concentrated) when the Gini index is ≥ 0.3.