The Size and Sources of Productivity Differentials across Britain's Functional Urban Areas, 2003-2010

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Abstract

This paper employs a new definition of urban areas as functional economic units developed by the OECD in collaboration with the European Union to investigate the size and sources of productivity disparities across urban areas in Great Britain. We use data from the UK Annual Survey of Hours and Earnings and the UK Labour Force Survey between 1997 and 2010 and a two-step estimation procedure that accounts for bias in the extent of agglomeration economies arising from individual sorting and area fixed unobservables. Our results suggest that doubling the population of a city in Great Britain, would, on average, increase city productivity by 1%. The magnitude of these estimates appear much smaller than those in the literature and suggests that previous studies from the UK that adopt urban area definitions based on strictly administrative boundaries may exaggerate the extent of agglomeration economies.

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1. Introduction

Productivity advantages arising from geographic concentration of economic activity in urban areas, also known as agglomeration economies, are a well-documented fact in the urban economics and regional development literature (Rosenthal and Strange, 2004; Puga, 2010). Given the prominence of urbanization worldwide, understanding the nature and sources of the higher productivity of cities is of fundamental importance for policies aiming to promote regional development and national economic performance.

A vast number of studies in the literature have been engaged with providing a better insight to the nature and source of agglomeration economies and although a lot of progress has been made there are still important knowledge gaps (Duranton and Puga, 2004). One of the most apparent gaps has been the lack of consistent international comparative studies documenting the differences in the size and sources of agglomeration economies across countries (Ahrend et al., 2017). Probably the key reason for the paucity of such studies in the literature is the lack of a common internationally recognised definition of urban areas as functional economic units. Such a definition is of great importance not only to conduct international comparisons of statistical estimates of the size and sources of the city productivity differentials, but also to test the extent to which differences in statistical estimates across studies even within the same national context are due to differences in the definition of urban area adopted.

In this paper we use a new definition of urban areas as functional economic units developed by the OECD in collaboration with the European Union (OECD, 2012a, 2012b) and data from the UK Annual Survey of Hours and Earnings and the UK Labour Force Survey between 1997 and 2010 to provide estimates of productivity differentials across urban areas in Britain and to identify some of the area factors explaining these differentials. This is the second study, to our knowledge to date in the literature (Ahrend et al., 2017) that employs this new international definition of "functional urban areas" to investigate the size and sources of agglomeration economies in the UK. One of the distinguishing features of this new definition of urban areas is that it is based on the economic functioning of urban areas, rather than their administrative boundaries and allows for better comparisons of economic performance across countries.

We adopt a two-step estimation approach that has been used by other studies in the literature of agglomeration economies (Monastiriotis, 2002; Combes, Duranton and Gobillon, 2008, 2011): in the first step we estimate a mincerian wage equation that aims to control for

sorting of individuals into areas on the basis of individual skills and derive estimates of area/year fixed effects that serve as measures of conditional wage (productivity) differentials across cities. In the second stage, we regress estimates of conditional wage differentials on a set of area factors that aim to measure some of the key sources of agglomeration economies in the literature.

Our preferred estimates that account for individual sorting and time-invariant fixed unobservables and the associated bias in estimates of the elasticity of urban area productivity with respect to size, suggest that doubling the population of a city in Great Britain, would on average increase city productivity by 1%. The magnitude of these estimates appear much smaller than those in the literature and suggests that previous studies from the UK that adopt urban area definitions based on strictly administrative boundaries may exaggerate the extent of agglomeration economies.

In the next section we present a detailed discussion of the OECD definition of "functional urban area" (FUA) and present population statistics for all FUAs in Great Britain. We then describe our methodology and the data used in our analysis and following this we present the empirical results and interpretation of our findings. The final section discusses some of the policy implications of our findings and concludes.

2. OECD Definition of Functional Urban Area

The new definition of urban area as a functional economic unit developed by the OECD in collaboration with the EU aims to address key issues related with poor monitoring of urban development and lack of robust comparisons of urban area statistics across countries (OECD, 2012a). One of the key features of this definition is that is based on the economic functioning of urban areas rather than their administrative boundaries. In particular, according to this definition "each functional urban area is an economic unit characterised by densely inhabited "urban cores" and "hinterlands"[1], and a labour market that is highly integrated with the cores.

The methodology used to identify the functional urban areas is described in detail in the book *Redefining "urban": A new way to measure metropolitan areas* (OECD, 2012a). According to this methodology the geographic building blocks to define urban areas are the municipalities. The cores are defined using the population grid from the global dataset

[1] The "hinterland" can be defined as the "worker catchment area" of the urban labour market, outside the densely inhabited core.

Landscan, referred to circa year 2000. Polycentric cores and the hinterlands of the functional areas are identified on the basis of commuting data (travel from home-to-work) referred to circa year 2000 (Census year).

Moreover, functional urban areas are classified into four types according to population size:

-Small urban areas, with a population below 200,000 people

-Medium-sized urban areas, with a population between 200,000 and 500,000

-Metropolitan areas, with a population between 500,000 and 1.5 million

-Large metropolitan areas with a population of 1.5 million or more

The methodology used to identify functional urban areas is applied to 29 OECD countries and 1,175 urban areas of different size are identified. In Great Britain, this method identifies in total 101 FUAs that include of 3 large metropolitan areas, 12 metropolitan areas, 46 medium-sized urban areas and 40 small urban areas (see Table A.1 in the Appendix for details).[2]

3. Methodology, Data, and Descriptive Statistics

One approach that has been used extensively in the literature to document and estimate the magnitude of agglomeration economies has been based on estimating individual wage differentials across areas (Puga, 2010). This approach rests on the assumption that labour markets are perfectly competitive and thus workers are paid their marginal product[3]. A key issue related with this approach is how to differentiate "true" productivity differentials from sorting of employees across areas on the basis of skills (Combes et al., 2011). Sorting is expected to lead to an overestimation of cross-area productivity differentials, provided that more skilled workers sort into more populated/dense urban areas (Combes et al., 2008). There are many empirical studies in the literature providing evidence that sorting can account for a large share of observed spatial wage disparities and has as a result an overestimation of cross-areas productivity differentials (Glaeser and Mare, 2001; Combes et al., 2008).

In order to estimate the magnitude of agglomeration economies and identify some of the factors explaining them we adopt a two-step methodology that has been widely used in the literature (Monastiriotis, 2002; Combes et al., 2008). In the first-step we estimate a Mincer wage equation that has a two objectives: a) to control for sorting by including individual characteristics and b) to estimate area/year effects that serve as measures of productivity

[2] Functional urban areas in the Northern Ireland have not been identified due to lack of commuting data.

[3] Puga (2010) suggests that "..even if labor markets are not perfectly competitive, higher wages in large/dense urban areas can be seen as evidence of higher productivity". Moreover, Combes et al. (2008) suggest that under non-perfectly competitive markets, the worker's marginal product is a mark-up over the wage.

disparities across areas and over time. In particular, in the first-step we estimate the following specification:

$$\log w_{iat} = X'_{it}\beta + d_{at} + u_{iat} \quad (1)$$

where $\log w_{iat}$ is the natural logarithm of the hourly wage of individual i who resides in area a in year t, X_{it} is a vector of individual characteristics that are either time-variant or time - invariant, β is a vector of coefficients, d_{at} is a vector of area-year effects, and u_{iat} is an error term. In the second step we regress the estimates of the area-year effects from (1) on a set of area characteristics and time effects using the following specification:

$$d_{at} = Q'_{at}\gamma + d_t + v_{at} \quad (2)$$

where Q_{at} is a vector of area characteristics that aim to measure some of the key sources of agglomeration economies identified in the literature, e.g., population density, area human capital, industry diversity, etc., d_t are time effects[4] and v_{at} is an error term.

The estimation of the first-stage is based on data from the UK Annual Survey of Hours and Earnings (ASHE) and its predecessor the New Earnings Survey (NES) and covers the period 1997-2010[5]. NES/ASHE is constructed by the Office of National Statistics (ONS) based on a 1% sample of employees on the Inland Revenue Pay as You Earn (PAYE) register for February and April (ONS, 2012). ASHE provides information on individuals including their home and work postcodes, while the NES provides similar data, but only reports work postcodes. The sample is of employees whose National Insurance numbers end in two specific digits (these have been the same since 1975), meaning NES/ASHE provides an individual level panel, in which workers are observed for multiple years. The sample is replenished as workers leave the PAYE system (e.g., to self-employment) and new workers enter it (e.g., from school). The data includes provides detailed information on individual earnings including basic pay, overtime pay, basic and overtime hours worked. In our analysis, we use basic hourly earnings as our wage measure. Moreover, NES/ASHE includes information on other individual characteristics, such as occupation, industry, whether the job is in the private or public sector,

[4] In some specifications we also include area fixed effects, thus estimating a specification as follows: $d_{at} = Q'_{at}\gamma + d_t + d_a + v_{at}$ (3).

[5] The description of the NES/ASHE data is taken from Gibbons et al. (2014).

the worker's age and gender. However, NES/ASHE does not provide information on education and this is why we simulate individuals years of schooling in NES/ASHE using estimates of the coefficients of the Best Linear Predictor of education using data from the Labour Force survey from the same period[6].

Table 1 presents descriptive statistics of individual characteristics in ASHE for individuals residing in the 101 UK FUAs during the period 1997-2010. According to Table 1, base hourly earnings in the sample during this period is around 12 pounds, half of individuals are male, whereas the average age is around 39 years. Moreover, around 60 percent of employees have completed upper secondary education and around 30 percent have completed university, wherears around three quarters of individuals in the sample are in full-time employment and around one quarter are working in the public sector. As far as the occupation and industry composition of the sample is concerned, there is a roughly uniform distribution of employees across the 9 major occupation groups with the majority, i.e., around 70 percent, working in the following three sectors : Public administration, education, and health (30 percent), Distribution, hotels, and restaurants (around 20 percent) and Banking and insurance (around 20 percent).

The estimation of the second stage employs as explanatory variables FUA characteristics that have been identified as significant predictors of productivity in the literature (Glaeser and Mare, 2001; Combes et al., 2008). For the purpose of our analysis information on these characteristics was drawn from the Quarterly Labour Force Survey (QLFS) for the same period as that for the ASHE data. The QLFS is the largest household study in the UK based on a representative sample of the population in the UK and provides the best source of information on individual characteristics, such as education, as well as employment and unemployment. It also includes detailed geographical area information for each individual at the most disaggregated, such as postcodes. This, combined with the sufficiently large number of observations at the area level allows us to produce precise measures of FUAs characteristics. We identified FUAs in the QLFS data using statistical ward information and data from the OECD that matches statistical wards into FUAs.

Table 2 presents descriptive statistics of key characteristics of UK FUAs as calculated using the QLFS data. Based on Table 2, the average FUA population is 420 thousands, the

[6] In particular, we regress years of schooling on the year of birth and year of birth square separately for each four-digit occupation using the LFS data from 1997-2010 and we use the coefficient estimates for each occupation and information in the year of birth and occupation in the ASHE to simulate years of schooling for all individuals in the ASHE. Other studies based in ASHE use occupation controls as proxies for education arguing that the former is a fairly good proxy for the latter (Kaplanis, 2010; D'Costa and Overman, 2013).

average area is around 790 squared kilometers, and, on average, around 1 fifth of the population has a university degree. Moreover, the Herfindhal index measuring industry concentration, at the two-digit level is 0.07, suggesting relatively low concentration. According to Table 2, the 101 FUAs account for around 60 percent of total UK employment and the distribution of total FUA employment across sectors is quite similar to that presented in Table 1 using the ASHE data, that is the largest employment share is in the Public administration, education, and health sector, followed by the Distribution, hotels, and restaurant sector and the Banking and finance sector, as well as Manufacturing. Finally, 16 percent of FUAs have a port and 14 percent can be characterised as polycentric (ESPON, 2007), that is they have population greater or equal to 500 thousands.

4. Estimation Results

Table 3 presents first-stage estimation results employing different specifications of equation (1). Estimates of coefficients of characteristics in specification (1) of Table 3 that includes the smaller set of controls for individual characteristics compared to subsequent specifications are in line with previous studies. In particular, these results are consistent with a significant male wage premium and with significantly higher earnings among those with higher educational qualifications and those in full-time employment. Moreover, results suggest that individual earnings increase, at a decreasing rate, with the years of working experience, as measured by age. Results remain similar when one includes additional controls for industry (specification (2)) and for whether the individual is working in the public sector and in a job that is covered by a collective agreement (specification (3)) that are both positively and significantly associated with individual earnings. Finally, specifications (4) and (5) in Table 3 include individual and individual/area fixed effects respectively that aim to control more tightly for time-invariant individual productive characteristics that may produce differential returns across areas. As discussed in the previous section, controlling for these effects aims to address sorting of individuals into areas on the basis of productive characteristics and purge the estimated area/year effects from associated bias.

Figures 1 to 5 present scatterplots of pairs of log population and area/year fixed effects estimated from specification (1) to (5) respectively of Table 3, as well as associated OLS fitted values for year 2010. In all figures, the fitted lines show a pattern consistent with higher productivity in areas with a larger population in 2010. In the first 3 figures, however, the fitted line appears less steep and the estimate of the slope is likely to reflect, at least partly, the presence of an extreme value of a very high productivity/population pair that one can easily

deduce that represents London. Moreover, Figures 4 and 5 that are based on area productivity estimates from specifications (4) and (5) in Table 3 that control for individual and individual/area fixed effects show, as expected, lower variation in productivity across areas, as suggested by the more compressed scale of the vertical axis, compared to Figures 1 to 3.

Tables 4a to 10 present second-stage estimation results of equation (2) employing different estimates of area productivity over time and different set of area controls. In particular, Tables 4a and 4b present estimation results based on area productivity estimates from specification (1) in Table 3. The first specification in Table 4a that includes the log population of the area and year dummies among the independent variables produces a positive, but weakly significant estimated coefficient of the log population. The second specification in Table 4a that replaces log population with log density, that is the log of the ratio of population to land area, produces no significant coefficient estimate of log density and the same holds for the third specification that includes both the log density and the log area as independent variables. Subsequent specifications in Table 4a that gradually introduce additional explanatory variables, such as the share of university graduates, the Herfindahl Index of industry concentration, and employment shares of different (one digit) industries also produce no significant relationship between area productivity and size, as measured by the log density variable.

Results are similar in additional estimated specifications presented in Table 4b that employ an alternative industry classification or the original classification and gradually introduce measures for whether the area is polycentric, has a port, and it is a capital. Nevertheless, results in Table 4b are consistent with significantly higher productivity in areas above a given population size, as suggested by the positive and significant coefficient of the indicator of whether the area is polycentric. Moreover, coefficient estimates from specification (11) in Table 4b that includes the most extensive set of controls are consistent with significantly higher productivity in areas with a higher share of university graduates and that have a port, as well as significantly higher productivity in London compared to other urban areas. In particular, the estimated coefficient of the share of university graduates in specification (11) suggests that a 10 percentage point increase in the share of university graduates in a city is associated with a 2.8% increase in productivity.

Tables 5a and 5b that have the same structure as Tables 4a and 4b respectively, present estimation results of equation (2) using as the area productivity measure the area/year effects estimated from specification (4) in Table 3 that accounts for sorting of individuals into areas

on the basis of individual productive characteristics.[7] Although, the coefficient of the log population variable is not significant in the specification that controls only for year effects, the estimated coefficient of the log density is positive and significant and very similar in magnitude in all specifications in both Tables 5a and 5b. In particular, in specification (11) that includes the most extensive set of controls, the estimated elasticity of urban area productivity with respect to area population (log density controlling for log area) is 0.003 that suggests that a city in Great Britain with double the population of another comparable British city is, on average, about 0.3% more productive.

These estimates, however, appear rather small compared to other studies in the literature that use either urban area definitions based on administrative boundaries (Combes et al., 2008) or, similar to us, definitions based on economic functioning of urban areas (Ahrend et al., 2017). Moreover, coefficient estimates of other determinants of area productivity, e.g., the share of university graduates and whether the area is a capital do not have the expected sign.

Tables 6a and 6b present results from estimation of equation (2) using as dependent variable the area/year effects produced from estimation of specification (5) in Table 2 that controls for individual/area fixed effects and thus that may be more effective in addressing individual sorting. Results, however, in this case, across specifications appear very similar to those presented in Tables 5a and 5b.

One explanation of these results is that second-stage estimated specifications do not account for a range of other area confounders. Results presented in Tables 7, 8, and 9 are from estimated second-stage specifications based on area/year effects from specifications (1), (4), and (5) respectively that account for some of these factors through controlling for area dummies. Estimates in Tables 8 and 9 that are our preferred estimates, as they are based on first-stage estimates that control adequately for sorting, from specifications including the full set of controls indicate a positive and significant elasticity of area productivity with respect to urban area size of 0.01 that is around five times as large as previous estimates. Nevertheless, none of the other potential sources of disparities in productivity across areas appears to have a significant association with area productivity.

Tables 10 and 11 present additional second-stage estimation results based on first-stage estimates of area/year effects from specification (1) and (4) respectively in Table 3. These estimates are produced by taking first-differences of equation (2) between the initial year and

[7] Results based on area/year effects produced by specifications (2) and (3) in Table 2 are very similar to those based on specification (1) in Table 2. These results are available from the authors upon request.

the final year in our data, i.e., 2003 and 2010 respectively, and estimating the resulting equation by OLS. This provides an alternative way to control for area fixed effects by eliminating them through first-differencing, but in contrast to estimates in Tables 7, 8, and 9 uses within area variation between the initial and final year in the data. Estimates of area productivity elasticities with respect to urban area size in this case are positive and significant and much larger in magnitude than previous estimates. The same holds for other area-specific factors that may affect productivity. A potential explanation of this is that these reflect different time trends between these two years in productivity and other area factors, such as population size, etc., across areas that may lead to overestimation of actual agglomeration economies (D'Costa and Overman, 2013). Although, this positive bias is expected to be also present in fixed effects estimates, presented in Tables 7, 8, and 9, that do not also account for differential time effects across areas, appears much less severe in these estimates. This is possibly due to the larger variance of explanatory variables in the fixed effects case, where there is information over more years compared to first-differences based only on the initial and final year in the data (Wooldridge, 2002). This is why, our preferred estimates are those from Table 11.

Overall, estimation results, based on our preferred estimates suggest that there are agglomeration economies associated with a larger population in urban areas in Great Britain, but that these are much smaller than those produced by previous studies (e.g., D'Costa and Overman, 2013). This may further suggest that definitions of urban areas based on administrative area boundaries adopted by the vast majority of existing studies in the literature may tend to exaggerate actual agglomeration economies.

5. Conclusion

Productivity disparities across space is a well-documented fact in the economics literature. A vast number of studies is engaged with understanding the nature and sources of higher productivity in cities as well as estimating the extent of agglomeration economies arising from city size. Nevertheless, there is still substantial disagreement in the literature on what the magnitude of the agglomeration economies. A potential explanation of this is that the majority of studies adopt definitions of urban areas based on strictly administrative boundaries that differ across countries and very few studies use a common internationally recognised definition of urban areas as functional economic units that may provide a more precise identification of agglomeration economies.

This paper addresses this gap in the literature by using a new definition of urban areas as functional economic units developed by the OECD in collaboration with the European Union

(OECD, 2012a, 2012b). We employ this definition and data from the UK Annual Survey of Hours and Earnings and the UK Labour Force Survey between 1997 and 2010 to estimate productivity differentials across urban areas in Britain and to identify some of the area factors explaining these differentials.

Our preferred estimates that account for individual sorting and time-invariant fixed unobservables and the associated bias in estimates of the elasticity of urban area productivity with respect to size, suggest that doubling the population of a city in Great Britain, would on average increase city productivity by 1%. The magnitude of these estimates appear much smaller than those in the literature and suggests that previous studies from the UK that adopt urban area definitions based on strictly administrative boundaries may exaggerate the extent of agglomeration economies.

Table 1: Descriptive Statistics of Individual Characteristics

Variable	Mean	Standard Deviation
Basic hourly earnings	12.11	11.98
Male	0.51	0.49
Age	39.51	12.04
Secondary education	0.07	0.26
Upper secondary education	0.58	0.49
University education	0.29	0.45
Postgraduate education	0.05	0.21
Full time	0.74	0.40
Public sector	0.28	0.45
Collective agreement	0.50	0.50
Occupation		
Managers and senior officials	0.14	0.34
Professional occupations	0.10	0.30
Associate professional and	0.14	0.35
Administrative and secretarial	0.16	0.37
Skilled trades occupations	0.07	0.25
Personal service occupations	0.07	0.25
Sales and customer service	0.11	0.31
Process, plant and machine	0.07	0.25
Elementary occupations	0.13	0.33
Industry		
Agriculture, forestry, and fishing	0.003	0.006
Energy and water	0.008	0.09
Manufacturing	0.12	0.33
Construction	0.04	0.2
Distribution, hotels, and restaurants	0.21	0.41
Transport, storage, and communication	0.07	0.25
Banking, finance, and insurance	0.21	0.40
Public administration, education, and health	0.30	0.45
Other services	0.03	0.17
Number of observations	871560	871560

Notes: Data source is the Annual Survey of Hours and Earnings (ASHE), 2003-2010. Because of lack of data on individual education in ASHE, education was simulated using coefficients' estimates from regressions of individual's years of education on individual year of birth and year of birth squared estimated separately by two-digit occupation code in the Quarterly Labour Force Survey (QLFS) 2003-2010 and information on year of birth and two-digit occupation code in ASHE. Occupational classification is based on the first digit of the 2000 Standard Occupational Classification codes and industry classification is based on the first digit of the 2003 Standard Industrial Classification codes. The sample is restricted to main jobs.

Table 2: Descriptive Statistics of Functional Urban Area Characteristics

Variable	Mean	Standard Deviation
Population (in millions)	0.42	1.1
Area (in sq. km)	740.9	874.6
Share with university degree	0.19	0.07
Herfindahl index	0.07	0.01
Industry Employment Share	0.58	0.49
Agriculture, forestry, and fishing	0.003	0.01
Energy and water	0.103	0.016
Manufacturing	0.14	0.05
Construction	0.08	0.02
Distribution, hotels, and restaurants	0.20	0.03
Transport, storage, and communication	0.07	0.02
Banking, finance, and insurance	0.14	0.04
Public administration, education, and health	0.29	0.05
Other services	0.05	0.01
Capital	0.01	0.11
Area with port	0.16	0.36
Polycentric	0.14	0.35
Number of observations	101	101

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010 for all variables except of area, area with port and polycentric that are based on authors' own calculations from other sources. The Herfindahl index was calculated for two-digit industry code. An area is defined as polycentric if its population is greater or equal to 500,000. Employment shares are reported for one digit industry code.

Table 3: First-Stage Regression Results for Individual Log Basic Hourly Earnings

	(1)	(2)	(3)	(4)	(5)
Male	0.109***	0.109***	0.108***		
	(0.002)	(0.002)	(0.002)		
Upper secondary education	0.056***	0.056***	0.055***		
	(0.003)	(0.003)	(0.003)		
University education	0.093***		0.082***		
	(0.004)		(0.004)		
Postgraduate education	0.071***	0.057***	0.051***		
	(0.008)	(0.008)	(0.007)		
Age	0.041***	0.039***	0.038***	0.053***	0.049***
	(0.0004)	(0.0004)	(0.0004)	(0.001)	(0.001)
Age squared	-0.0004***	-0.0004***	-0.0004***	-0.0003***	-0.0002***
	(0.000005)	(0.000004)	(0.000005)	(0.000008)	(0.000008)
Full time	0.066***	0.060***	0.059***	0.052***	0.063***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Collective agreement			0.021***	0.008***	0.007***
			(0.001)	(0.001)	(0.001)
Public sector			0.110***	0.066***	0.066***
			(0.003)	(0.004)	(0.004)
Occupation dummies	Yes	Yes	Yes	Yes	Yes
Industry dummies	No	Yes	Yes	Yes	Yes
Area/Year fixed effects	Yes	Yes	Yes	Yes	Yes
Individual fixed effects	No	No	No	Yes	No
Individual/Area fixed effects	No	No	No	No	Yes
R-squared	0.089	0.083	0.089	0.110	0.120
Number of observations	871560	871560	871560	871560	871560

Notes: Data source is the Annual Survey of Hours and Earnings, 2003-2010. The sample is restricted to main jobs. Standard errors clustered at the individual level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Occupation dummies are at the three-digit level. Industry dummies are at the one-digit level.

Table 4a: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)	(6)
Log population	0.016*					
	(0.009)					
Log density		-0.005	0.009	0.008	0.005	0.008
		(0.006)	(0.009)	(0.008)	(0.008)	(0.005)
Log area			0.019*	0.004	0.002	0.009*
			(0.010)	(0.009)	(0.009)	(0.005)
Share of university graduates				0.459***	0.450***	0.267***
				(0.062)	(0.056)	(0.029)
Herfindahl Index					-1.148***	0.529*
					(0.284)	(0.287)
Industry employment shares (classification 1)						
Agriculture, fishing, and mining						0.287***
						(0.096)
Manufacturing						0.044
						(0.079)
Electricity, gas, and water supply						-0.016
						(0.197)
Wholesale and retail trade						0.001
						(0.087)
Hotels and restaurants						-0.248**
						(0.102)
Transport, storage, and communication						0.475***
						(0.094)
Financial intermediation						0.164
						(0.108)
Real estate, renting, and business activities						0.729***
						(0.123)
Public administration						-0.060
						(0.088)
Education, health and social work						-0.290***
						(0.074)
Other services						0.342***
						(0.099)
Industry employment share (classification 2)						
Agriculture, fishing, and mining						
Electricity, gas, and water supply						
High-tech manufacturing						
Med-high tech manufacturing						
Med-low tech manufacturing						
Low tech manufacturing						

Knowledge intensive services						
High tech services						
Low knowledge intensive services						
Polycentric						
Port						
Capital						
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.666	0.649	0.673	0.778	0.794	0.882
Number of observations	808	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (1) in Table 2. The share of construction industry is omitted.

Table 4b: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(7)	(8)	(9)	(10)	(11)
Log population					
Log density	0.009	0.003	0.006	0.002	-0.002
	(0.008)	(0.005)	(0.005)	(0.004)	(0.004)
Log area	0.007	0.004	0.007	0.003	-0.001
	(0.007)	(0.005)	(0.005)	(0.004)	(0.004)
Share of university graduates	0.191***	0.278***	0.271***	0.272***	0.282***
	(0.040)	(0.029)	(0.029)	(0.029)	(0.029)
Herfindahl Index	-0.875***	0.350	0.444	0.252	0.104
	(0.267)	(0.259)	(0.283)	(0.237)	(0.239)
Industry employment shares (classification 1)					
Agriculture, fishing, and mining		0.312***	0.249***	0.277**	0.268**
		(0.101)	(0.088)	(0.110)	(0.105)
Manufacturing		0.035	0.030	0.016	0.003
		(0.078)	(0.080)	(0.076)	(0.077)
Electricity, gas, and water supply		-0.054	-0.101	-0.023	-0.108
		(0.197)	(0.203)	(0.197)	(0.206)
Wholesale and retail trade		0.031	-0.010	0.029	0.039
		(0.086)	(0.086)	(0.086)	(0.086)
Hotels and restaurants		-0.263***	-0.268***	-0.247**	-0.270***
		(0.099)	(0.100)	(0.101)	(0.099)
Transport, storage, and communication		0.472***	0.458***	0.458***	0.446***
		(0.093)	(0.093)	(0.095)	(0.094)
Financial intermediation		0.176*	0.139	0.134	0.127
		(0.104)	(0.109)	(0.104)	(0.103)
Real estate, renting, and business activities		0.709***	0.715***	0.694***	0.675***
		(0.118)	(0.121)	(0.119)	(0.115)
Public administration		-0.071	-0.108	-0.047	-0.090
		(0.080)	(0.083)	(0.087)	(0.080)
Education, health and social work		-0.262***	-0.303***	-0.242***	-0.237***
		(0.070)	(0.074)	(0.070)	(0.068)
Other services		0.314***	0.312***	0.283***	0.249***
		(0.093)	(0.099)	(0.090)	(0.090)
Industry employment share (Classification 2)					
Agriculture, fishing, and mining	0.301**				
	(0.138)				
Electricity, gas, and water supply	-0.493**				
	(0.208)				
High-tech manufacturing	0.430**				
	(0.167)				
Med-high tech manufacturing	-0.085				
	(0.122)				
Med-low tech manufacturing	-0.623***				
	(0.106)				
Low tech manufacturing	-0.263**				
	(0.121)				

Knowledge intensive services	-0.104 (0.078)				
High tech services	0.682*** (0.184)				
Low knowledge intensive services	-0.035 (0.093)				
Polycentric		0.028** (0.011)			0.019** (0.009)
Port			0.010** (0.005)		0.007 (0.004)
Capital				0.078*** (0.011)	0.069*** (0.011)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.859	0.885	0.883	0.887	0.889
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (1) in Table 2. The share of construction industry is omitted.

Table 5a: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)	(6)
Log population	0.0001					
	(0.0003)					
Log density		0.002***	0.002***	0.002***	0.002***	0.002***
		(0.0004)	(0.001)	(0.000)	(0.001)	(0.001)
Log area			-0.0004	-0.0002	-0.0002	-0.0004
			(0.0003)	(0.0003)	(0.0003)	(0.0005)
Share of university graduates				-0.004	-0.004	-0.008
				(0.004)	(0.004)	(0.008)
Herfindahl Index					0.030	-0.032
					(0.040)	(0.077)
Industry employment shares (classification 1)						
Agriculture, fishing, and mining						-0.018
						(0.024)
Manufacturing						-0.029
						(0.021)
Electricity, gas, and water supply						-0.112*
						(0.059)
Wholesale and retail trade						-0.014
						(0.025)
Hotels and restaurants						-0.007
						(0.037)
Transport, storage, and communication						-0.044**
						(0.022)
Financial intermediation						-0.023
						(0.029)
Real estate, renting, and business activities						0.011
						(0.027)
Public administration						-0.024
						(0.023)
Education, health and social work						-0.020
						(0.023)
Other services						-0.056
						(0.038)
Industry employment share (classification 2)						
Agriculture, fishing, and mining						
Electricity, gas, and water supply						
High-tech manufacturing						
Med-high tech manufacturing						
Med-low tech manufacturing						
Low tech manufacturing						

Knowledge intensive services						
High tech services						
Low knowledge intensive services						
Polycentric						
Port						
Capital						
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.967	0.968	0.968	0.968	0.968	0.968
Number of observations	808	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (4) in Table 2. The share of construction industry is omitted.

Table 5b: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(7)	(8)	(9)	(10)	(11)
Log population					
Log density	0.002***	0.003***	0.002***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log area	0.001**	0.001	0.001	0.001*	0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Share of university graduates	-0.006	-0.013*	-0.012*	-0.013*	-0.013*
	(0.008)	(0.007)	(0.007)	(0.007)	(0.007)
Herfindahl Index	-0.022	-0.044	-0.057	-0.035	-0.038
	(0.054)	(0.073)	(0.072)	(0.074)	(0.074)
Industry employment shares (classification 1)					
Agriculture, fishing, and mining		-0.004	-0.006	-0.003	-0.007
		(0.028)	(0.029)	(0.028)	(0.029)
Manufacturing		-0.018	-0.019	-0.017	-0.018
		(0.020)	(0.020)	(0.020)	(0.020)
Electricity, gas, and water supply		-0.022	-0.031	-0.023	-0.030
		(0.053)	(0.055)	(0.053)	(0.055)
Wholesale and retail trade		0.006	0.006	0.005	0.004
		(0.024)	(0.024)	(0.024)	(0.024)
Hotels and restaurants		-0.033	-0.035	-0.033	-0.035
		(0.036)	(0.036)	(0.036)	(0.036)
Transport, storage, and communication		-0.018	-0.019	-0.017	-0.019
		(0.025)	(0.025)	(0.025)	(0.026)
Financial intermediation		-0.019	-0.020	-0.017	-0.020
		(0.028)	(0.029)	(0.028)	(0.029)
Real estate, renting, and business activities		0.019	0.017	0.020	0.019
		(0.025)	(0.025)	(0.025)	(0.025)
Public administration		0.00005	-0.004	-0.001	-0.005
		(0.026)	(0.028)	(0.026)	(0.028)
Education, health and social work		-0.005	-0.005	-0.006	-0.008
		(0.023)	(0.024)	(0.023)	(0.024)
Other services		0.001	-0.003	0.003	0.001
		(0.031)	(0.031)	(0.031)	(0.031)
Industry employment share (Classification 2)					
Agriculture, fishing, and mining	-0.010				
	(0.026)				
Electricity, gas, and water supply	-0.032				
	(0.052)				
High-tech manufacturing	0.010				
	(0.036)				
Med-high tech manufacturing	-0.015				
	(0.028)				
Med-low tech manufacturing	-0.013				
	(0.029)				
Low tech manufacturing	-0.038				
	(0.026)				

Knowledge intensive services	-0.012 (0.021)				
High tech services	-0.017 (0.030)				
Low knowledge intensive services	-0.006 (0.023)				
Polycentric		-0.001 (0.001)			-0.001 (0.001)
Port			0.001 (0.001)		0.001 (0.001)
Capital				-0.004** (0.002)	-0.004* (0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.984	0.984	0.984	0.984	0.984
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (4) in Table 2. The share of construction industry is omitted.

Table 6a: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)	(6)
Log population	0.0001					
	(0.0003)					
Log density		0.002***	0.002***	0.002***	0.002***	0.002***
		(0.0004)	(0.001)	(0.000)	(0.001)	(0.001)
Log area			-0.0004	-0.0002	-0.0002	-0.0004
			(0.0003)	(0.0003)	(0.0003)	(0.0005)
Share of university graduates				-0.004	-0.004	-0.008
				(0.004)	(0.004)	(0.008)
Herfindahl Index					0.030	-0.032
					(0.040)	(0.077)
Industry employment shares (classification 1)						
Agriculture, fishing, and mining						-0.018
						(0.024)
Manufacturing						-0.029
						(0.021)
Electricity, gas, and water supply						-0.112*
						(0.059)
Wholesale and retail trade						-0.014
						(0.025)
Hotels and restaurants						-0.007
						(0.037)
Transport, storage, and communication						-0.044**
						(0.022)
Financial intermediation						-0.023
						(0.029)
Real estate, renting, and business activities						0.011
						(0.027)
Public administration						-0.024
						(0.023)
Education, health and social work						-0.020
						(0.023)
Other services						-0.056
						(0.038)
Industry employment share (classification 2)						
Agriculture, fishing, and mining						
Electricity, gas, and water supply						
High-tech manufacturing						
Med-high tech manufacturing						
Med-low tech manufacturing						
Low tech manufacturing						

Knowledge intensive services						
High tech services						
Low knowledge intensive services						
Polycentric						
Port						
Capital						
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.967	0.968	0.968	0.968	0.968	0.968
Number of observations	808	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (5) in Table 2. The share of construction industry is omitted.

Table 6b: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(7)	(8)	(9)	(10)	(11)
Log population					
Log density	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Log area	-0.000	-0.000	-0.000	-0.001	-0.000
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Share of university graduates	-0.006	-0.007	-0.008	-0.008	-0.008
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Herfindahl Index	0.009		-0.021	-0.034	-0.015
	(0.054)		(0.080)	(0.079)	(0.080)
Industry employment shares (classification 1)					
Agriculture, fishing, and mining		-0.017	-0.019	-0.019	-0.017
		(0.023)	(0.024)	(0.025)	(0.023)
Manufacturing		-0.025	-0.028	-0.029	-0.027
		(0.019)	(0.021)	(0.021)	(0.021)
Electricity, gas, and water supply		-0.106*	-0.109*	-0.114*	-0.111*
		(0.057)	(0.059)	(0.061)	(0.059)
Wholesale and retail trade		-0.015	-0.016	-0.014	-0.016
		(0.024)	(0.025)	(0.025)	(0.025)
Hotels and restaurants		-0.005	-0.006	-0.007	-0.007
		(0.037)	(0.037)	(0.037)	(0.037)
Transport, storage, and communication		-0.042**	-0.044*	-0.045*	-0.043*
		(0.021)	(0.022)	(0.023)	(0.022)
Financial intermediation		-0.019	-0.024	-0.024	-0.021
		(0.027)	(0.029)	(0.029)	(0.029)
Real estate, renting, and business activities		0.013	0.012	0.011	0.013
		(0.027)	(0.027)	(0.027)	(0.026)
Public administration		-0.023	-0.023	-0.025	-0.024
		(0.023)	(0.023)	(0.024)	(0.023)
Education, health and social work		-0.022	-0.021	-0.020	-0.023
		(0.021)	(0.023)	(0.023)	(0.023)
Other services		-0.053	-0.055	-0.057	-0.053
		(0.039)	(0.038)	(0.039)	(0.039)
Industry employment share (Classification 2)					
Agriculture, fishing, and mining	-0.011				
	(0.021)				
Electricity, gas, and water supply	-0.106*				
	(0.056)				
High-tech manufacturing	-0.008				
	(0.037)				
Med-high tech manufacturing	0.001				
	(0.028)				
Med-low tech manufacturing	-0.041				
	(0.031)				
Low tech manufacturing	-0.048*				
	(0.026)				

Knowledge intensive services	-0.021 (0.021)				
High tech services	-0.029 (0.032)				
Low knowledge intensive services	-0.025 (0.019)				
Polycentric			-0.002 (0.002)		
Port				0.0003 (0.001)	
Capital					-0.005** (0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
R-squared	0.968	0.968	0.969	0.968	0.969
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (5) in Table 2. The share of construction industry is omitted.

Table 7: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)
Log population	0.009**	0.009**	0.009**	0.008**	0.008**
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Share of university graduates		-0.006	-0.005	-0.015	-0.014
		(0.031)	(0.031)	(0.030)	(0.032)
Herfindahl Index			0.118	-0.032	0.027
			(0.130)	(0.174)	(0.148)
Industry Employment Shares (classification 1)					
Agriculture, fishing, and mining				0.043	
				(0.086)	
Manufacturing				-0.071	
				(0.053)	
Electricity, gas, and water supply				-0.018	
				(0.131)	
Wholesale and retail trade				-0.010	
				(0.053)	
Hotels and restaurants				-0.050	
				(0.072)	
Transport, storage, and communication				-0.071	
				(0.057)	
Financial intermediation				0.019	
				(0.079)	
Real estate, renting, and business activities				0.107*	
				(0.055)	
Public administration				0.054	
				(0.065)	
Education, health and social work				0.011	
				(0.050)	
Other services				-0.015	
				(0.066)	
Industry Employment Shares (classification 2)					
Agriculture, fishing, and mining					0.056
					(0.088)
Electricity, gas, and water supply					-0.016
					(0.123)
High tech manufacturing					0.017
					(0.102)
Med-high tech manufacturing					-0.059
					(0.089)
Med-low tech manufacturing					-0.095
					(0.067)
Low tech manufacturing					-0.090
					(0.076)
Knowledge intensive services					0.014
					(0.048)
High tech services					-0.002
					(0.091)
Low knowledge intensive services					-0.019
					(0.047)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Area fixed effects	Yes	Yes	Yes	Yes	Yes

R-squared	0.972	0.972	0.972	0.973	0.972
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (1) in Table 2. The share of construction industry is omitted.

Table 8: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)
Log population	0.011***	0.011***	0.011***	0.011***	0.011***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Share of university graduates		0.016	0.017	0.015	0.017
		(0.019)	(0.019)	(0.019)	(0.020)
Herfindahl Index			0.061	0.002	0.031
			(0.085)	(0.109)	(0.093)
Industry Employment Shares (classification 1)					
Agriculture, fishing, and mining				-0.056	
				(0.048)	
Manufacturing				-0.058*	
				(0.031)	
Electricity, gas, and water supply				-0.085	
				(0.075)	
Wholesale and retail trade				-0.037	
				(0.032)	
Hotels and restaurants				-0.056	
				(0.044)	
Transport, storage, and communication				-0.050	
				(0.038)	
Financial intermediation				-0.080	
				(0.055)	
Real estate, renting, and business activities				0.028	
				(0.036)	
Public administration				-0.028	
				(0.039)	
Education, health and social work				-0.033	
				(0.029)	
Other services				-0.005	
				(0.041)	
Industry Employment Shares (classification 2)					
Agriculture, fishing, and mining					-0.050
					(0.048)
Electricity, gas, and water supply					-0.086
					(0.074)
High tech manufacturing					0.010
					(0.059)
Med-high tech manufacturing					-0.034
					(0.048)
Med-low tech manufacturing					-0.073
					(0.047)
Low tech manufacturing					-0.080*
					(0.041)
Knowledge intensive services					-0.037
					(0.027)
High tech services					-0.021
					(0.049)
Low knowledge intensive services					-0.030
					(0.029)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Area fixed effects	Yes	Yes	Yes	Yes	Yes

R-squared	0.986	0.986	0.986	0.986	0.986
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (4) in Table 2. The share of construction industry is omitted.

Table 9: Second Stage Regression Results for Conditional Functional Urban Area Wage Differentials

	(1)	(2)	(3)	(4)	(5)
Log population	0.010***	0.010***	0.010***	0.010***	0.010***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Share of university graduates		-0.008	-0.008	0.002	-0.005
		(0.023)	(0.023)	(0.025)	(0.024)
Herfindahl Index			0.022	-0.040	0.007
			(0.087)	(0.120)	(0.098)
Industry Employment Shares (classification 1)					
Agriculture, fishing, and mining				-0.041	
				(0.054)	
Manufacturing				-0.042	
				(0.039)	
Electricity, gas, and water supply				-0.148	
				(0.098)	
Wholesale and retail trade				-0.039	
				(0.037)	
Hotels and restaurants				-0.032	
				(0.051)	
Transport, storage, and communication				-0.069**	
				(0.035)	
Financial intermediation				-0.067	
				(0.063)	
Real estate, renting, and business activities				0.032	
				(0.037)	
Public administration				-0.053	
				(0.043)	
Education, health and social work				-0.042	
				(0.037)	
Other services				-0.064	
				(0.050)	
Industry Employment Shares (classification 2)					
Agriculture, fishing, and mining					-0.020
					(0.049)
Electricity, gas, and water supply					-0.127
					(0.093)
High tech manufacturing					0.026
					(0.083)
Med-high tech manufacturing					0.042
					(0.058)
Med-low tech manufacturing					-0.068
					(0.063)
Low tech manufacturing					-0.093*
					(0.048)
Knowledge intensive services					-0.037
					(0.030)
High tech services					-0.023
					(0.066)
Low knowledge intensive services					-0.045*
					(0.026)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Area fixed effects	Yes	Yes	Yes	Yes	Yes

R-squared	0.970	0.970	0.970	0.971	0.971
Number of observations	808	808	808	808	808

Notes: Data source is the Quarterly Labour Force Survey, 2003-2010. Standard errors clustered at the area level in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the area/year fixed effect estimated from specification (4) in Table 2. The share of construction industry is omitted.

Table 10: Second Stage Regression Results for the Change in Conditional Functional Urban Area Wage Differentials between 2003 and 2010

	(1)	(2)	(3)	(4)	(5)
Change in log population	0.182*** (0.006)	0.131*** (0.010)	0.085*** (0.011)	0.052*** (0.010)	0.067*** (0.012)
Change in the share of university graduates		1.241*** (0.165)	0.764*** (0.125)	0.119 (0.102)	0.550*** (0.123)
Change in Herfindahl Index			4.688*** (0.465)	3.038*** (0.675)	4.436*** (0.572)
Change in Industry Employment Shares (Classification 1)					
Agriculture, fishing, and mining				0.157 (0.572)	
Manufacturing				0.026 (0.222)	
Electricity, gas, and water supply				1.099* (0.574)	
Wholesale and retail trade				-0.043 (0.248)	
Hotels and restaurants				0.335 (0.293)	
Transport, storage and communication				-0.216 (0.224)	
Financial intermediation				1.126*** (0.335)	
Real estate, renting, and business activities				-0.307 (0.220)	
Public administration				0.254 (0.260)	
Education, health, and social work				-0.049 (0.243)	
Other services				0.761*** (0.222)	
Change in Industry Employment Shares (Classification 2)					
Agriculture, fishing, and mining					-0.160 (0.762)
Electricity, gas and water supply					1.211 (0.732)
High tech manufacturing					-0.091 (0.455)
Med-high tech manufacturing					-0.143 (0.384)
Med-low tech manufacturing					0.550 (0.408)
Low tech manufacturing					-0.068 (0.445)
Knowledge intensive services					-0.110 (0.277)
High tech services					0.188 (0.334)
Low knowledge intensive services					0.394 (0.240)
R-squared	0.598	0.737	0.871	0.942	0.896
Number of	101	101	101	101	101

observations

Notes: Data source is the Quarterly Labour Force Survey, 2003 and 2010. Robust standard errors in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the difference between the area year fixed effect in 2010 and 2003 estimated using specification (1) in Table 2. The change in the share of construction industry is omitted.

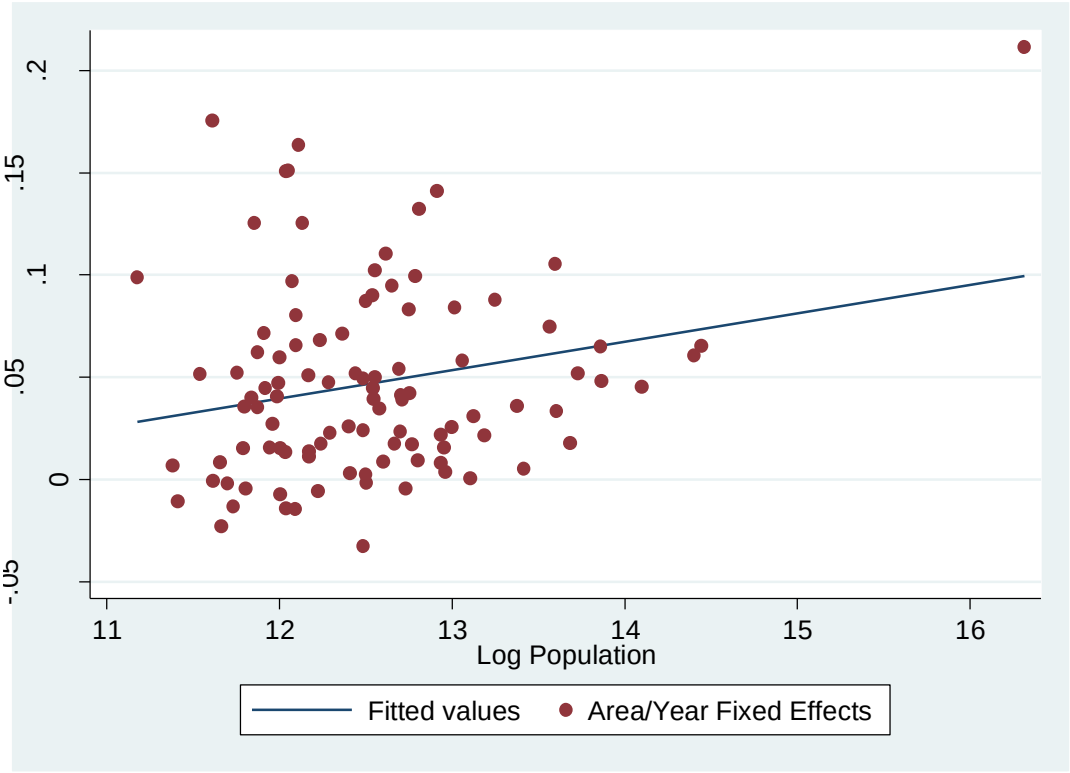
Table 11: Second Stage Regression Results for the Change in Conditional Functional Urban Area Wage Differentials between 2003 and 2010

	(1)	(2)	(3)	(4)	(5)
Change in log population	0.206*** (0.007)	0.148*** (0.010)	0.098*** (0.011)	0.057*** (0.010)	0.078*** (0.012)
Change in the share of university graduates		1.411*** (0.180)	0.895*** (0.144)	0.136 (0.103)	0.665*** (0.123)
Change in Herfindahl Index			5.063*** (0.497)	3.056*** (0.616)	4.870*** (0.558)
Change in Industry Employment Shares (Classification 1)					
Agriculture, fishing, and mining				0.162 (0.482)	
Manufacturing				0.157 (0.218)	
Electricity, gas, and water supply				1.498*** (0.527)	
Wholesale and retail trade				0.041 (0.222)	
Hotels and restaurants				0.380 (0.268)	
Transport, storage and communication				-0.149 (0.216)	
Financial intermediation				0.930*** (0.302)	
Real estate, renting, and business activities				-0.350 (0.220)	
Public administration				0.225 (0.237)	
Education, health, and social work				-0.024 (0.223)	
Other services				0.986*** (0.222)	
Change in Industry Employment Shares (Classification 2)					
Agriculture, fishing, and mining					-0.200 (0.713)
Electricity, gas and water supply					1.712** (0.766)
High tech manufacturing					0.115 (0.434)
Med-high tech manufacturing					0.056 (0.401)
Med-low tech manufacturing					0.719* (0.423)
Low tech manufacturing					0.246 (0.468)
Knowledge intensive services					-0.129 (0.300)
High tech services					0.161 (0.345)
Low knowledge intensive services					0.551** (0.248)
R-squared	0.612	0.756	0.880	0.958	0.912
Number of	101	101	101	101	101

observations

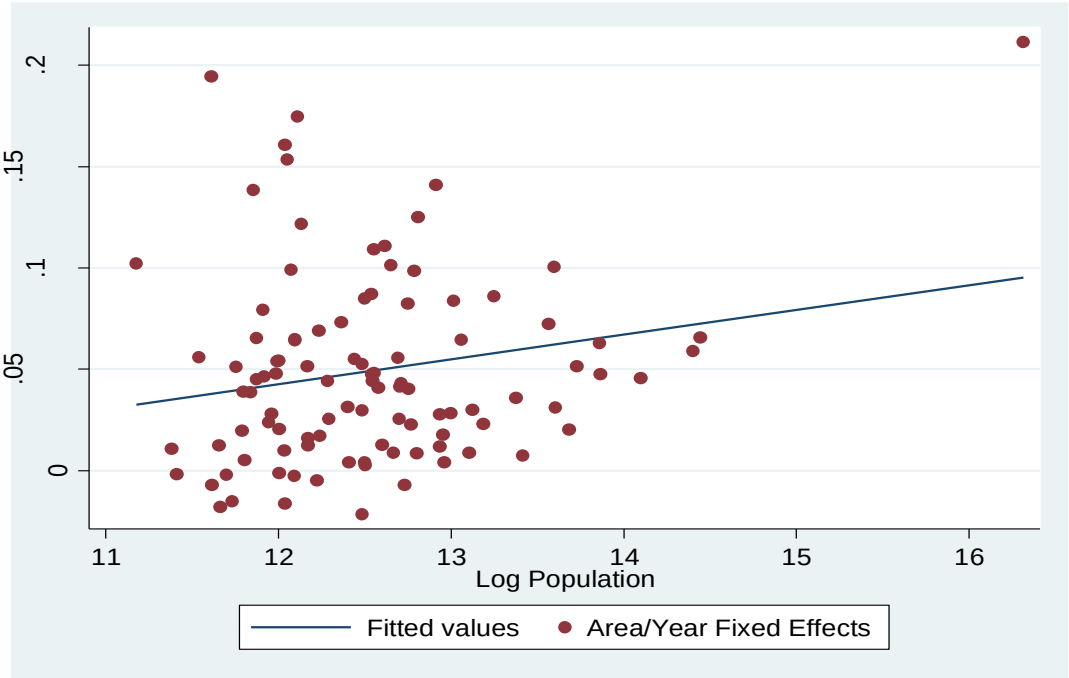
Notes: Data source is the Quarterly Labour Force Survey, 2003 and 2010. Robust standard errors in parentheses, ***significant at 1%, **significant at 5%., *significant at 10%. Dependent variable is the difference between the area year fixed effect in 2010 and 2003 estimated using specification (4) in Table 2. The change in the share of construction industry is omitted.

Figure 1: Functional Urban Area Wage Differentials in 2010



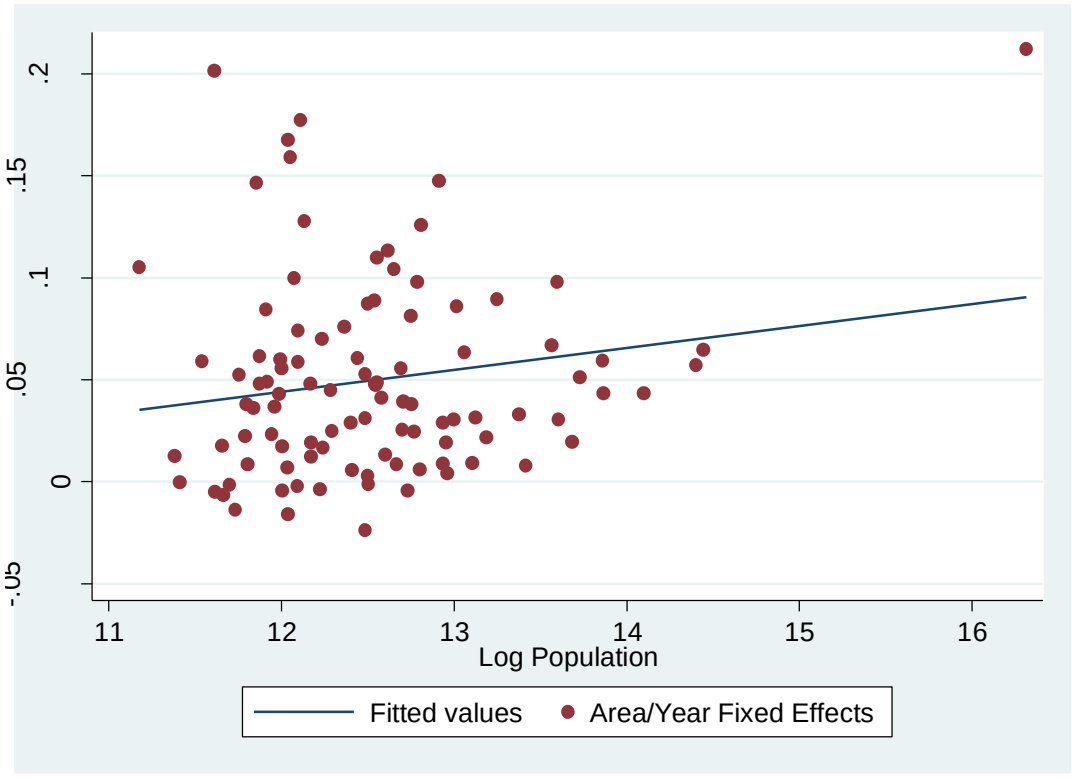
Source: ASHE, 2010. Area/year fixed effects are estimated from specification (1) in Table 2.

Figure 2: Functional Urban Area Wage Differentials in 2010



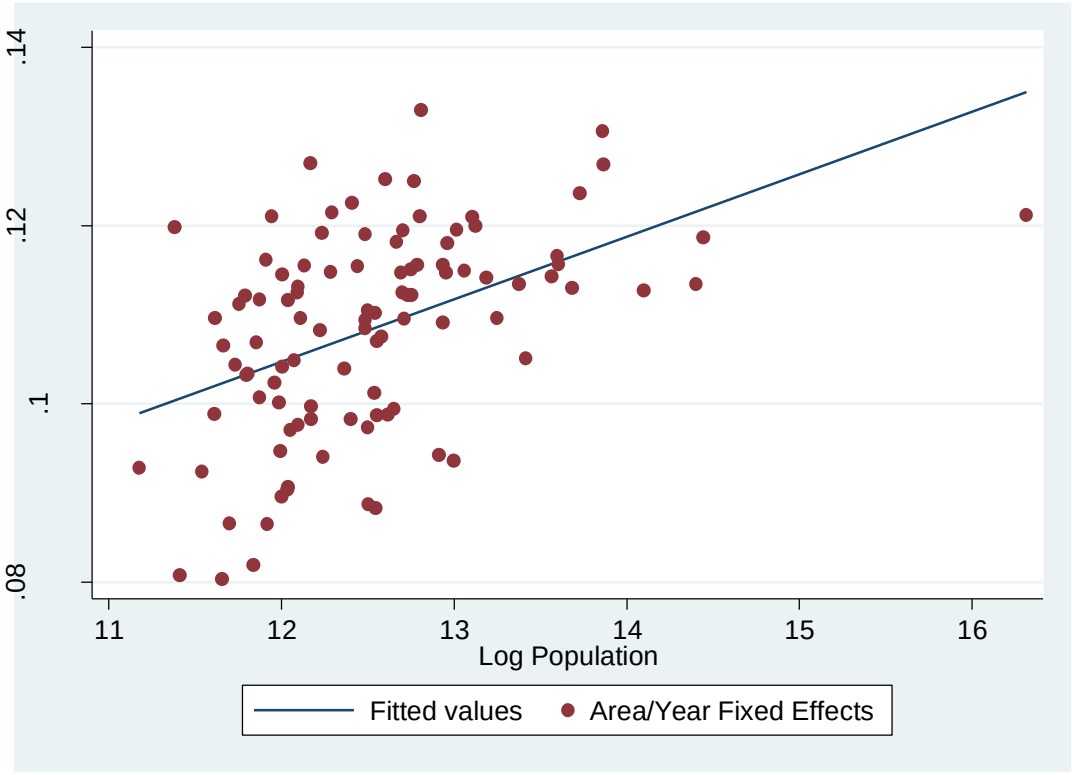
Source: ASHE, 2010. Area/year fixed effects are estimated from specification (2) in Table 2.

Figure 3: Functional Urban Area Wage Differentials in 2010



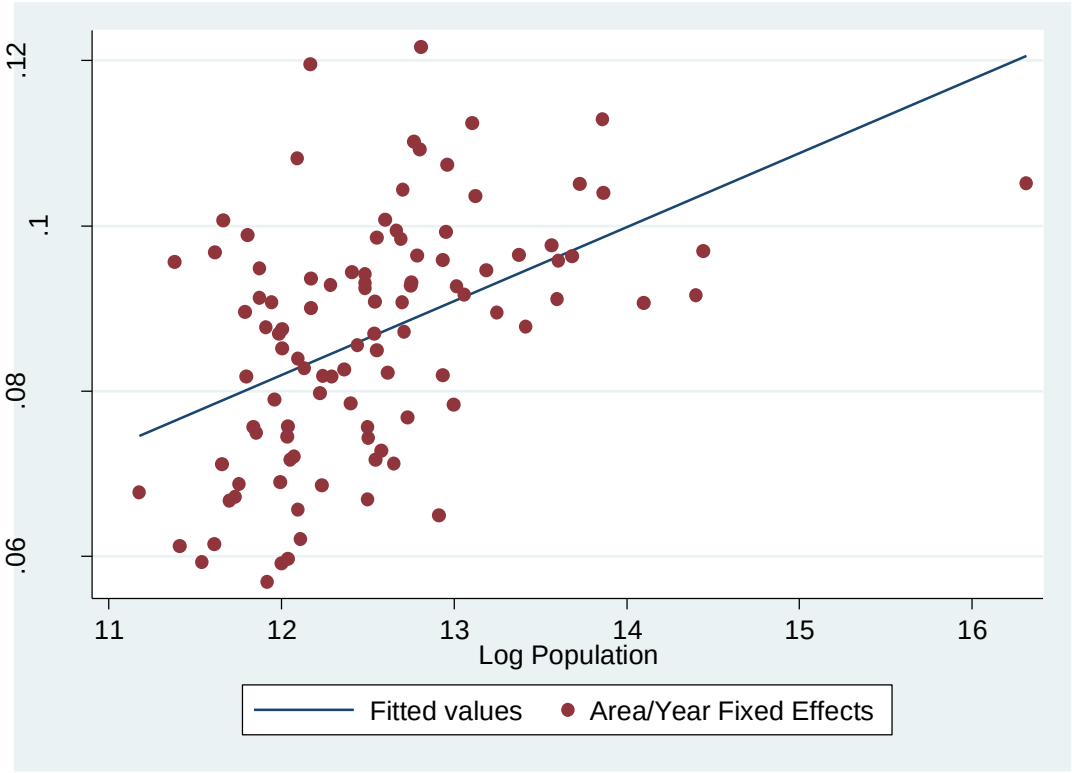
Source: ASHE, 2010. Area/year fixed effects are estimated from specification (3) in Table 2.

Figure 4: Functional Urban Area Wage Differentials in 2010



Source: ASHE, 2010. Area/year fixed effects are estimated from specification (4) in Table 2.

Figure 5: Functional Urban Area Wage Differentials in 2010



Source: ASHE, 2010. Area/year fixed effects are estimated from specification (5) in Table 2.

References

Ahrend, R., Farchy, E., Kaplanis, I., and Lembcke, A. (2017). "What Makes Cities More Productive? Evidence from Five OECD Countries on the Role of Urban Governance", *Journal of Regional Science*, 57(3): 385-410.

Combes, P.P., Duranton, G., and Gobillon, L. (2008). "Spatial Wage Disparities: Sorting Matters!", *Journal of Urban Economics*, 63: 723-742.

Combes, P.P., Duranton, G., and Gobillon, L. (2011). "The Identification of Agglomeration Economies", *Journal of Economic Geography*, 11: 253-256.

D'Costa, S., and Overman, H. (2013). "The Urban Wage Growth Premium: Sorting or Learning?", SERC discussion paper no. 135.

Duranton, G., and Puga, D. (2004). "Micro-Foundations of Urban Agglomeration Economies", in *Handbook of Regional and Urban Economics*, vol. 4, ed. J.V. Henderson, and J.F. Thisse, 2063-2117, Amsterdam: North Holland.

ESPON. (2007). "Study on Urban Functions", European Spatial Planning Observation Network report.

Gibbons, S., Overman, H., and Pelkonen, P. (2014). "Area Disparities in Britain: Understanding the Contribution of People vs. Place through Variance Decompositions", *Oxford Bulletin of Economics and Statistics*, 76(5): 745-763.

Glaeser, E, and Mare, D. (2001). "Cities and Skills", *Journal of Labor Economics*, 12(2): 316-342.

Kaplanis, I. (2010). "Wage Effects from Changes in Local Human Capital in Britain", SERC discussion paper no. 39.

Monastiriotis, V. (2002). "Human Capital and Wages: Evidence for External Effects from the UK Regions", *Applied Economics Letters*, 9: 843-846.

OECD. (2012a). *Redifining "Urban": A New Way to Measure Metropolitan Areas*. Paris: OECD Publishing.

OECD. (2012b). *OECD Territorial Reviews: The Chicago Tri-State Metropolitan Area, United Stages.* Paris: OECD Publishing.

Puga, D. (2010). "The Magnitude and Causes of Agglomeration Economies", *Journal of Regional Science*, 50(1): 203-219.

Rosenthal, S., and Strange, W. (2004). "Evidence on the Nature and Sources of Agglomeration Economies", in *Handbook of Regional and Urban Economics*, vol. 4, ed. J.V. Henderson, and J.F. Thisse, 2119-2171, Amsterdam: North Holland.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, Massachusetts, MIT Press.

APPENDIX

Table A1: Functional Urban Areas in Great Britain and Their Characteristics

FUA Name	Population in 2010 (in millions)	Area (in sq. km)
London	12.15	7004.60
Birmingham	1.80	1480.99
Leeds	1.33	1816.18
Bradford	0.53	443.16
Liverpool	0.92	565.35
Manchester	1.87	1462.77
Cardiff	0.64	737.01
Sheffield	0.87	1113.64
Bristol	0.81	935.96
Newcastle	1.05	2920.62
Leicester	0.67	1278.57
Cambridge	0.30	1079.14
Exeter	0.22	1247.91
Lincoln	0.19	1123.80
Steevenage	0.07	103.05
Wrexham	0.14	607.60
Portsmouth	0.57	469.63
Worcester	0.17	592.33
Coventry	0.47	351.28
Kingston Upon Hull	0.42	1404.42
Stoke-on-trent	0.49	880.03
Wolverhampton	0.29	263.68
Nottingham	0.81	1128.65
The Wirral	0.30	163.94
Bath	0.23	597.10
Guilford	0.17	403.55

Margate	0.12	103.30
Lowestoft	0.13	693.30
Royal Tunbridge Wells	0.15	651.75
Ashford	0.12	784.26
Burton upon Trent	0.16	513.68
Darlington	0.13	499.58
Worthing	0.16	119.01
Masfield	0.15	235.46
Chesterfield	0.16	246.05
Rugby	0.10	509.07
Burnley	0.12	187.20
Great Yarmouth	0.09	173.85
Hartlepool	0.11	104.82
Cannock	0.13	149.29
Eastbourne	0.14	251.80
Hastings	0.13	299.79
Redditch	0.09	62.87
Hidness	0.13	94.74
Huddersfield	0.41	414.65
Dudley	0.34	201.68
Wigan	0.33	223.23
Doncaster	0.33	787.71
Sunderland	0.32	209.03
Bolton	0.27	167.63
Walsall	0.27	109.66
Rochester	0.24	244.85
Brighton	0.34	209.42
Plymouth	0.35	947.49
Swansea	0.36	836.20

Derby	0.36	672.71
Bransley	0.24	331.81
Southampton	0.45	412.03
Oldham	0.22	141.05
Milton Keynes	0.31	782.20
Rochdale	0.20	177.70
Northampton	0.28	747.42
Warrington	0.21	175.95
Luton	0.27	249.50
York	0.27	1337.93
Swindon	0.28	1037.04
Middlesbrough	0.50	1014.96
St Helens	0.17	136.30
Poole	0.44	705.17
High Wycombe	0.17	351.85
Teldford	0.21	872.34
Grimsby	0.19	842.56
Petersborough	0.33	1389.19
Colchester	0.25	677.16
South Shields	0.16	64.03
Basingstoke	0.18	674.33
Barford	0.18	625.22
Wokingham	0.41	584.29
Blackpool	0.27	193.71
Maidstone	0.15	440.86
Hemel Hepstead	0.14	281.74
Blackburn	0.27	438.19
Newport	0.33	758.25
Oxford	0.28	924.63
Torbay	0.18	207.54

Preston	0.41	937.97
Solihull	0.16	588.03
Norwich	0.42	1560.45
Chester	0.28	841.62
Ipswich	0.28	907.43
Cheltenham	0.18	492.35
Gloucester	0.18	503.99
Bracknell	0.11	109.38
Carlisle	0.14	1953.86
Crawley	0.19	272.87
Glasgow	1.04	1573.39
Edinburgh	0.78	2044.42
Aberdeen	0.37	4100.69
Motherwell	0.35	473.85
Dundee	0.19	716.22
Falkirk	0.16	299.62

Notes: Population estimates are based on UK Quarterly Labour Force Survey data 2010 and used individual sampling weights. Information on area and whether the area has a port is from authors own sources.