The London School of Economics and Political Science

The spatial dimension of labour markets: An investigation of economic inequalities and a local employment shock

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Declaration

I certify that the thesis I have presented for examination for the PhD degree of the London School of Economics and Political Science is solely my own work other than where I have clearly indicated that it is the work of others (in which case the extent of any work carried out jointly by me and any other person is clearly identified in it). The copyright of this thesis rests with the author. Quotation from it is permitted, provided that full acknowledgement is made. This thesis may not be reproduced without the prior written consent of the author. I warrant that this authorization does not, to the best of my belief, infringe the rights of any third party.

Teresa Schlüter London, 22^{nd} December, 2014

Statement of conjoint work

Chapter III and Chapter IV involve conjoint work. This statement is to confirm that I contributed a minimum of 50% to Chapters III and IV.

Chapter III was produced jointly with Dr. Luisa Gagliardi. I contributed to the

- Development of the research question and methodological approach
- Statistical analysis using STATA
- Presentation of the project at the LSE Work-in-Progress Seminar
- Write-up of the paper

Chapter IV was produced jointly with Dr. Giulia Faggio and Dr. Philipp vom Berge. I contributed to the

- Development of the research question and methodological approach
- Data collection from official documents and research of the historical background
- Grant proposal for the "Data without Boundaries Project"
- Statistical analysis using STATA
- Presentation of the work at seminars and conferences
- Write-up of the paper.

Abstract

This thesis consists of four chapters positioned at the interface of economics and geography. They analyse spatial disparities in economic activity using applied microeconometric methods.

Chapter I describes trends in wage inequality once differences in local costs of living are taken into account. I use spatial variation in house prices to construct a local consumer price index and show that prices rose faster for non-graduates than for graduates between 2001 and 2011. In a period when nominal wage inequality came to a halt real wage inequality kept rising.

Chapter II builds up on this result and analyses the effect of real wage differentials on working hours. Looking at individuals that face different wages and house prices as they move across labour markets, I find that working hours are significantly higher in low real wage areas. The effect is due to labour supply adjustments of low skilled workers implying that affordability considerations are more important than additional leisure options due to a higher amenity level.

Within a city amenities are important determinants of an individual's location decision. Chapter III looks at the role of amenities for skill specific sorting in British cities. An amenity value is inferred from a hedonic regression and correlated with neighbourhood as well as individual characteristics. The results suggest that holding income constant graduates are willing to pay 0.2% more for amenities than individuals with a lower educational status.

Chapter IV studies the effect of a public sector employment shock on private sector employment using the relocation of the German government from Bonn to Berlin as a natural experiment. The findings indicate that the relocation of jobs generates localized employment spill-over effects in the service sector. 100 additional public sector jobs generate 60 private sector jobs up to a 1km distance from the area receiving the relocation.

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Data disclaimer

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Chapter IV uses the weakly anonymous Establishment History Panel (years 1991 - 2010). Data access was provided via on-site use at the Research Data Centre (FDZ) of the German Federal Employment Agency (BA) at the Institute for Employment Research (IAB) and remote data access.

Introduction

Context

This thesis consists of four chapters which have in common that they explore the spatial dimension of the labour market. The questions relate to the field of urban economics which addresses the distribution of income and production across space and the geographic location of economic agents relative to one another. The discipline is based on theoretical reasoning and the use of quantitative methods to test the theoretical predictions on data. One of the main contributions of the field of urban economics is to provide micro-foundations leading to the emergence of agglomeration and spatial inequality. The field addresses explicitly the production and consumption externalities which give rise to cities (Quigley, 1998) and derives policy recommendations on issues such as land use, environmental quality, transportation, housing, income distribution and financing of urban public services.

That productivity differs across space becomes evident when looking at differentials of factor prices across labour markets. Local labour markets in the UK and elsewhere are characterized by considerable differences in earnings and land costs. In the absence of a corresponding productivity advantage firms would locate to labour markets offering cheaper inputs. This argument holds especially for firms producing traded goods as they face the same price on the national or international market. Therefore, average productivity has to be higher in cities where nominal wages and prices for land are higher (Acemoglu and Angrist, 2001).

What are the dominant factors that make some places more productive than others? Some places might have a natural advantage such as a natural port, which reduces shipping costs and makes it easier and less costly to trade. Another natural advantage might be access to raw materials such as coal or iron ore allowing specialized industries that heavily depend on these inputs to develop. As over time

moving goods across space became faster and cheaper due to the invention of new technologies and logistic systems (e.g. freight trains and aeroplanes, containers and largely automated transport hubs) and as the focus of production shifted towards knowledge as the most important input, places endowed with natural resources lost most of their relative competitive advantage. Today, Combes et al. (2008) estimate that only 3% of differentials in productivity advantages (of the French economy) can be attributed to natural endowments.

Alternative explanations dating back to Marshall (1890) gained in importance over time. In this view the clustering of economic agents is an advantage itself and gives rise to 'agglomeration economies'. Agglomeration of economic activity allows a better match between the required skill level of a job and a worker's skill set and also makes it easier for workers to find a new job in case they are laid off. Proximity and density also facilitate knowledge spill-overs. Workers who are close to one another have more chances to interact, spread ideas and learn from each other. Finally, agglomeration benefits might accrue from input sharing due to linkages between intermediate and final goods suppliers.

For each of these sources of agglomeration economies empirical tests have been designed. See for instance Costa and Kahn (2000); Overman and Puga (2010) for labour market pooling, Jaffe et al. (1993); Glaeser and Maré (2001); Arzaghi and Henderson (2008) for knowledge spill-overs, Holmes (1999) for input sharing and Rosenthal and Strange (2001); Ellison et al. (2010); Faggio et al. (2014) for the relative importance of each of the sources of agglomeration. I contribute to this literature by providing evidence on the reinforcing mechanisms of agglomeration economies. Chapter IV of this thesis shows that the size of an external employment shock to an area amplifies itself by triggering demand for local goods and services. This demand creates new jobs in the private service sector, the so called local multiplier effect.

Chapter I to III are based around the fact that productivity differentials are capitalized in both wages and rents, and that spatial wage disparities alone are therefore uninformative about differences in standards of living and economic welfare. Differences in wages have been widely studied as wage inequality raises equity and fairness questions. Similar questions arise when looking at the cost side of local labour markets as different people choose to live in different locations. Chapter I starts by exploring how inequality measures change, when local cost of living are taken into

account and how these measures evolve over time. For which reasons do individuals choose to live in areas characterized by relatively low wages and relatively high cost of living? If workers are sufficiently mobile they would move from low to high real wage areas in order to increase their utility level. Rosen (1979) and Roback (1982) noticed that if the assumption of spatial equilibrium holds, areas where high costs of land or housing are not offset by higher wages must offer another form of compensation. Their model predicts that regions characterized by low real wages must be more desirable places to live. Among others Gibbons et al. (2011b) and Albouy (2008) provide recent empirical evidence for the capitalization of amenities into local wages and house prices. Chapter II builds on previous findings and looks at the relationship between real wage differentials and working hours across labour market areas. Higher relative costs of living may reflect a higher amenity level, thus increasing the quality of leisure in an area. But they also make an area more difficult to afford, thus requiring low income workers to increase their labour time.

The distinction between high skilled and lower skilled workers is further pursued in Chapter III, as preferences for amenities are likely to vary across different groups of individuals. The chapter addresses the question whether high skilled workers concentrate in certain areas because they have a higher preference for amenities than lower skilled workers.

The increased interest in research questions that have a spatial focus would not have been possible without improvements in the availability of data and the development of adequate statistical methods and software packages. For example, determining the attenuation of agglomeration economies with distance is impossible with aggregate data as it requires geographically refined data that has information on the precise location of an economic agent.

Today detailed micro data, i.e. large data sets that have information for a single agent such as a firm or an individual, are collected and made available for research and governmental purposes by the national statistical offices. These data have often been attributed a detailed geography that allows the exact location of the agent in space. Recently, the movement of 'Open Data' has gained momentum and other public institutions have made their data freely available. For instance, in the UK it is now possible to look up the number of crimes that happened within the last year in one's immediate neighbourhood and the underlying crime level data is freely available for download on the police website.

The increase in the availability and quality of data has been accompanied by methodological improvements of quantitative methods and the design of new instruments to determine causal relationships. The surge in georeferenced data led to the development of geographic information systems (GIS) that are able to manage, analyse and present all types of spatial or geographical data.
These developments have made it possible to address research questions that have previously not been possible to address and to reassess existing questions with better data. My research is thus part of an exciting and dynamically evolving field. I summarize the approach taken in this thesis and the four main chapters in the next section before I turn to the full exposition of each research question in Chapter I - IV.

Summary of Chapter I - IV

The approach taken in this thesis is to explore the spatial dimension of the labour market in a number of distinct settings using micro-data and applied micro-econometric methods. While Chapter I and Chapter II treat local labour markets as single functional units, Chapter III and Chapter IV take a closer look at dynamics that take place within the unit of a labour market. The thesis centres around the observation that economic activity and economic outcomes are unevenly distributed across space. Chapter I and II focus on differences in the cost of living across space and show their impact on economic outcomes such as inequality and labour supply. Chapter III and IV look at possible reasons why some areas are more productive than others.

Chapter I

Chapter I analyses how wage inequality changes when local cost of living are taken into account. Unequal economic outcomes of different population groups have been widely studied as the fair distribution of economic gains is considered as crucial for the social cohesion of society. Differences in costs across population groups have received less attention, though they have similar implications.
In this chapter inequality is measured as the real wage difference between university degree holders and non-degree holders. As a starting point I describe differences in the distribution of skilled workers across UK labour markets along with differences

in the distribution of house prices and house price growth between 2001 and 2011. I then follow the procedure proposed by Moretti (2013) and use spatial variation in house prices to construct a local price index. As individuals spend a large share of their total expenditure on housing, high house prices considerably reduce the purchasing power of wages in local labour markets.

The regression analysis shows that nominal wage inequality remained unchanged over the decade. When differences in local prices are accounted, for I get a different result as local prices rose faster for non-university graduates than for graduates. Real wage inequality, which takes differences in local costs of living into account, kept rising in a period when nominal wage inequality came to a halt.

In order to understand which processes drove the increase in real wage inequality, I decompose the change in costs of living for each skill category into changes in the distribution of skill groups across space and changes in prices for different skill groups as in Moretti (2013). The analysis shows that high skilled workers at least partially offset increases in costs of living by moving into cheaper areas whereas lower skilled workers are less mobile and stay put even though prices in their area increase.

Chapter II

Chapter II builds on the results of Chapter I and looks at the relationship between real wage differentials and working hours across labour market areas. High costs of living that are not offset by equally high wages might reflect a higher amenity level, thus increasing the quality of leisure in an area. But they also make an area more difficult to afford which might make it necessary for workers to increase their labour time.

I construct a measure of area level real wages by combining information on house prices and wages for the analysis. Following Gibbons et al. (2011b), I adjust local wage levels for differences in skills across areas and local house prices for differences in the quality of the housing in terms of structure. I then observe how individuals adjust their working hours when moving across labour market boundaries that offer different real wage levels.

I find that working hours are significantly longer in low real wage areas and that this effect is stronger for low skilled workers. This indicates that affordability con-

siderations are more important than the additional leisure options that arise from the presence of better local amenities. I also test for a direct effect of amenities on working hours but find no conclusive evidence for a link between the two.
While amenities make an area more attractive, they also make it more difficult to afford living there. To get by, poorer workers in high-price areas have to work longer hours than similar workers in cheaper places. Alternatively, high-income people in high-price areas trade off cash for leisure time. Understanding these choices helps policymakers understand just how 'liveable' some cities are.

Chapter III

Chapter III focuses on reasons for the location choices of high skilled workers. As seen in the previous chapters high and low skilled workers increasingly chose to live in different areas. As the level of human capital is an important determinant of the economic success of an area (Lucas, 1988) it is crucial to understand which factors drive individual location choices. Chapter III addresses the question whether high skilled workers choose to live in areas offering a higher level of amenities because they have a higher preference for amenities than lower skilled workers. We investigate the relation between amenities and skills by looking at the sorting behaviour of individuals within British cities.
Several studies have linked the sorting of highly skilled workers across labour markets to differences in the local level of amenities. It is, however, difficult to separate the impact of amenities on an individual's location choice from labour market characteristics such as for instance differences in the local productivity level.
We propose an empirical test for the existence of education biased preferences for amenities in UK cities based on a two stage estimation approach. The analysis is done at the within city level to rule out the confounding role of job opportunities. In the first stage, we estimate a standard hedonic regression assuming that the value of amenities is capitalized into housing prices. From this regression we derive a composite amenity measure that captures all unobserved neighbourhood characteristics, such as for instance crime levels, proximity to green areas, restaurants and cafes. In the second stage, we analyse how the amenity consumption as captured by this measure is distributed across individuals belonging to different education groups.
Our results show that high skilled individuals, earning the same income as low skilled

workers with similar characteristics, locate in more attractive neighbourhoods. This sorting behaviour provides empirical evidence in favour of a preference bias since individuals with higher educational achievements are willing to forgo a greater portion of their wage to live in attractive places. Skill related sorting into areas offering a high amenity level is, therefore, one channel that explains spatial differences in productivity.

Chapter IV

In Chapter IV we study a setting that gives insight into possible policy levers for the attenuation of existing spatial inequalities and differences in economic performance. The aim of the chapter is the identification of employment spill-over effects. It shows that a public sector employment shock generates demand for services and thus creates new jobs in the private service sector. This result provides evidence on the reinforcing mechanisms of agglomeration economies.

We use the move of the seat of the German government from Bonn to Berlin in 1999 as an exogenous shock to quantify the effect of job relocations on the spatial pattern of employment changes within local labour markets. The main theoretical argument for employment multiplier effects is that each additional public sector job may increase demand for locally-produced goods and services and that this increase in demand may trigger additional jobs in the private non-tradable sector. The theoretical counter argument is that higher rents and wages increase local production costs which impede new businesses from forming or hamper existing businesses' competitiveness. These general equilibrium effects may offset the multiplier effects as the new jobs might crowd out existing ones.

We approach the question of the existence of job multipliers empirically. We have access to detailed panel data based on a 50% sample of all Berlin establishments between 1992 and 2010. Due to the lack of official sources on local public sector employment, we collected information on the number of jobs of each relocating institution, the year the institution moved in or out of Berlin and the address of the institution in Berlin from historical sources. This new and rich database allows us to estimate an empirical model across small areas in Berlin and to quantify possible employment spill-overs into neighbouring areas. Following Gibbons et al. (2011a) we apply a special form of a difference-in-difference strategy where we compare

employment changes in postcodes receiving relocations at different distances with postcodes further away from any relocation. A standard difference-in-difference strategy would not allow for the possibility of employment spill-overs as it compares areas that were directly treated with those not receiving any direct treatment.

We find evidence for the presence of a local employment multiplier. Relocating 100 public sector jobs into an area generates 52 additional jobs in the private sector. We also find evidence for spatial spill-over effects: relocating 100 public sector workers into a 1 km wide distance ring around the postcode boundary increases employment in the private sector by 33 jobs. This effect comes through job gains in the service sector, while manufacturing employment is not influenced by the relocation.

Public sector relocation programmes thus seem to be a suitable measure to address very local employment problems.

Chapter 1

Real wage inequality in the UK

1.1 Introduction

From the late 70s onwards wage inequality in the UK rose at a fast pace (see for instance Gosling (2000) and Atkinson (1999)). The topic has been discussed extensively as wage inequality may directly reflect an uneven distribution of opportunities between different groups of people. Due to the equity dimension of the problem, many fear that wage inequality causes social and economic instability. Studies have linked increases in inequality to higher crime rates (Kelly, 2000), lower civic participation (Costa and Kahn, 2003; La Ferrara, 2002) as well as lower productivity and economic growth (Stiglitz, 2012). In light of these findings, it is good news that wage inequality came to a halt in the 2000s.

Similar distributional questions arise when looking at the cost side between different groups of people. One of the reasons for the rise in wage inequality throughout the 80s and 90s is that education became more highly valued in the labour market. Relative to workers without a university degree, graduates improved their position in the labour market substantially (Machin, 2011). Workers with different educational attainments are, however, unevenly distributed across space and are thus likely to face differences in local costs of living. For example, if consumer prices were higher in areas with a high concentration of educated workers, their purchasing power measured at the national level would be relatively lower than of workers with a lower educational attainment. That this factor matters becomes apparent when looking at rental prices across areas in the UK. The price for a representative house in London,

for instance, is more than 40% higher than the price of a similar house in Brighton.[1] Similarly, if consumer prices underwent differential changes across space and grew faster in areas with a high concentration of highly educated workers, this group of workers would lose out on purchasing power over time relative to workers with a lower educational attainment.

As price movements are measured for the country as a whole, the implications of spatially disaggregated price changes on the evolution of real wages can easily go unnoticed. Therefore, new challenges arise when thinking about the measurement of wage inequality in a spatial sense and taking local costs of living into account is likely to substantially alter common measures of wage inequality.

This paper addresses these challenges by analysing trends in inequality once differences in costs of living across labour markets are taken into account. As an official statistic for this purpose does not exist in the UK,[2] I follow the methodology by Moretti (2013) to construct a local cost of living index, that captures price differences across local labour markets as well as changes in spatial price differences over time. The index is based on the Retail Price Index (RPI), which was used until 2013 as the official inflation measure in the UK and is published by the Office for National Statistics. As individuals spend a large share of their total expenditure on housing and data for local house prices is readily available in the UK, the newly constructed local component of the RPI is based on house prices. The new measure shows considerable variation of price levels and price changes across labour market areas.

The analysis is based on information from several datasets. The Census 2001 and 2011 provide a detailed picture of the distribution of highly educated workers across space and allow the documentation of changes in the spatial skill distribution over time. In contrast to local prices of consumer goods and services, local house prices are readily available. The Land Registry publishes information on all prices and addresses of housing transaction in England and Wales which I use to construct the local cost of living index. Finally, the Annual Survey of Hours and Earnings (ASHE) has detailed information on wages and earnings as well as the geographic location for a 1% sample of employees on the Inland Revenue PAYE register. The data sources used in the analysis are described in Appendix A.1.

[1] Price information are based on Land Registry data in 2011.

[2] The most detailed geography for Regional Consumer Price levels for goods and services that is produced by the ONS is at the level of Government Office Regions.

The paper makes several contributions to the existing literature. To the best of my knowledge it is the first study that looks at the co-evolution of wages and local prices over time in England and Wales. A measure of real wages is derived by deflating nominal wages with the local cost of living index. I document changes in real wage inequality by comparing the evolution of real wages for university degree holders and non-degree holders between 2001 and 2011. I furthermore look at the most recent time period, for which little evidence on the evolution of wage inequality or real wage inequality is currently available.

The results of the analysis suggest that real wage inequality which takes into account local costs of living is less pronounced than nominal wage inequality, as university graduates are overrepresented in expensive areas. However, between 2001 and 2011, degree holders experienced relatively slower increases in local costs of living. On the one hand, cost of living in very skilled labour markets increased relatively less than cost of living in less skilled labour markets. On the other hand, university degree holders chose to move to areas characterized by relatively lower costs of living. As a result real wage inequality between university graduates and non-graduates kept rising between 2001 and 2011 even though nominal wage inequality came to a halt. For men the increase amounts to 2.5 percentage points, for women to 1.8 percentage points.

The remainder of the paper is structured as follows. Section 2 documents the distribution of degree holders across LMAs in England and Wales and geographical differences in house price levels. Section 3 describes the construction of the local RPI. Section 4 uses the measure to show how real wage inequality evolved in comparison to nominal wage inequality. Section 5 discusses the results. Section 6 presents robustness checks and Section 7 concludes.

1.2 The location of skilled and unskilled workers and spatial variation in prices

Real wage inequality will differ from nominal wage inequality if (i) skilled and unskilled workers are unevenly distributed across labour markets and (ii) local costs of living differ across labour markets. In this section I analyse the spatial distribution of skills and prices in England and Wales to motivate the subsequent construction

of a local price index.

1.2.1 The location of skilled and unskilled workers

In the UK skilled workers are concentrated in specific areas. Figure 1.1 shows the geographic distribution of highly qualified workers across Labour Market Areas in England and Wales. Areas refer to 138 Labour Market Areas that were derived from the 2001 definitions of travel to work areas.[3] The share of qualified workers measured as the number of employed university degree holders aged 16 to 64 with respect to the total number of employed workers ranges from above 40% in areas around London to less than 25% in the north and north east of England.

Table 1.1 gives an overview over the ten most skilled and least skilled Labour Market Areas in England and Wales in 2001 and 2011. In 2011, 47% of workers hold a university degree in London, university cities such as Cambridge, Warwick and Oxford have equally high values of c. 44%. Among the least skilled areas are Norfolk, Lincolnshire Fens with a share of degree holders of less than 20% and Mansfield and West Lincolnshire with shares of 22%.

The national share of employees holding a university degree rose quite dramatically from a national average of 24.7% in 2001 to a national average of 35.2% in 2011.[4] Those places with a high concentration of degree holders in 2001 became even more skilled in comparison to places where the share of graduates was relatively low in 2001. With the exception of London all cities in the top list experienced an increase of the share of university degree holders of more than the national average of 10.5%. London's position as an outlier is most likely due to graduates choosing to live in cities around London and accepting long commutes for a job in the capital. Guildford, for instance, which is a labour market in the direct neighbourhood of London, experienced an increase in the share of university graduates amounting to 11.3 percentage points, in Brighton, 53 miles south of London, the share of university graduates increased by 12.0 percentage points. With the exception of East Cornwall, all places in the bottom list experienced increases of less than the national average. A possible explanation for these pattern is that cities offering a high level of amenities

[3]Some rural TTWAs were aggregated into contiguous units to assure a large enough sample size in each geographical area based on the ASHE sample. See Gibbons et al. (2011b) for additional information on the exact aggregation procedure

[4]These shares amount to 19% in 2001 and 27% in 2011 when all people aged 16 to 74 respectively 16 to 64 are chosen as the baseline.

disproportionally attract highly-educated workers (Carlino and Saiz, 2008). Another possibility is that complementarities exist between an individual's education level and city size, and university graduates sort into specific labour markets because they are more productive in large cities (Behrens et al., 2010).

1.2.2 Variation of local costs in England and Wales

This section documents spatial variation in the costs of living which are inferred from differences in house prices across labour markets. In contrast to local prices of consumer goods, local house prices are readily available. The underlying data are taken from the Land Registry which tracks all residential property sales in England and Wales. In 2001 a total of 1.23 million sales were recorded, in 2011 total sales amounted to 0.65 million.

To begin with average prices are calculated for each of the 138 LMAs in England and Wales. Figure 1.2 (left) shows average prices of houses sold in 2001. House prices differ substantially across labour markets. Average prices in London are more than four times as high as average prices in Burnley, Nelson and Colne the cheapest LMA. Though indicative, these estimates might suffer from bias as they are uncorrected for structural building attributes. The bias arises as, for instance, rural areas are likely to have a much higher share of free standing homes than urban areas. Simple average prices are therefore likely to be relatively higher in rural areas and relatively lower in urban areas. This sort of bias can be alleviated using the characteristics available in the data source in order to adjust housing prices for differences in structural attributes. Equation 1.1 shows a hedonic estimation approach.

$$ln(p_{ia}) = \mu_a + \gamma X_i + \epsilon_{ia} \tag{1.1}$$

$ln(p_{ia})$ is the transaction price of house i in area a, μ is an area fixed effect, X_i a vector of housing characteristics including the property type (Detached, Semi, Terraced or Flat/Maisonette), whether the property is newly built or not and whether the property is freehold or leasehold and ϵ_{ia} denotes the residual. The regression output is shown in Table 1.2.[5] As expected, semi-detached, terraced houses and flats are

[5]The analysis has also been conducted using data on housing sales provided by the Nationwide Building Society. The dataset has less transactions but more variables on the structural attributes of each house. See Appendix A.1 for a description of the dataset. Using the Nationwide data in the main analysis yields very similar results with respect to the Land

more expensive than detached houses, buyers pay a premium for new buildings and freehold properties are more expensive than leasehold properties. I recover the coefficients from this regression and estimate the price of a house with average national characteristics for each Labour Market Area.[6]

After the correction LMAs in the South East turn out to be slightly more expensive compared to the uncorrected averages as shown on the middle map in Figure 1.2. Brighton and Bristol, for instance, changed the price category after the correction for structural attributes, as they have a larger share of relatively cheaper flats and terraced houses than the average LMA. Even in the case that differences in housing attributes are accounted for, spatial price variation remains very pronounced. London is the most expensive LMA where houses with average structural characteristics are sold at five times the price as in Hartlepool.

Looking at price growth rates reveals a strikingly different picture. Prices increased faster in areas with initially low prices and at a slower pace in areas where prices were relatively high in 2001. The right map in Figure 1.2 shows growth rates between 2001 and 2011 for house prices corrected for differences in structural attributes. LMAs near the Scottish border, in West Wales and cities around Doncaster experienced the highest price growth, South East and Central England saw prices increase at a slower rate. In Portsmouth or Oxford, for instance, prices grew by less 80%, whereas in areas such as Hartlepool and Doncaster prices increased by 140% within the decade.

1.2.3 House prices and education levels

In England and Wales high skilled workers tend to concentrate in expensive cities. Figure 1.3 (left) plots the relation between a labour market's share of degree holders in 2001 and average house prices in 2001. The plot shows that prices and the share of degree holders are positively correlated. However, those places with a high concentration of the highly educated in 2001 experienced slower increases in house prices. This becomes apparent when looking at the right scatterplot in Figure 1.3 which plots the relation between the share of degree holders in 2001 and price growth

Registry data. Tables are available on request.

[6]The price is estimated as $ln(\bar{p_a}) = \hat{\mu_a} + \hat{\gamma}\bar{X}$. If x is a categorical variable the coefficient is multiplied with the share of houses in England and Wales that have the specific characteristic.

between 2001 and 2011. The relation holds across the LMA size distribution; in the scatterplots the size of the circle is proportional to the size of the LMA population.

1.3 Construction of a local price index

Spatial disparities in the costs of living are pronounced, as has been shown in the previous section. An official statistic that measures differences in local price levels and price inflation across local areas does, however, not exist in the UK. Price inflation in the UK is measured by the Retail Price Index that is published by the Office of National Statistics.[7] It measures price changes of a consumer basket that represents average consumption patterns of UK households. Every month the ONS collects approximately 110,000 prices for this representative basket made up of 650 items. As a locally disaggregated index would require the repeated collection of this data in every area of interest, it is clear that such an effort would drastically increase the time and cost of the construction of the RPI.

The local price index derived in this paper uses variation in house prices across Labour Market Areas to circumvent this problem. Expenditure on housing related items makes up a considerable share of total household expenditure and amounts to c. 40%. The share of expenditure on housing is much higher than the expenditure share on other non-tradable goods. As prices of tradable goods are unlikely to differ much across areas, the focus on house prices is likely to give a representative approximation of general differences in local prices.

As in Moretti (2013), the inflation measure is constructed in several steps. First, I calculate average house prices in each LMA using transaction price data. Second, I net out price changes in the housing component of the RPI to get a RPI based on non-housing goods and services only. Finally, I calculate a local RPI that takes into account variation in local prices in the base year as well as differences in price changes over the following decade. The measure is then used to demonstrate differences in the level of costs of living across education groups.

[7] It was superseded the Consumer Price Index as the principal inflation measure in 2013 to meet international standards. The RPI is preferred over the CPI as it includes expenditure on owner occupied housing. I could have equally used the CPIH which the ONS started publishing in 2014 as it equally includes estimates of owner occupied housing cost. The official time series goes back only until 2005 which makes the measure unsuitable for my analysis.

1.3.1 Technical details

The procedure used to construct a local cost of living measure in this paper closely follows the procedure of the ONS for the Retail Price index. Table 1.3 shows expenditure shares for the five broad groups in the Retail Price Index in 2001 and 2011. Expenditure on housing related items made up 36.2% of total household expenditure in 2001 and increased to 40.8% in 2011. Housing expenditure includes rentals, owner-occupiers' housing costs[8], utilities and households goods and services. It is possible to net out the housing component of the RPI as the exact price changes and weights for the division are available for download on the ONS website. The RPI is calculated as the sum of price increases of each good weighted by the percentage of total expenditure that is spent on the specific good.

$$RPI_{t,0} = \sum_{i=1}^{n} \frac{p_t^i}{p_0^i} \cdot w^i$$

For the case where we consider only two goods, namely housing related goods and non-housing goods the formula simplifies to

$$RPI = RPI^{nh} \cdot (1 - w^h) + RPI^h \cdot w^h$$

By rearranging the equation the formula can be used to calculate a RPI for non-housing goods such that

$$RPI^{nh} \quad = \quad RPI \cdot \frac{1}{1 - w^h} - RPI^h \cdot \frac{w^h}{1 - w^h}$$

where RPI is the official price index published by the ONS, w^h is the share of total expenditure spend on housing goods and services and RPI^h is the price inflation measure for the housing component only. Price increases of the representative consumer basket used for the construction of the RPI and the consumer basket without housing are stated in Table 1.4. The upper lines of Table 1.4 show that the RPI increased by 36% between 2001 and 2011, whereas price levels increased by only 28% once the housing expenditure component is taken out.

[8]Owner-occupiers' housing costs consist of mortgage interest payments, house depreciation, buildings insurance, ground rent, and other house purchase costs (such as estate agents' fees and conveyancing fees).

Based on the non-housing index, I calculate the local RPI using the quality adjusted average house prices that vary across LMAs. To begin with prices are brought on a scale that is comparable to the RPI. LMA price levels are divided by the employment weighted average price across all LMAs in 2001. The local RPI for 2001 is then estimated as the weighted average of the national RPI (net of housing) normalized to one and the normalized house prices that vary across LMAs. Following the official procedure of the ONS local price inflation is measured as the sum of the increase in house prices between 2001 and 2011 weighted by the expenditure share on housing in 2011 and the official RPI net of housing weighted by the expenditure share on non-housing goods. Using the 2001 index as a baseline the 2011 local RPI is calculated as the product of the local RPI in 2001 and local price inflation between 2001 and 2011.

1.3.2 Average costs of living across education groups

Real wage inequality differs from nominal wage inequality as university degree holders are overrepresented in areas characterized by higher costs of living relative to non-degree holders. Accordingly, changes in real wage inequality depend on relative changes in wages for skilled and unskilled workers as well as relative changes in local costs of living for both groups. Table 1.4 shows the average house prices and the average local cost level faced by degree and non-degree holders in 2001 and 2011. The average costs are calculated as

$$\begin{aligned} p_{01}^{q} &= \sum_{a=1}^{n} \omega_{a,01}^{q} \cdot p_{a,01} \\ p_{11}^{q} &= \sum_{a=1}^{n} \omega_{a,11}^{q} \cdot p_{a,11} \end{aligned}$$

p_{01}^{q}, p_{11}^{q} denote the local price, respectively RPI, in 2001 and 2011, for q=high skilled workers or q=lower skilled workers, ω_{a}^{q} denotes the share of skill category q in LMA a and $p_{a,01}$ denotes the local price respectively RPI of LMA a in year 2001. In both years, high skilled workers face on average higher housing costs than lower skilled workers. The difference amounted to 17.6% in 2001. Between 2001 and 2011 house prices almost doubled for both skill groups. High skilled workers faced a house price increase of 86.8%, the increase amounted to 93.0% for lower skilled workers. As a

result the price gap between the two skill groups narrowed to 13.8% in 2011.
A similar pattern is visible for local costs of living. The lower panel shows that in 2001 the overall cost of living experienced by degree holders is 6.2% higher than the cost of living experienced by non-degree holders. The gap decreases to 4.6% by 2011. The difference in the local RPI between education groups is less pronounced than the difference in house prices because the local RPI includes non-housing costs as well as housing costs.

1.4 Analysis of real wage inequality

In this section, I estimate the nominal wage premium for skilled workers and show how the premium changes when differences in local costs of living are accounted for. The analysis is based on wage information from the Annual Survey of Hours and Earnings. As this dataset does not hold any information on university attainment, a skill proxy is derived from the 3-digit occupation code according to the procedure peoposed in Elias and McKnight (2001). Those occupations that are grouped into the highest skill category are used as a proxy for degree holders. The sample includes all full-time workers aged 25 to 60. The ASHE does not provide information on income other than wages such as social security benefits or capital income. The largest source of income is income from work which amounts to c. 70% of total income. The focus on earnings is, therefore, able to provide a general overview over inequality and is the source of income which has received most attention in the inequality literature.
The first subsection presents estimates of the wage premium for skilled workers in nominal and real terms. The second subsection shows a decomposition of the overall effect into a part that is due to differential price increases for different skill groups and another part that is due to relative changes in the spatial distribution of skill levels.

1.4.1 Regression analysis of real wage inequality

Columns (1) to (4) in Table 1.5 show estimates of the conditional nominal wage difference between high skilled and lower skilled workers for women and men. Equation

1.2 shows the main estimating equation.

$$ln(he_{it}) = \beta_0 + \beta_1 S_{it} + \beta_3 T_t + \beta_4 S_{it} \cdot T_t + \beta_5 age_{it} + \beta_6 age_{it}^2 + \epsilon_{it} \qquad (1.2)$$

The dependent variable is the log of nominal hourly earnings of individual i in year t, which is regressed on an indicator S_{it} equal to one if worker i is high skilled and zero otherwise, a time dummy T_t which is equal to one if the year equals 2011, the individual's age and age squared and an interaction term of the skill dummy and the time dummy.

Results in column (1) show that male high skilled workers in 2001 earn on average 60.9% more than lower skilled workers.[9] Between 2001 and 2011 hourly earnings increased on average by 25%. The increase is similar for both skill groups as the interaction term of the skill and year dummy is insignificant. For women the earnings gap for high skilled and lower skilled workers is lower than for men and amounts to 51.7% as shown in column (2). For both skill groups, earnings increased by 31% between 2001 and 2011. Nominal wage inequality remained stable in the 2000 which is in line with findings by, for instance, Machin (2011).

Looking at wage inequality within labour markets leads to similar results. Columns (3) and (4) in Table 1.5 show estimates with LMA fixed effects. Wage inequality is 2 to 3 percentage points lower when differences in wages across LMAs are controlled for, otherwise the results do not change.

To assess the role of differences in local costs of living hourly earnings are deflated by the local RPI. The lower panel in Table 1.5 shows regression results based on the log of real hourly earnings as the dependent variable. Taking into account local price differences reduces inequality in 2001 by c. 5 percentage points for male (60.9% to 55.3%) and female workers (51.7% to 46.4%). Between 2001 and 2011 wage gains could not keep up with local price increases, all workers saw their real hourly wage decrease substantially. In 2011 male high skilled workers earned on average 16.2% less than a decade before, for male lower skilled workers the fall in earnings amounted to 18.7%. Even though nominal wage inequality remained constant during this time real wage inequality continued to rise due to heterogeneous price increases for high and lower skilled workers. For male workers real wage inequality increased by 2.5,

[9] The number is similar in size to estimates by Machin (2011) who uses the General Household Survey and Labour Force Survey as underlying datasets.

for female workers by 1.8 percentage points.

1.4.2 Decomposition of the effect

Two possible channels can explain the relatively stronger price increase for the lower skilled. Between 2001 and 2011 lower skilled workers might have moved to areas that were relatively more expensive in 2011 or areas where mostly lower skilled workers lived in 2001 experienced higher price increases. Accordingly, the change in cost of living can be decomposed for each skill category into changes in the distribution of skill groups and changes in prices for different skill groups (Moretti, 2013). The decomposition is shown in Equation 1.3.

$$\begin{aligned} p^q_{2011} - p^q_{2001} &= \sum_{a=1}^{n} \omega^q_{a,2011} \cdot \bar{p}_{a,2011} - \sum_{a=1}^{n} \omega^q_{a,2001} \cdot \bar{p}_{a,2001} \\ &= \sum_{a=1}^{n} (\omega^q_{a,2011} - \omega^q_{a,2001}) \cdot \bar{p}_{a,2011} + \sum_{a=1}^{n} \omega^q_{a,2001} \cdot (\bar{p}_{a,2011} - \bar{p}_{a,2001}) \end{aligned} \quad (1.3)$$

$p^q_{2011} - p^q_{2001}$ denotes the absolute change in prices between 2001 and 2011 for q=high skilled workers or q=lower skilled workers, ω^q_a is the share of skill category q in LMA a and $\bar{p}_{a,2001}$ is the price of an average house in LMA a in year 2001, respectively $\bar{p}_{a,2011}$ in 2011. Dividing the expression by the average price paid by a worker of skill category q in 2001 gives the corresponding growth rates.

$$\begin{aligned} \frac{p^q_{2011} - p^q_{2001}}{p^q_{2001}} &= \frac{\sum_{a=1}^{n} (\omega^q_{a,2011} - \omega^q_{a,2001}) \cdot \bar{p}_{a,2011}}{p^q_{2001}} \\ &+ \frac{\sum_{a=1}^{n} \omega^q_{a,2001} \cdot (\bar{p}_{a,2011} - \bar{p}_{a,2001})}{p^q_{2001}} \end{aligned} \quad (1.4)$$

The expression on the left denotes the growth rate of housing prices for skilled (less skilled) workers between 2001 and 2011. On the right it is expressed as the growth rate due to the change in the distribution of skilled (less skilled) workers across LMAs and the growth rate due to LMAs holding different concentration levels of skilled (less skilled) workers in 2001.

The upper panel in Table 1.6 shows the decomposition of the overall price change. If the distribution of degree holders across LMAs had not changed degree holders would have experienced a price increase of 90.5% between 2001 and 2011. This increase is muted by 3.7 percentage points, however, as degree holders moved to

less expensive labour market areas. High skilled workers at least partially offset increases in costs of living by moving into relatively cheaper areas. For lower skilled workers the respective numbers are 92.7% and 0.4 percentage points, indicating that the distribution of non-degree holders across space changed only marginally. Lower skilled workers are less mobile and stay put even though prices in their area increase. Table 1.6 shows that prices increased everywhere in England and Wales, but areas where many lower skilled workers lived in 2001 increased by more relative to areas with a high concentration of high skilled workers.

The differential increases in house prices translate into differential increases in the local RPI. The lower panel of the table shows the decomposition of the local RPI according to qualification class. If the distribution of degree holders across LMAs had remained unchanged degree holders would have experienced an increase in the local RPI of 54.6% between 2001 and 2011. As the spatial distribution changed the increase was 1.1 percentage points lower. Costs of living increased by 2.4 percentage points for low skilled worker relative to high skilled worker between 2001 and 2011. Half of this change is due to skilled workers moving into relatively cheaper areas the other half is due to the fact that areas where mostly lower skilled workers lived in 2001 experienced a higher increase in costs of living.

1.5 Discussion of results

So far there is only one study that proposes a theory explaining changes in real wage inequality. Moretti (2013) develops a spatial equilibrium model where expensive cities experience localized skill biased technological change (SBTC), leading to higher demand for high skilled workers in expensive places relative to cheaper ones. The model explains that in the US real wage inequality increased by less than nominal wage inequality between 1980 and 2000 because skilled workers concentrated in cities that became more and more expensive over the same time period.

This paper considers the subsequent decade, which in contrast to the decades before is characterized by a constant level of nominal wage inequality. An additional difference is that during this period in the UK high skilled workers moved to cheaper LMAs relative to lower skilled workers. Notwithstanding these differences, it is possible that the UK experienced a similar development between 1980 and 2000 as the US. The large difference in average prices paid by university graduates relative to

non-graduates which amounted to 17.6% in 2001 is likely to be the result of a similar sorting process as took place in the US.

Rises in real wage inequality cannot in all cases be transferred one to one into changes in disparities in wealth. As the local cost of living index is based on variation in house prices, one has to note that rising house prices themselves generate changes in the wealth distribution. As houses are an asset, increasing house prices enrich homeowners whereas renters and first time buyers face higher costs of living. If all lower skilled workers were homeowners, the stronger price increase they experienced would in principle increase their wealth relative to high skilled homeowners. Empirically, c. 27% of non-degree holders rented their home in 2001 compared to 16% of employees holding a university degree. These numbers increased to 19%, respectively 32% in 2011.[10] This implies that increases in house prices increase wealth of high skilled workers relative to lower skilled workers. The rise in real wage inequality by 2.5 percentage points is thus most likely a lower bound for the rise in wealth inequality.

Another question is in how far recent changes in house prices translate into ongoing costs for owner occupiers. Owners who bought their houses 10 years ago incur the costs associated with price levels of that time rather than with current price levels.[11] The Land Registry data used in this analysis shows that each year a large number of people buy and sell a house: in 2001 1.2 Million and in 2011 0.65 Million houses were sold. Though, not every worker is equally concerned by changes in current house price levels, they are still a meaningful indicator for local costs of living due to the large number of yearly transactions as well as the increasing share of renters. Whether rises in real wage inequality are equivalent to changes in relative well-being depends on why university graduates moved to cheaper labour markets. One possibility is an increase in relative labour demand. If the relative demand of skilled labour increases in cheaper LMAs, for instance, because new firms locate in these cities to hire skilled labour, relative inequality of skilled workers increases as much as the relative nominal wage. This is because the new jobs created for the high skilled are equally well paid relative to low skilled jobs in more expensive LMAs and local costs of living are considerably lower.

[10] Numbers are taken from the Labour Force Survey.

[11] Another factor that impacts on ongoing costs for owners are changes in interest rates. Between 2001 and 2011 interest rates fell by around 3 percentage points from 7% to 4%. The decrease in interest rates, therefore, alleviates the actual increase in house prices.

The finding that costs of living grew relatively less in areas that experienced a high increase in the share of skilled workers is surprising given that high skilled workers receive a higher income than low skilled workers and are thus able to spend more on housing. A possible explanation is that workers increasingly chose to rent in high price areas. As noted above the national share of workers who rent their home increased by 5 percentage points for lower skilled workers and by 3 percentage points for high skilled workers. This indicates that house prices reached a level that makes is difficult even for the well-educated to afford to buy a property. Another possibility why house prices for high skilled workers decreased relative to lower skilled workers is that the relatively low house prices themselves underlie the decision of the high skilled to move to another area. Between 2001 and 2011 national house prices increased by over 90% due to the lack of new developments.[12] Graduates in LMAs with a high share of skilled workers face the highest price levels. First time buyers might have decided to look for a house in relatively cheaper areas. As can be seen in Table 1.1 London, which is the city with the highest house prices, experienced an increase in the skill share below average, while cities around London experienced high increases in the LMA skill share. This would results in an increase in commuting time for high skilled relative to lower skilled workers between 2001 and 2011. To avoid increasing house prices high skilled workers accept longer commutes that in part offset the benefit of lower housing costs.

1.6 Robustness checks

In this section I undertake several robustness checks for the above findings. Table 1.7 shows alternative specifications for the wage and real wage regressions. The dependent variable in the upper panel is the log of hourly earnings, the dependent variable in the lower panel is the log of real hourly earnings. Columns (1) and (2) show inequality estimates using urban workers and rural workers, respectively. Column (3) excludes London workers from the sample and column (4) looks at cities only, excluding London. Results for women are presented in columns (5) to (8). Estimates in the upper panel show that nominal wage inequality remained constant for all sub-samples apart for male workers living in rural areas, where

[12] In Britain each year c. 260,000 additional houses would have to be built to keep up with increased housing demand and to stabilise affordability (Cheshire, 2014).

nominal inequality decreased by 2.4 percentage points between 2001 and 2011. Estimates in the lower panel show that the increase in real wage inequality is due to workers in urban labour markets. In rural LMAs, real inequality remained constant between 2001 and 2011. Relative rises in prices for high skilled workers in rural areas are offset by relative rises in wages. Real wage inequality rose faster for workers in London. Excluding London workers reduces the rise in real wage inequality to 1.1 percentage points and the coefficient is insignificant. In cities other than London real wage inequality kept rising by 1.7 percentage points between 2001 and 2011. Real wage inequality increased by 2.4 percentage points for women in cities and remained constant in rural areas as shown in columns (5) and (6). For women London has a less prominent role, outside London real wage inequality increased by 2 percentage points, in cities other than London by 2.9 percentage points.

As a further check, I divide the class of lower skilled workers into subclasses. I use skill categories ranging from one for the highest skilled workers to four for the lowest skilled workers based on the three digit occupation classification (see Elias and McKnight (2001) for details). Columns 1 and 2 in Table 1.8 show regression results with the alternative skill classification for male and female workers. Wage inequality for men remained unchanged for workers of different skill levels. For women the picture is different, wage inequality between the highest and the lowest skill group (which refers to elementary occupations) remained constant whereas wages increased at a slower pace for medium high skilled and medium low skilled workers.

1.6.1 Allowing regional expenditure shares to vary across regions

All estimates in the previous sections are based on constant expenditure shares on housing across areas. One concern is that housing expenditure shares may vary across labour markets, for instance individuals living in high price areas might spend a larger share of their income on housing than individuals living in low price areas. Because college graduates are over-represented in expensive cities like London and under-represented in less expensive cities like Hull, this could increase the housing expenditure share of college graduates relative to high school graduates, everything else constant.

To address this possibility I use housing expenditure shares that vary across Government Office Regions (GORs). The shares are based on the Living Costs and Food Survey and published by the ONS.[13] Expenditures are detailed for the internationally agreed standard classification for reporting household consumption expenditure. I use this information to reconstruct expenditure on housing for each Government Office Region. Details on this approach are provided in Appendix A.2.

The results are shown in Table 1.9. Each entry shows the interaction term of a skill indicator with a 2011 year dummy from separate regressions. As a benchmark, I deflate wages by a GOR level RPI that is constructed using constant expenditure shares on housing across regions. The left part of the table shows how the change of the geographical unit for the local RPI effects the results of the main specification shown in Table 1.5. Considering changes in the local RPI across GORs instead of LMAs leads to a smaller increase in inequality, for women the increase changes from 1.84 to 1.47 percentage points, for men from 2.53 to 1.99 percentage points. Real wage inequality significantly increased for urban workers of both gender groups. Inequality remained unchanged between 2001 and 2011 for workers living in rural areas and increased for urban workers living outside London.

The results based on varying expenditure shares on housing that are shown in the left column of Table 1.9 exhibit a very similar pattern. As expenditure shares are higher in high cost areas the increase in real wage inequality is slightly lower than in the case where constant housing expenditures are assumed and the significance level decreases. Qualitatively little changes when expenditure shares on housing are assumed to vary across GORs.

1.7 Conclusion

This chapter analyses trends in inequality once differences in costs of living across labour markets are taken into account. University graduates and non-graduates increasingly chose to live in different areas. As workers with different educational attainments are unevenly distributed across space they face differences in local costs of living.

I find that deflating the skill premium by a local RPI that takes into account varia-

[13] Due to the small sample size of the Living Costs and Food Survey is is not possible to derive expenditure shares that vary across labour markte areas.

tion in prices across labour markets yields two results. First, real wage inequality is c. 5 percentage points lower than nominal wage inequality as university graduates face on average higher costs of living than non-graduates. Second, after the rise in nominal inequality came to a halt by the end of the 90s real wage inequality continued to rise at a moderate pace because local prices rose faster for non-graduates. Between 2001 and 2011 real wage inequality increased from 55.3% to 57.8% for men and from 46.4% to 48.2% for women. Nominal wage inequality remained at 60.9% for men and 51.7% for women.

The decomposition of increases in local costs of living shows that areas that had a high share of non-degree holders experienced faster cost increases than areas that had a high share of degree holders. Furthermore, degree holders moved into relatively cheaper labour markets during the time period which further increased the differential cost increase between the two skill groups.

The results imply that more attention should be paid to the differential costs that individuals face as wage disparities alone are uninformative about differences in standards of living and economic welfare.

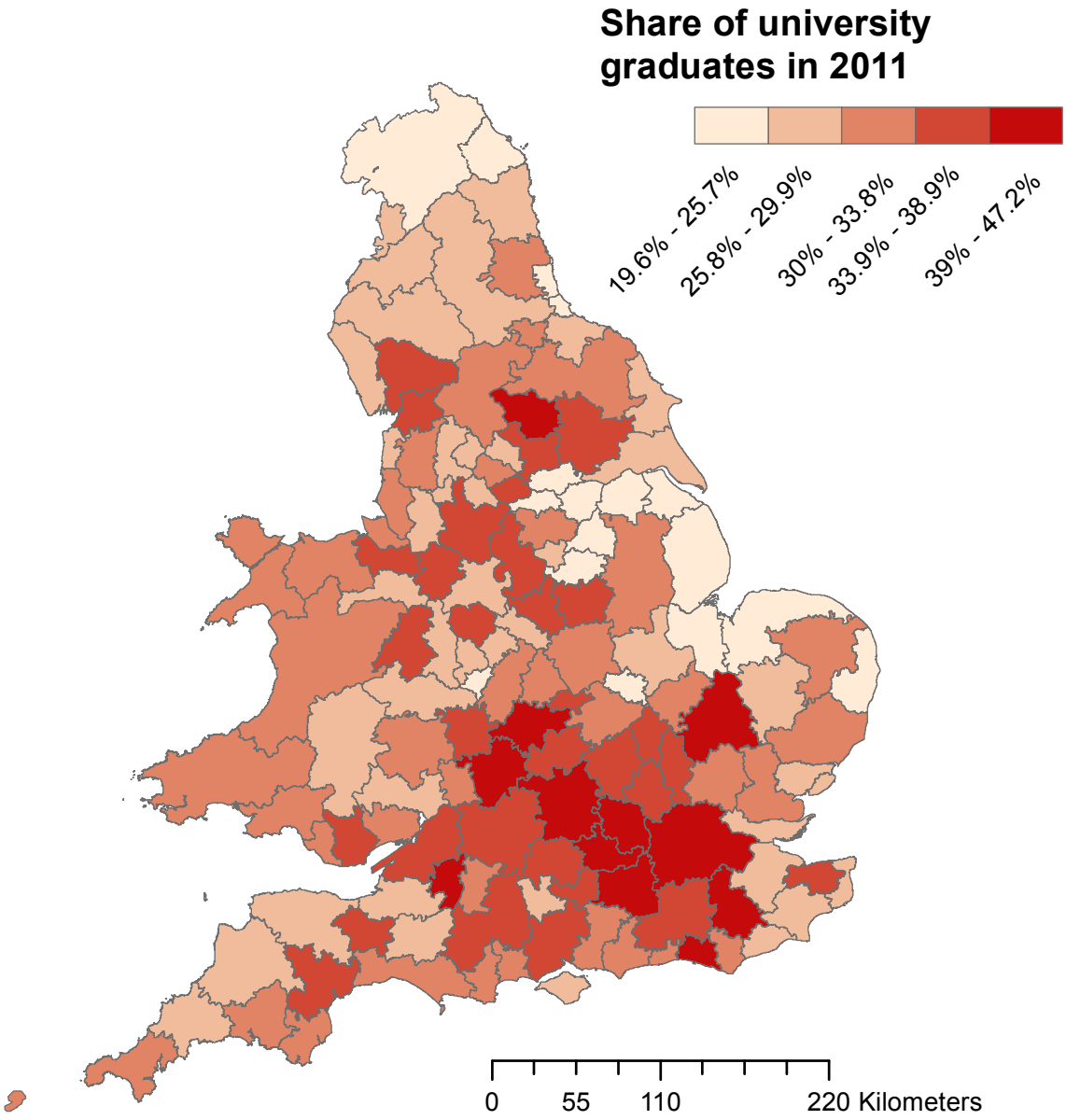

Figure 1.1: Percentage of workers holding a university degree across labour markets in 2011.

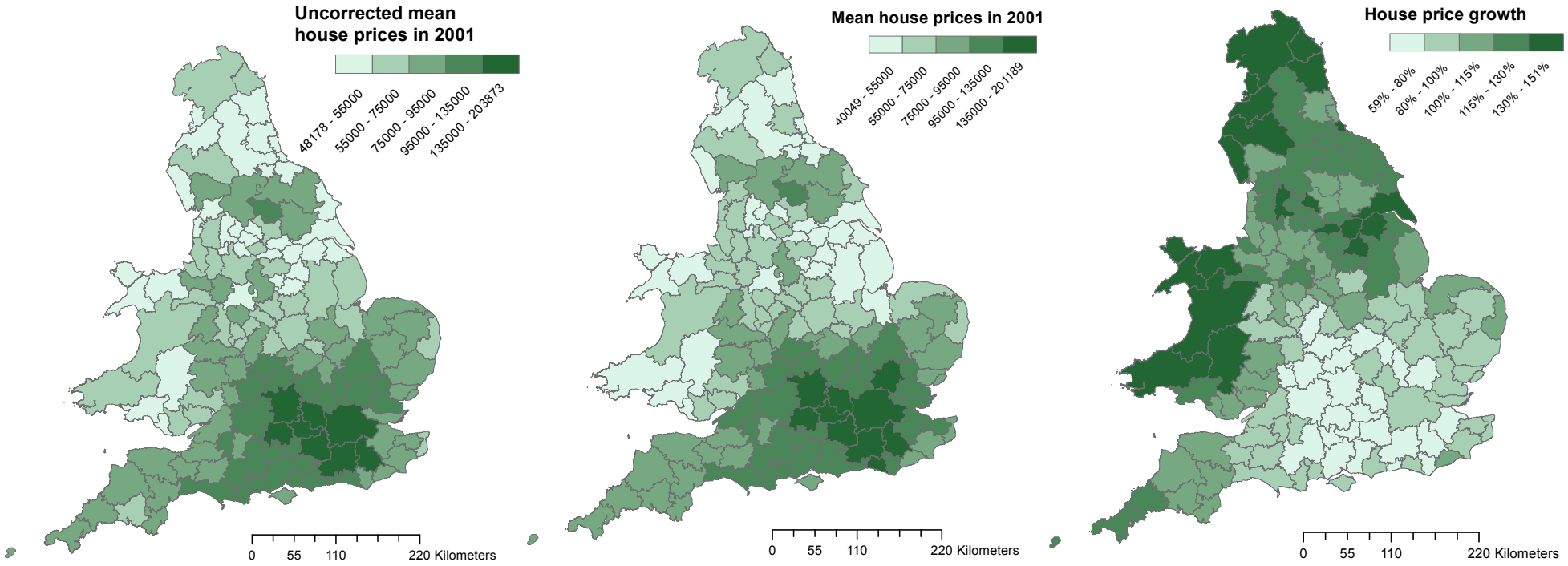

Figure 1.2: Average house prices across 138 LMAs in England and Wales in 2001 (left) and price growth between 2001 and 2011 (right).

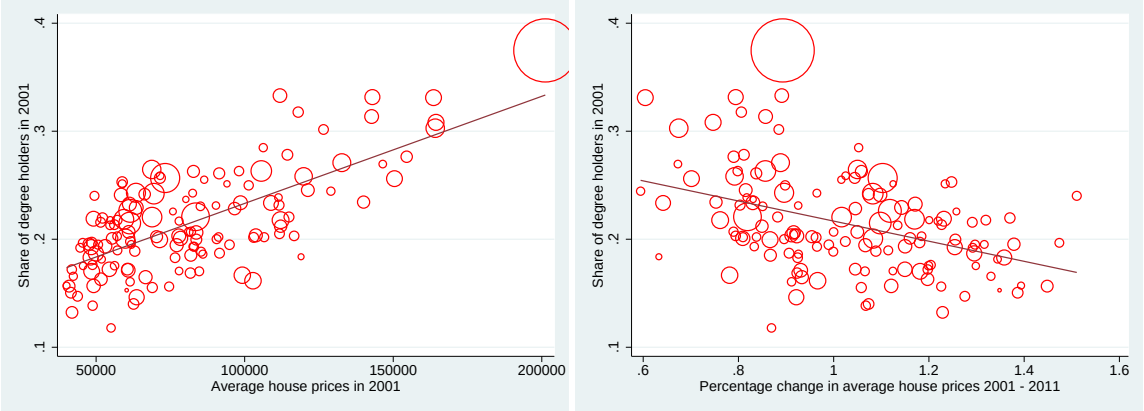

Figure 1.3: Relation between the share of degree holders in 2001 and house prices in 2001 (left) and changes in house prices between 2001 and 2011 (right).

Table 1.1: Top and bottom 10 LMA ranked according to the share of skilled workers in 2011.

Labour market area	share of degree holders in 2001	share of degree holders in 2011	% point change
Most skilled LMAs in 2001			
London	37.5%	47.2%	9.7%
Cambridge	33.3%	44.8%	11.5%
Oxford	33.2%	44.1%	10.9%
Reading and Bracknell	33.1%	43.8%	10.7%
Warwick and Stratford-upon-Avon	31.8%	44.4%	12.6%
Brighton	31.4%	43.4%	12.0%
Wycombe and Slough	30.8%	41.5%	10.7%
Guildford and Aldershot	30.3%	41.6%	11.3%
Bath	30.2%	41.1%	10.9%
Harrogate	28.5%	39.5%	11.0%
Least skilled LMAs in 2001			
East Cornwall	15.6%	27.0%	11.4%
North Norfolk	15.5%	24.6%	9.1%
Scottish Borders	15.3%	24.1%	8.8%
Barnsley	15.1%	24.2%	9.2%
Grimsby	14.7%	23.5%	8.8%
Dudley and Sandwell	14.6%	24.9%	10.3%
East Anglia Coast - Gt Yarmouth and Lowestoft	14.0%	22.5%	8.5%
West Lincolnshire	13.9%	22.2%	8.3%
Mansfield	13.2%	22.0%	8.8%
Norfolk, Linolnshire Fens	11.8%	19.6%	7.8%

The shares of qualified workers are based on 2001 and 2011 Census data. The upper panel shows the ten Labour Markt Areas with the highest share of highly qualified workers in 2001. The lower panel shows the teb Labour Market Areas with the lowest share of highly qualified workers in 2001.

Table 1.2: House price regressions using 2001 and 2011 price data from the Land Registry.

	(1)	(2)
VARIABLES	Log price	Log price
semi-detached	-0.540***	-0.493***
	[0.00120]	[0.00155]
terraced	-0.821***	-0.694***
	[0.00119]	[0.00156]
flat	-0.795***	-0.747***
	[0.00228]	[0.00314]
new	0.261***	0.151***
	[0.00148]	[0.00197]
leasehold	-0.128***	-0.128***
	[0.00188]	[0.00271]
Constant	11.97***	12.62***
	[0.000929]	[0.00117]
N	1228250	654263
R-sq	0.571	0.515

Notes: Standard errors are clustered by Labour Market areas. ***, ** and * indicate the 1%, 5% and 10% significance level. The dependant variable is the log of 2001 and 2011 prices. Regressions are based on data from the Land Registry. LMA fixed effects are included in all regressions.

Table 1.3: Expenditure shares on the five broad groups in the Retail Price Index in 2001 and 2011.

Broad Group	2001	2011
Food and Catering	16.9%	16.5%
Alcohol and tobacco	9.7%	8.8%
Housing and household expenditure	36.2%	40.8%
Personal expenditure	9.6%	8.2%
Travel and leisure	27.6%	25.7%

Source: Office for National Statistics - RPI detailed annual average indices: 1988 to 2011.

Table 1.4: House prices and costs of living across education groups.

	2001	2011	% change
Official RPI	1	1.357	35.7%
Official RPI without housing	1	1.278	27.8%
House prices			
Degree holders	116,085	216,832	86.8%
Non-degree holders	98,698	190,503	93.0%
Difference	*17.62%*	*13.82%*	
Local RPI			
Degree holders	1.046	1.606	53.5%
Non-degree holders	0.985	1.536	55.9%
Difference	*6.20%*	*4.57%*	

Notes: The upper panel shows price changes according to the official RPI as published by the Office for National Statistics and the official RIP without its housing component. The middle panel shows house prices for degree holders and non-degree holders. This information was derived from Land Registry data on house prices and 2001 and 2011 Census data on the spatial distribution of workers with different qualification levels. The middle panel shows the local cost of living measure derived in this chapter for degree holders and non-degree holders.

Table 1.5: Estimates of real wage inequality in 2001 and 2011.

VARIABLES	(1) male	(2) female	(3) male	(4) female
	log hourly wage			
High skill	0.609***	0.517***	0.571***	0.482***
	(0.0196)	(0.0206)	(0.0112)	(0.0112)
Year 2011	0.250***	0.311***	0.247***	0.311***
	(0.00704)	(0.0104)	(0.00850)	(0.0106)
High skill*year 2011	0.0105	0.00544	0.0121	0.00824
	(0.0133)	(0.00684)	(0.0131)	(0.00654)
	log hourly real wage			
High skill	0.553***	0.464***	0.565***	0.477***
	(0.00783)	(0.00900)	(0.0115)	(0.0114)
Year 2011	-0.187***	-0.119***	-0.185***	-0.119***
	(0.00607)	(0.00720)	(0.00558)	(0.00706)
High skill*year 2011	0.0253**	0.0184***	0.0232*	0.0166***
	(0.0124)	(0.00651)	(0.0126)	(0.00636)
N	115,177	64,836	115,177	64,836
LMA FE	NO	NO	YES	YES

Notes: Standard errors are clustered by Labour Market areas. Significance levels *: 10% **: 5% ***: 1%. The dependant variable is the log of hourly earnings in the upper panel and the log of real hourly earnings in the lower panel, where real hourly earnings are defined as hourly earnings divided by the local RPI. The skill indicator is derived from the 3-digt SOC2000 classification. Columns (1) and (2) show estimates for male workers, columns (3) and (4) show estimates for female workers. Age and age squared are included as controls in all specification. LMA fixed effects are included in columns (3) and (4).

Table 1.6: Decomposition of overall effect.

	% change	Compo-sition	Price change
House prices			
Degree holders	86.8%	-3.7%	90.5%
Non-degree holders	93.0%	0.4%	92.7%
Local CPI			
Degree holders	53.5%	-1.1%	54.6%
Non-degree holders	55.9%	0.1%	55.8%
Difference across skill groups	**2.4%**	**1.2%**	**1.2%**

Notes: The upper panel shows house prices for degree holders and non-degree holders. This information was derived from Land Registry data on house prices and 2001 and 2011 Census data on the spatial distribution of workers with different qualification levels.

Table 1.7: Robustness checks for real wage inequality in 2001 and 2011.

	male				female			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
VARIABLES	urban	rural	no London	urban - no London	urban	rural	no London	urban - no London
	log hourly wage							
High skill	0.612***	0.560***	0.581***	0.583***	0.518***	0.483***	0.484***	0.482***
	(0.0185)	(0.0155)	(0.00819)	(0.00876)	(0.0197)	(0.0209)	(0.00990)	(0.0109)
Year 2011	0.243***	0.283***	0.257***	0.250***	0.305***	0.338***	0.322***	0.318***
	(0.00733)	(0.00819)	(0.00429)	(0.00475)	(0.0114)	(0.00942)	(0.00581)	(0.00673)
High skill*year 2011	0.0185	-0.0242*	-0.00535	0.000522	0.0109	-0.0210	0.00687	0.0139
	(0.0143)	(0.0143)	(0.00590)	(0.00645)	(0.00687)	(0.0231)	(0.00905)	(0.00954)
	log hourly real wage							
High skill	0.556***	0.533***	0.547***	0.548***	0.463***	0.464***	0.457***	0.454***
	(0.00864)	(0.0132)	(0.00578)	(0.00613)	(0.0103)	(0.0193)	(0.00798)	(0.00866)
Year 2011	-0.192***	-0.168***	-0.182***	-0.186***	-0.122***	-0.108***	-0.112***	-0.114***
	(0.00668)	(0.00892)	(0.00475)	(0.00548)	(0.00809)	(0.00800)	(0.00555)	(0.00664)
High skill*year 2011	0.0325**	-0.00859	0.0114	0.0170**	0.0238***	-0.0118	0.0208**	0.0286***
	(0.0133)	(0.0146)	(0.00715)	(0.00819)	(0.00688)	(0.0222)	(0.00850)	(0.00893)
N	94,780	20,397	94,892	74,495	53,982	10,854	51,741	40,887

Notes: Standard errors are clustered by Labour Market areas. Significance levels *: 10% **: 5% ***: 1%. The dependant variable is the log of hourly earnings in the upper panel and the log of real hourly earnings in the lower panel, where real hourly earnings are defined as hourly earnings divided by the local RPI. The skill indicator is derived from the 3-digt SOC2000 classification. Columns (1) and (2) show estimates for male workers, columns (3) and (4) show estimates for female workers. Age and age squared are included as controls in all specification. LMA fixed effects are included in columns (3) and (4).

Table 1.8: Nominal and real wage inequality for four skill classes.

	(1)	(2)	(3)	(4)
	log hourly wage		log hourly real wage	
VARIABLES	male	female	male	female
Medium high skill	-0.430***	-0.232***	-0.383***	-0.197***
	(0.00864)	(0.0166)	(0.00530)	(0.0118)
Medium low skill	-0.710***	-0.593***	-0.644***	-0.534***
	(0.0301)	(0.0252)	(0.0146)	(0.0111)
Low skill	-0.861***	-0.844***	-0.804***	-0.775***
	(0.0365)	(0.0494)	(0.0251)	(0.0292)
Year 2011	0.261***	0.315***	-0.162***	-0.102***
	(0.00770)	(0.0115)	(0.00915)	(0.00911)
Medium high skill*year 2011	-0.00350	-0.0436***	-0.0155	-0.0490***
	(0.0172)	(0.0122)	(0.0156)	(0.0104)
Medium low skill*year 2011	-0.00527	-0.0221***	-0.0263***	-0.0350***
	(0.00712)	(0.00752)	(0.00855)	(0.00820)
Low skill*year 2011	0.0135	0.0233	0.00351	-0.00111
	(0.0155)	(0.0155)	(0.0124)	(0.0133)
N	115,177	64,836	115,177	64,836

Notes: Standard errors are clustered by Labour Market areas. Significance levels *: 10% **: 5% ***: 1%. The dependant variable in columns (1) and (2) is the log of nominal hourly earnings, the dependant variable in columns (3) and (4) is the log of real hourly earnings, where real hourly earnings are defined as hourly earnings divided by the local RPI. The skill indicators are derived from the 3-digit SOC2000 classification. Columns (1) and (3) show estimates for male workers, columns (2) and (4) show estimates for female workers. Age and age suared are included as controls in all specifications.

Table 1.9: Robustness checks allowing expenditure shares to vary across Government Office Regions.

	constant shares		varying shares	
	male	female	male	female
change in real wage inequality	0.0199	0.0147**	0.0176	0.0128*
	(0.0125)	(0.00666)	(0.0131)	(0.00679)
change in *urban* real	0.0286**	0.0217***	0.0261**	0.0198***
wage inequality	(0.0133)	(0.00678)	(0.0127)	(0.00704)
change in *rural* real	-0.0178	-0.0202	-0.0182	-0.0212
wage inequality	(0.0146)	(0.023)	(0.014)	(0.0232)
change in real wage	0.00571	0.0161*	0.0048	0.0156*
inequality *outside London*	(0.00666)	(0.0088)	(0.00928)	(0.00885)
change in *urban* real wage	0.0129*	0.0253***	0.0118	0.0249***
inequality *outside London*	(0.00746)	(0.00916)	(0.0102)	(0.00921)

Notes: Standard errors are clustered by Labour Market areas. ***, ** and * indicate the 1%, 5% and 10% significance level. The dependant variable the log of real hourly earnings, where real hourly earnings are defined as hourly earnings divided by the local RPI. The coefficients shows are the coefficients of the interaction of a skill indicator with a year 2011 dummuy. The skill indicator is derived from the 3-digt SOC2000 classification. Model 1 and 2 show estimates assuming constant expenditure on housing across GORs, model 3 and 4 show estimates assuming that expenditure shares on housing vary across GORs. Age and age squared are included as controls in all specifications.

Chapter 2

Real wages, amenities and the adjustment of working hours across local labour markets

2.1 Introduction

Differences in working hours across local labour markets are substantial but they are largely undocumented and unexplained in the economic literature. For instance, inhabitants of Newbury work on average c. 35 hours per week, whereas inhabitants of South Devon work only 31 hours. When looking at part-time workers these differences are even more pronounced. Working hours vary by up to six hours across different areas.[1] Putting these figures in relation to cross country comparisons shows that differences in working hours across local labour markets can be as pronounced as across countries. For instance, French workers worked on average 953 hours in 2007, UK Workers 1094 and US workers 1321 (Blundell et al., 2011). Assuming 46 working weeks a year this translates into a weekly difference of three hours between France and the UK and five hours between the UK and the US.

Various explanations for the observed cross country differences in working hours have been offered. These include differences in labour market regulation, tax and welfare systems (Prescott, 2004) and cultural predilections for leisure (Alesina et al., 2005; Blanchard, 2004). All these factors are firmly grounded in the literature as explanatory variables for differences in working hours between countries. However,

[1]Numbers are taken from pooled observations of the Annual Survey of Hours and Earnings.

as they are predominantly determined on a national level, they cannot explain the observed differences across labour markets within countries.[2] Therefore, local factors have to be considered.

Recent work that looks into labour supply adjustments within countries mainly focuses on changes in working hours over time. Several studies assess the effect of newly introduced policies such as the minimum wage (Stewart, 2004; Stewart and Swaffield, 2008; Zavodny, 2000) or tax reforms (e.g. (Meghir and Phillips, 2011)). This literature ignores the spatial dimension of the phenomenon. As a result geographical differences in working hours within a country so far have received very limited attention.

This paper focuses on the link between area level real wages and labour supply. The analysis is based on a real wage index that captures differences in wages and house prices for 157 labour market areas in the UK. Wage and price levels differ substantially across local labour markets. The average wage in London in 2011 was 38% higher than the average wage in Liverpool. At the same time the rent for a two bedroom apartment in London was almost two and a half times as much as the rent of a similar apartment in Liverpool.[3] This implies that an area which is characterized by high wages and high prices might offer the same real wage level as an area which is characterized by low wages and low prices. The comparison of wage disparities alone would yield a very different result.

Differences in real wages have two different interpretations in the related literature. Studies of the housing market usually see high house prices that are not offset by equally high incomes as an affordability problem (Kutty, 2005; Quigley and Raphael, 2004; Stone, 2006). This view is especially prevalent for moderate-income households. In contrast, the regional and urban economics literature usually follows the equilibrium interpretation introduced by Rosen (1978) and Roback (1982). In their view regions characterized by low real wages must be more desirable places to live. As workers are mobile, they would move from low to high real wage areas if they were not compensated by a higher amenity level. Among others Albouy (2008) and Gibbons et al. (2011b) provide recent empirical evidence for the capitalization of

[2]Tax levels are determined on a national level and calculated on total income. In areas where costs of living are high and workers get a wage premium as compensation for the higher costs of living, taxes might actually be higher relative to areas with lower wage levels and lower costs of living. The subsequent analysis mainly works with after tax wages to account for this issue.

[3]Information for rents was taken from the website of the Valuation office Agency (http://www.voa.gov.uk).

amenities into local wages and house prices.

If higher relative costs of living reflect a higher amenity level, they increase the quality of leisure in an area. But they also make an area more difficult to afford. These facts suggest that not only wages but also local prices could be important determinants of an individual's labour supply choice.

This chapter enhances the existing literature in several ways. First, it focuses on a phenomenon that has previously received little attention and documents the variation in working hours across local labour markets in the UK. Theoretical papers usually assume that labour supply is constant across space. However, as this chapter shows, spatial differences in working hours are as pronounced as differences between countries. Second, it proposes an explanation for why spatial differences in working hours exist by establishing a link between local real wages and labour supply. The findings indicate that affordability is a key consideration for workers in relatively high cost areas when determining their labour supply. Working hours are significantly longer in low real wage areas and this effect is stronger for low skilled workers. Finally, the paper provides evidence that this link can be partly attributed to differences in the local amenity level.

The empirical analysis uses panel data and individual level information on working hours. It is thus possible to estimate individual fixed effect models which are able to control for time invariant individual heterogeneity in working hours. Compared to OLS the fixed effect estimation increases the consistency of the results as all time invariant unobserved variables that might bias the results are controlled for. To the best of my knowledge this paper is the first that looks at labour supply differences across British labour markets and which considers spatial differentials in real wages and the level of amenities as driving factors of local labour supply decisions.

So far few papers in the economic literature focused on the analysis of local labour supply. A brief documentation of differences in working hours across regions is provided by Dex et al. (1995) using the BHPS.[4] Ward and Dale (1992) choose a functional unit of analysis when looking at differences in female labour supply across UK TTWAs. They find that for women full-time and part-time working status varies across space but as Kodz and Britain (2003) notice there is not much further analysis or explanation of these patterns in the existing literature. Commuting time is considered by Black et al. (2013) as an explanation for differences in local labour

[4]The paper looks at difference for first level NUTS regions across Britain

supply in the US as it impacts labour force participation of women. Their approach contains some similarities to the one taken in this paper, however, their focus lies on the extensive margin and they explain local differences in the employment rate, whereas I focus on the intensive margin and explain differences in working hours. A notable study that provides an explanation for differences at the intensive margin is the work by Rosenthal and Strange (2008a) on hours and agglomeration. They argue that highly qualified workers increase their working hours in densely populated areas due to fierce competition, whereas low skilled workers in dense areas decrease their hours as their work load is spread across a larger number of people.

The remainder of the paper is structured as follows. Section 2 documents the distribution of working hours across space and presents descriptive evidence on working hour differentials for 157 labour market areas in Britain. Section 3 describes the conceptual framework and explains the mechanisms underlying the empirical analysis. The construction of the real wage measure that the empirical analysis is based on is described in Section 4. The outline of the empirical strategy follows in Section 5. Results and several robustness checks are discussed in Sections 6 and 7 and Section 8 concludes.

2.2 Working hours across labour market areas

Information on working hours is taken from the Annual Survey of Hours and Earnings. The data is a 1% sample of workers on the PAYE register and is considered the most reliable dataset on working hours in the UK.[5] The ASHE contains information on basic working hours, overtime working hours and total working hours measured as hours per week. The results presented in this section are based on basic weekly hours rather than total working hours.[6] Basic working hours are preferred as the ASHE contains data on paid overtime but not on unpaid overtime. For low skilled workers it is much more common to be paid for overtime hours, whereas for high skilled workers overtime tends to be unpaid (Kodz and Britain, 2003). Using total working hours in the analysis could, therefore, lead to skill related bias. The de-

[5]The responses to the survey are provided by employers who report contract hours and paid overtime working hours; employees are believed to overstate their hours worked in Labour Force surveys as time use data as well as hours reported by employers are generally lower (Blundell et al., 2011)

[6]Total hours are calculated as basic plus overtime hours.

scriptive statistics are based on workers aged 25 to 60. [7]

In a first step mean working hours are calculated for 157 labour market areas[8] using the pooled dataset. Working hours in South Devon the lowest ranked LMA amount to 31.2 hours per week, whereas residents of Newbury work on average 35.3 hours. For urban areas the differences are less pronounced but still remarkable. For instance working hours in Northampton (34.2) and Southend-on-Sea (32.7), two medium sized cities in England, differ by 1.5 hours per week.[9] The map in Figure 2.1 shows the spatial distribution of working hours across LMAs. The highest working hours are found in central England. They generally decrease when moving closer to the coast with the exception of the cities Cardiff and Newport.

To get a more detailed picture the ASHE data is stratified according to full-time and part-time worker status,[10] gender and skill levels[11]. Gender differences in the labour market are prevalent due to a variety of reasons (see Killingsworth and Heckman, 1986, for a survey). Skill related differences have increasingly gained attention in the urban and regional economic literature as workers sort across different labour markets according to their skill level (Combes et al., 2008; Lee, 2010). It is, therefore, expected that average working hours differ across these categories. Table 2.1 shows different percentiles of mean working hours as well as the minimum and maximum value across LMAs for full-time workers. Comparing the difference between hours worked in the highest and lowest LMA for the different strata reveals that variation for full-time workers amounts to two to three hours. The variation is quite similar across the different categories, but women work on average one hour less than men. Higher skilled male workers tend to work one hour less than lower skilled male workers while for female workers there is no such difference across skill classes.

Table 2.2 shows the same statistics for part-time workers. The first noteworthy fact is the much larger variation in working hours by part-time workers in comparison to full-time workers. Looking, for instance, at the group of high skilled female workers

[7] Results using total working hours and different age groups are presented in the robustness section.

[8] LMAs are derived from the 2001 definition of TTWAs by the University of Newcastle. As in Gibbons et al. (2011b) TTWAs with sample sizes of less than 200 workers were grouped into contiguous units.

[9] I conduct a two sample t-test with equal variance to test for differences in means. The differences of mean working hours are highly significant with a t-value of 13.94 for rural areas and 10.78 for urban areas.

[10] Throughout the paper full-time workers are defined as those that work between 35 and 80 hours per week, part-time workers as those who work less than 35 hours per week.

[11] Following the classification proposed by Elias and McKnight (2001) the standard occupational classification 2001 (SOC03) is used to derive four skill categories. I subsume skill class 1 and 2 as low skilled workers and skill class 3 and 4 as high skilled workers.

in urban areas shows a difference of 5.5 hours between the area where the longest and shortest hours are worked. Some of the patterns for full-time workers are reversed. Working hours of high skilled workers vary much more than those of low skilled workers and they work on average longer hours.

The two tables suggest that local factors are important determinants of labour supply as significant differences in working time are found within all strata.[12]

2.3 Conceptual framework

Wages differ substantially across space, which by itself should have implications for the amount of labour supplied in different areas. Two microeconomic effects determine the adjustment of labour supply in response to a change in wages. An increase in the wage rate induces workers to increase their leisure time as leisure is a normal good. The income effect of the wage increase, therefore, reduces working hours. At the same time opportunity costs of leisure increase when workers are paid more. This induces workers to substitute away from leisure and work longer hours. As the two effects work in opposite directions, the sign of the total effect of a wage increase on labour supply is unclear.

Barzel and McDonald (1973) introduced a novel argument into the discussion on labour supply that focuses on working time decisions of low wage workers. Those who earn a very low wage and who have no other source of income than the remuneration of their labour might not be able to earn a subsistence income defined as an income just enough to buy a consumption bundle that covers all basic needs. Starting with an hourly wage rate of zero an increase in the wage rate constitutes a point where the worker is able to earn the subsistence income when he supplies the highest possible amount of labour. As the maximal possible amount of labour is supplied at this point a further increase of the wage rate can only decrease a workers labour supply.

Now consider two labour markets LM_1 and LM_2 and assume that costs of living are higher in LM_2. Figure 2.2 shows the hour wage combinations s_1 and s_2 that generate an income high enough to cover the subsistence level in the two labour markets. The diagram illustrates that at each given wage rate longer hours have to

[12]These numbers are not corrected for other factors such as industry composition or individual sorting yet

be worked in LM_2 to meet the local subsistence level.

For most workers the position of the subsistence line does not have an influence on their working time decision as wages are high enough to make subsistence considerations irrelevant. However, for those workers who are at the lower end of the wage distribution affordability is a major concern. For very low wage rates the labour supply curve is likely to follow the subsistence line and, therefore, predicted to be negatively sloped. Figure 2.3 shows the example of a backward bending labour supply curve. The labour supply curve is negatively sloped for high wage workers as the income effect is stronger than the substitution effect, the slope eventually changes as the income effect decreases with lower wage rates. For low wage workers the labour supply curve is positively sloped up to the point where the labour supply curve intersects with the subsistence line. The result in this example is an inverse S-shaped curve.

In a labour market where costs of living are higher the intersection of the subsistence curve and the labour supply curve occurs at a higher wage level as shown in Figure 2.3. Workers in LM_2 who are at the lower end of the wage distribution have to increase their working hours relative to workers in LM_1 if local differences in prices are not exactly offset by higher wages, i.e. if real wages are lower in LM_2 than in LM_1.

The urban and regional economic literature provides an explanation on why differentials in costs of living and wages exist. The theoretical work by Rosen (1978) and Roback (1982) shows that differences in real wages across space can be seen as a measure for the level of local amenities. Workers are willing to accept lower wages and pay higher rents in order to live in nice areas.

This amenity interpretation has two implications for the labour supply framework. First, amenities make an area more attractive and facilitate a wide range of enjoyable leisure activities. Nice weather, scenic views, proximity to the sea or natural parks are examples of attributes that increase the liveability of an area. The list can be extended by cultural and historical amenities such as museums, theatres, art galleries or historical sites and buildings and consumption amenities such as cafes, bars and restaurants, cinemas, leisure centres etc. The presence of these amenities makes leisure more valuable in some areas than others. Therefore, everything else equal, an individual is expected to consume more leisure in an area that offers a higher amenity level. Second, to the extent that amenities are capitalized into wages they

lead to income and substitution effects. To the extent that they are capitalized into prices they lead to affordability effects. This implies that amenities might indirectly influence working hours through their effect on real wages and that all arguments made for the effect of real wages on working hours equally apply to amenities.

2.4 Construction of the real wage index

The real wage index uses information on area level wages that are derived from the ASHE and area level prices derived from the housing transaction provided by the Nationwide Building Society (see Appendix A.1 of Chapter I). The wage index takes into account that the composition of the workforce varies across areas. Similarly the price index takes into account that the housing stock differs across areas. The procedure to calculate skill adjusted wages and quality adjusted house prices for each of the 157 LMAs in the UK follows the approach taken in Gibbons et al. (2011b).
As in areas where costs of living are high and workers get a wage premium as compensation for the higher costs of living, taxes are higher relative to areas with lower wage levels and lower costs of living, I subtract taxes and national insurance contributions from annual earnings. These are based on wage information from the ASHE. The after tax wages are then normalized to 2007 levels using the consumer price index of the ONS. In order to correct local wage levels for the skill composition the log of after tax wages is regressed on individual and LMA fixed effects. From the regression results I predict area specific annual net wages for a person with national mean characteristics.
Housing prices are corrected for structural attributes in a similar manner to account for the fact that structural attributes of houses differ across areas. For instance, in dense urban areas houses are much smaller as households substitute housing for other goods. The log of prices is regressed on a vector of housing characteristics and an LMA fixed effect. The regression results are used to predict area specific house prices, for a property with national mean characteristics.[13]
Similar to the approach taken in Chapter I, this information is used to derive a local price index. The index is a weighted average of house prices and prices of non-housing goods where the weights correspond to the average expenditure share on housing and the average expenditure share on non-housing goods. For the cal-

[13]A full description of the approach is given in Gibbons et al. (2011b).

culation of the index house prices are rescaled so that the area with average house prices has the value one. The price of non-housing goods is assumed to be one. See Chapter 1.3.1 of this thesis for a more detailed exposition of the procedure.
Finally, to derive the real wage index area local annual net wages are divided by the local price index.

2.5 Empirical Strategy

Establishing a link between hours and wages brings up several identification problems. Unobserved preferences for working hours might well be correlated with unobserved factors that determine productivity as workers differ in their propensity to work long hours as well as in many other factors that influence their labour supply decisions. It is also possible that observed working hours do not correspond to desired working hours. As workers face constraints in the choice of their hours external shocks to the labour market are unlikely to be immediately reflected in working hours.
The main estimating equation that aims at identifying the effect of area level real wages on working hours is shown in Equation 2.1.

$$ln(h_{irt}) = \beta_1 I_r^{re} + x'_{irt}\gamma + z'_{irt}\delta + \mu_i + \tau_t + \epsilon_{irt} \tag{2.1}$$

The log of working hours h of individual i in region r is regressed on the real wage index I_r^{re}, a vector of personal characteristics x_{irt} and a vector of structural characteristics of the industry z_{irt}. γ and δ are vectors containing the marginal effects of the personal and industry characteristics and τ_t denotes time dummies for each year between 1997 and 2007. The error term in Equation 2.1 is decomposed into a time invariant individual fixed effect μ_i and a time varying error term ϵ_{irt} .
Equation 2.1 is estimated using the real wage index I^{re} as explanatory variable of interest and controlling for standard labour supply variables such as age, age^2, gender and occupation as well as a public sector dummy, firm size and a collective agreement dummy. Additionally, 60 two digit industry fixed effects are included. Sectors, such as the construction and transport sector, tend to have particularly high working hours (Dex et al., 1995; Kodz and Britain, 2003). As industries are not equally distributed across LMAs not controlling for differences in the local in-

dustry composition would bias the estimation results.

The individual fixed effect μ_i captures all permanent heterogeneity of workers, such as, for example, differences in general attitudes or tastes towards working long hours which are generally difficult to measure. It also accounts for all unobservable factors that do not change over time. These might include non-labour income as well as marital status or the number of children. The inclusion of time dummies τ_t controls for general macro-economic shocks that influence working hours such as for example a change in the tax system or national welfare program.

As the real wage index is time invariant, it only changes when a worker moves to a different location. Therefore, the identification of the real wage coefficient comes from workers who move across labour market boundaries only. This specification has the advantage that it resolves the problem of constraints in a worker's choice of hours. Prior research has shown that most adjustments in working hours after an economic shock occur through job changes (Altonji and Paxson, 1990; Blundell et al., 2008) as opposed to adjustments within the same job. Workers who move to a different labour market also change their job and are thus able to choose a wage hour package that reflects their preferences on working hours. As a result actual hours are more likely to correspond to desired working hours after the move.

The problem of endogeneity between hours and wages arises in all labour supply studies. I follow the approach taken in Rosenthal and Strange (2008a) who adopt a reduced form approach to control for wage rates. Wage rates are not directly included as an explanatory variable to avoid the reversed causality bias. Instead individual fixed effects as well as the set of personal characteristics are used as a proxy for market wage.[14] Fixed effects capture the time invariant part of an individual's wage such as different unobserved abilities and job preferences. However, they do not capture the part of the wage that varies when individuals move across LMAs. A mover faces a different wage level in his destination as well as a different price level. These level differences are reflected in the real wage index. The time invariant part of wages is thus captured in the fixed effect and the time variant part is captured by the real wage index. This holds for sure for the representative individual that is used to calculate the index. Under the assumption that movers who have the same origin and move to the same destination undergo the same change in real wages it

[14]Rosenthal and Strange (2008a) rely on education dummies and personal characteristics to proxy for wages. Due to the panel structure of my data I am able to include individual fixed effects which further reduce possible bias.

equally holds for all other individuals.

In order to get unbiased estimates from Equation 2.1 the decision to move has to be independent from the decision to work a certain number of hours after controlling for observable and time invariant unobservable factors. Factors known to determine labour supply decisions which might at the same time influence the moving decision such as age and gender are included as controls. The individual fixed effects capture unobservable factors such as different attitudes to working long hours and preferences for a certain type of job. This reduces substantially the number of confounding factors that might determine hours as well as the decision to move. Nevertheless, it is possible that for instance due to changing private circumstances such as the birth of a child the decision to move and the decision to change working time patters coincide. Also commuting time is likely to be different before and after the move. I will try to rule out these concerns in the robustness section where I include proxies for the likelihood that a worker got married or had a child at the time of the move as well as approximate commuting time.

It might also be the case that a worker moves in response to a negative or positive income shock. Benito and Saleheen (2013) find that workers who experienced a negative shock significantly increase their working time and that adjustments are made to some extent through job moves. It would be problematic if workers increased their working hours and moved to a higher real wage area in response to a negative shock. As will be seen later on, I find the opposite effect. Workers decrease their working hours when moving to high real wage areas. A negative income shock seems an unlikely driver of this result.

To address possible affordability considerations Equation 2.1 is augmented by an interaction term of the real wage index with a dummy that denotes workers at the lower end of the wage distribution. Instead of classifying the sample according to different wage levels I use different skill categories to reduce endogeneity issues between wages and working hours.[15] As shown in Figure 2.3, high costs of living increase the local subsistence level, i.e. for each given wage level workers have to work longer hours in order to meet a minimum living standard. If the local wage level is low and costs of living are high, a larger share of workers is in proximity to the subsistence threshold. These workers have to increase their working hours. No effect should be

[15]The skill groups were derived from the occupation classification using the method proposed by (Elias and McKnight, 2001)

found for high skilled workers for whom affordability considerations are irrelevant. Equation 2.2 includes the interaction term $I_r^{re} * sk'_{irt}$ of the real earnings index with different skill categories.

$$ln(h_{irt}) = \beta_1 I_r^{re} + I_r^{re} * sk'_{irt}\alpha + x'_{irt}\gamma + y'_{irt}\delta + \mu_i + \tau_t + \epsilon_{irt} \tag{2.2}$$

Since differences in real wages are seen as a measure of local amenities in the urban economics literature (Rosen, 1978; Roback, 1982) I also test for a direct link between amenities and working hours. Such a test is difficult to implement as measuring all attributes people value about an area is impossible. For instance, the beauty of a landscape or a public place in the city is very difficult to quantify and the list of amenities that impact the attractiveness of an area is arbitrarily long. As a consequence estimates might be biased due to omitted variables or measurement error. Also, many of the amenities are highly correlated with each other. This issue raises concerns about multicollinearity in the regression approach.

I deal with these issues by using physical amenities only as they are objectively measurable and, therefore, less prone to measurement error. For instance, the daily sunshine duration is much easier to measure than for example a scenic view. Multicollinearity remains a concern when using natural amenities. Variables, such as, for example, January and July temperature, are highly correlated with sunshine duration. They are, therefore, not included in the regression as this would undermine the precision of the estimate.[16]

The regression that includes a set of physical amenities is shown in In Equation 2.3.

$$ln(h_{irt}) = a'\beta + x'_{irt}\gamma + y'_{irt}\delta + \mu_i + \tau_t + \epsilon_{irt} \tag{2.3}$$

The real wage index I^{re} is replaced by a set of physical amenities denoted as vector a; β denotes a vector of the amenity coefficients. The amenity vector includes sunshine duration, rainfall, wind speed, coastal length and the difference between the lowest and highest point within a LMA as a proxy for mountains. As a novel variable I introduce wind speed in the analysis which is not included in prior studies. For Britain's geographic position wind is expected to be a disamenity. Coastal regions in Britain are exposed to strong winds from the Atlantic sea and especially in high latitudes and on the westerly facing coast these winds can reach very high speeds.

[16]The correlation between sunshine duration and July temperature is equal to 0.84

A wind chill factor is, therefore, likely to be important in the case of Britain.

2.6 Results

The ASHE has c. 1.1 million observations for c. 232,000 individuals between 1997 and 2007.[17] In this time period I count c. 76,000 moves across LMA boundaries done by c. 50,000 individual movers. More details on the dataset and cleaning procedure are provided in Appendix B.

Table 2.4 shows the estimation results for Equation 2.1. A simple OLS regression without controls in column (1) shows that the real wage index and working hours are negatively correlated, though, the estimated coefficient is not significantly different from zero. This result does not change when control variables are included in column (2). In column (3) the sample is restricted to workers who change labour market areas at least once as this is the sub-sample used for the identification of the real wage coefficient in the fixed effect estimation. Movers differ from non-movers with respect to observable characteristics as can be seen in Table 2.3. They are thus likely to differ also with respect to unobservable factors which in turn might determine working hours. Column (3) shows that movers tend to increase working hours in high real wage LMAs but the effect is not significant and close to zero in absolute size. The comparison of columns (2) and (3) suggests that basing the identification on the sub-sample of movers provides an upper boundary of the effect of real wages on working hours, as the OLS coefficient is larger for movers.

As discussed in the previous section, simple OLS results are likely to suffer from bias. Unobservable factors, such as, for instance, non-labour income and the propensity to work long hours, result in an upward bias if individuals who like to work long hours predominantly live in high real wage areas and individuals who have a high non-labour income or savings predominantly live in low real wage areas. A fixed effect estimation as in Equation 2.1 is able to capture these factors. The inclusion of worker fixed effects as shown in column (4) results in an estimated coefficient of -0.033 which is significant at the 1% level and decreases slightly to -0.042 when

[17] I exclude post 2007 observations as the UK was hit by the global economic crisis. The crisis led to substantial changes in working practices. From the first quarter of 2008 to the first quarter in 2009 British GDP fell by 6.1%, the unemployment rate increased by 2.6% (Quelle OECD). Low skilled workers were hit hardest, unemployment increased by almost 5% for elementary occupations and process, plant and machine operatives between March 2008 and March 2009 (Muriel and Sibieta, 2009)

control variables are added in column (5). A 10% increase in area level real wages results in a 0.42% decrease in working hours. As the real wage index differs by 44% across areas, this leads to a variation in working hours of 1.85%. Assuming a worker works 35 hours per week in the LMA offering the highest real wage he would increase working hours by 38 minutes per week when moving to the LMA offering the lowest real wage.

The negative sign of the coefficient might imply a strong affordability effect or that the income effect is significantly larger than the substitution effect. If affordability considerations were driving this result the effect should be strongest for those workers earning lower incomes. Column (6) shows the results of Equation 2.2 where real wages are interacted with a skill dummy indicating low skilled workers. The skill interaction term is negative and highly significant implying that low skilled workers reduce their working hours by more than high skilled workers when real wages increase. Lower skilled workers who move to an area offering a 10% lower real wage increase their working hours by about 0.85% more than high skilled workers. Higher skilled workers do not change their labour supply when facing differences in area level real wages. The overall negative effect of real wages on working time is, therefore, due to labour supply adjustments of lower skilled workers.

The results from the fixed effect regressions imply that on average workers tend to work longer hours in low real wage LMAs. In the urban economics literature real wages are seen as a measure of the local amenity level. Real wages are lower in high amenity areas as the value attributed to amenities is capitalized into local wages and house prices. If differences in the amenity level were underlying the relation between real wages and working hours, it should be possible to replicate the result by directly including a set of amenities. In such a regression it is expected that amenities are signed in the opposite way than the real wage index as a higher amenity level induces lower real wages. In this interpretation amenities are expected to increase working hours, whereas disamenities are expected to reduce working hours.

Column (1) in Table 2.5 shows the results of Equation 2.3 where the real earnings index is substituted with a set of amenities. Sunshine and the presence of mountains which are natural amenities are positively signed, whereas disagreeable weather conditions such as rainfall and wind speed are negatively signed. All coefficients apart from the coast length coefficient are significant at the 5%, respectively, 1%

level.[18] Proximity to the coast is an important factor in hedonic regressions when US data is used. However, the distance between east and west coast in the US is at its widest point c. 5500 km, whereas in Britain the maximum distance from any geographical point to the sea is less than 106 km.[19] Direct access to the sea or coastal length of a LMA is, therefore, likely to be less important in the case of Britain. The results show a significant correlation between natural amenities and working hours. Disamenities are signed in the same way as the real wage index, whereas amenities are signed in the opposite way. To test whether this effect comes mostly through the amenities' effect on real wages, the real wage index is equally included in the regression in column (2). Conditional on local amenities, the real wage index does not have a significant effect on labour supply. The effect of amenities remains significant indicating that they affect working hours through additional channels rather than through their effect on real wages only.

To further explore this issue each amenity is interacted with the skill dummy. As shown in column (3) coastal length and wind speed decrease working hours of low skilled by more than working hours of high skilled workers. All other amenity variables have the same effect on working hours for both skill groups. The real wage index is included in column (4). Conditional on physical amenities low skilled workers increase their labour supply with falling real wages. The results in Table 2.5 are mixed with respect to the hypothesis that amenities influence working hours by lowering local real wages. Whereas columns (1) and (2) seem to support the hypothesis that amenities at least partly affect working hours through their effect on real wages columns (3) and (4) do not provide any further evidence for this effect.

2.7 Robustness checks

The findings that working hours decrease with real wages and that this effect is primarily due to adjustments of low skilled workers are tested using a variety of alternative specifications. The upper panel of Table 2.6 shows robustness tests for different gender and age groups. Columns (1) and (2) show results for separate regressions for female and male workers. For both gender groups higher real wages do

[18] The importance of wind speed as a disamenity is confirmed by the fact that the coastal length becomes negative and highly significant when wind speed is omitted in the amenity regression.

[19] The distance was calculated in ArcMap using a negative buffer. The village Kirk Ireton in Derbyshire is the built up area furthest away from the coastline.

not influence labour supply of high skilled workers but significantly decrease labour supply of low skilled workers. The effect is stronger for female workers than for male workers. Next, results are shown for different age bands. Column (3) shows results for prime age workers aged 30 to 50. Column (4) shows results for workers aged 25 to 40 and column (5) for workers aged 40 to 60. The real wage effect remains stable across all age groups.

A drawback of the ASHE is that it reports only few individual characteristics. The lack of information on marital status and on the presence of children is of particular concern as it is known from prior studies that both factors affect working hours (see Blundell and MaCurdy (1999) for a survey). The inclusion of individual fixed effects controls for these factors as long as they do not change over time. However, it is of course possible that a worker moves, for instance, because of the birth of a child. As the presence of children influences labour supply, the main identification assumption, namely that the decision to move is independent from the decision of working a certain number of hours, would be violated. To alleviate this problem proxies for the birth of a child and a change in legal status are calculated using information from the 2001 Census. Each worker in the ASHE is matched with the share of households with children and the share of households with cohabiting couples in the worker's neighbourhood before and after the move.[20] A worker who moves from a neighbourhood where most people do not have any children to a neighbourhood where most people have children is very likely to do so because of the birth of a child. To a lesser extent the same argument is valid for workers getting married or moving together with their partner.

Column (1) in the middle panel of Table 2.6 reports regression results that include proxies for marital status and the presence of children as additional controls. The additional controls do not substantially alter the main result. For high skilled workers real wages do not have a significant effect on working hours, whereas for low skilled workers higher real wages significantly decrease working time. The labour supply elasticity with respect to real wages once family conditions are controlled for equals -0.15 for low skilled workers which is about twice the effect as in the baseline specification.

Another factor that is frequently discussed as a determinant of labour supply is com-

[20]The neighbourhood is defined as the output area of the worker's home postcode. This information is only available from 2001 onwards as for prior years the home postcode is not reported in the ASHE

muting time. Commuting time can be viewed as a fixed cost of going to work. In theoretical papers it is, therefore, often assumed that commuting time is negatively correlated with working hours. For instance, Zenou (2002) assumes that workers living far away from jobs provide lower effort levels than those residing closer to jobs because of tiredness after the long commuting trip. Empirical studies did not find a negative correlation between commuting time and working hours (Gutiérrez-i Puigarnau and van Ommeren, 2010) and the direction of the effect remains ambiguous. In the main specification of the analysis the effect of real wages on working hours would be biased downward if average commuting time was higher in areas offering high real wages and commuting time had a negative effect on labour supply. As a robustness check, the geographical distance between home and work post code is added to the main specification as a proxy for commuting time. The distance variable is also interacted with gender as Black et al. (2013) found that female workers are more sensitive to commuting time than male workers when making labour participation decisions. The results in column (2) show that the inclusion of commuting distance on top of family conditions leaves the results unchanged.

Columns (3) and (4) in the middle panel analyse heterogeneous effects for rural and urban areas. High skilled rural workers tend to work longer hours in high real wage areas. As column (5) shows, this effect can be explained by differences in the spatial distribution of households with children. Once this factor is controlled for, the difference between working hour adjustment for high skilled workers in rural areas and urban areas becomes insignificant. For low skilled workers the real wage effect remains negative for workers living in urban and rural areas, though, it is not significant for rural workers.

Column (1) of the lower panel of Table 2.6 shows results when London workers are excluded from the sample. London has a dominant role in the British economy and 10.7% of the total number of moves are from or to London. Though, wages are high in London the city offers the lowest real wages in the UK as costs of living are even higher in comparison to other labour market areas. The main result for low skilled workers is unchanged, high skilled workers tend to increase their working hours in LMA offering higher real wages when London is excluded.

Rosenthal and Strange (2008a) found evidence for longer working hours in dense urban areas because of increased competition between high skilled workers. I, therefore, control for population density and an interaction of population density and

skill level in column (2). The real wage coefficient remains negative and highly significant for low skilled workers.

In column (3) industry fixed effects are dropped from the regression, which does not change the results. Industry fixed effects make a difference when running OLS specifications but in the fixed effect regression they are largely captured by the individual fixed effects.[21] Column (4) shows results for total working hours that include over-time hours which are very similar to the results based on basic working hours. Finally, high skilled and low skilled workers are further divided into subclasses. I use four skill categories which are based on the three digit occupation classification (see Elias and McKnight (2001) for details). Column (5) shows that higher skilled and medium high skilled workers do not change their working hours when real wages vary. Medium low skilled worker decrease their working time in higher real wage areas and the lowest skilled workers increase their working time the most.

Table 2.7 shows results for the sub-sample of full-time and part-time workers. The results are based on movers who work full-time, respectively, part-time, for the entire period of observation. For both groups low skilled workers decrease their working time when they face higher real wages. Table 2.7 confirms the finding from the main analysis. The fact that the magnitude of the coefficients of the split sample is smaller than for the full sample suggest that part of the adjustment occurs through changes from full-time to part-time status.

2.8 Conclusion

This chapter documents and explains labour supply decisions in a local context. Geographical differences in working hours within a country so far have received very limited attention and the paper is one of very few that proposes mechanisms to explain these patterns. In particular, it is the first to analyse a link between working hours, local real wages that take differences of housing costs into account and different levels of local amenities.

The results show that working hours are higher in low real wage areas. A decrease of local real wages by 10% adds about 0.42% to typical working week. Differences in real wages are able to explain 38 minutes of the variation in weekly working hours

[21] The coefficient changes from -0.0623 (OLS without any controls) to -0.085 when industry fixed effects are included and becomes weakly significant.

across British labour market areas. This finding is driven by working time decisions of low skilled workers indicating that workers have to work long hours to afford living in areas where costs of living are not offset by equally high wages. A reduction of the annual real wage of 10% increases weekly working hours of a low skilled worker by 0.85% more than working hours of a high skilled worker or put differently, differences in real wages are able to explain c. 78 minutes of the observed difference in working hours between high and low skilled workers across labour market areas. Amenities, which are considered as the underlying reason for time persistent differences in real wages, can at best partly explain this result.

These findings are relevant to a variety of policy questions ranging from the discussion of the local living wage to the provision of affordable housing. Also, this chapter shows the need to consider the interaction of local characteristics and labour market outcomes rather than conducting empirical research at the national level only.

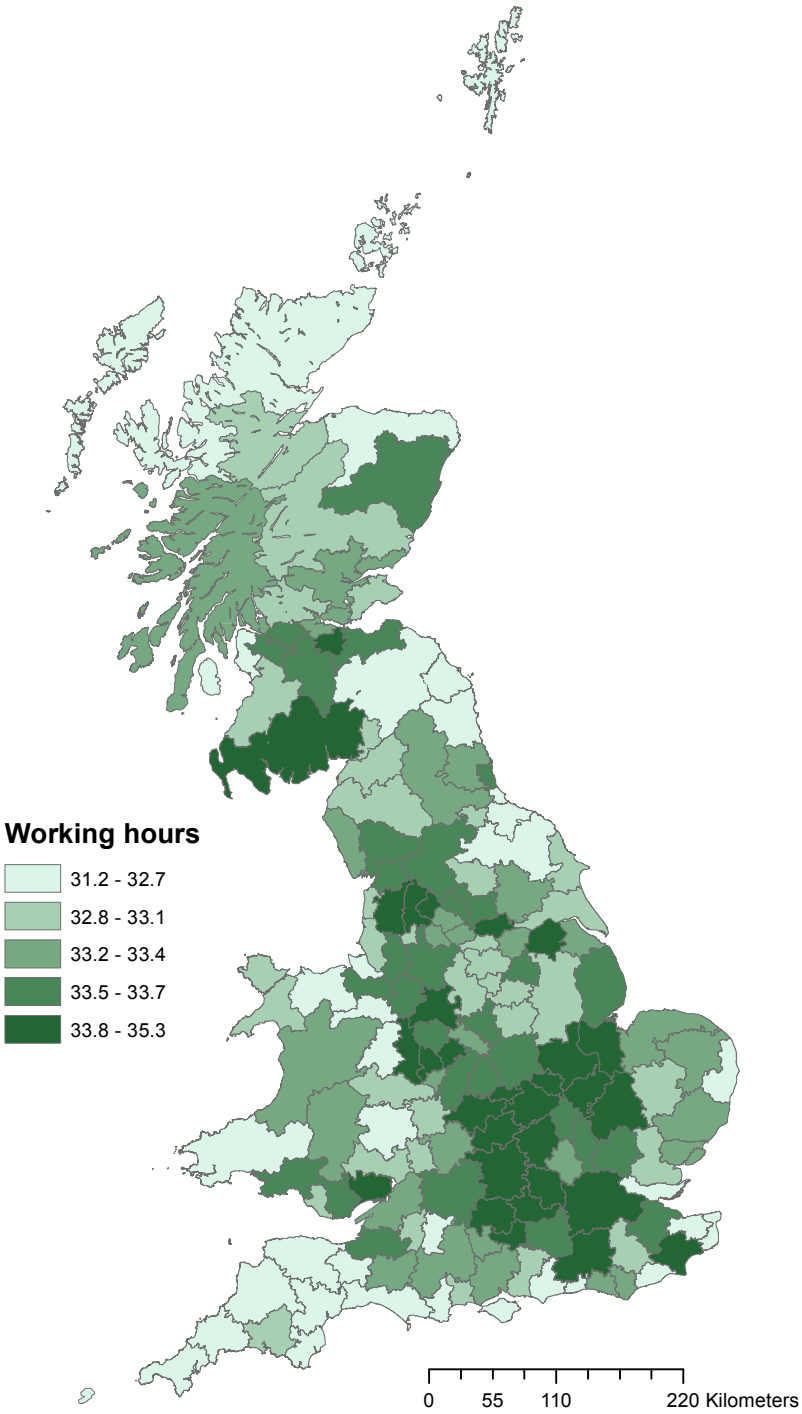

Figure 2.1: Average weekly working hours for 157 LMAs.

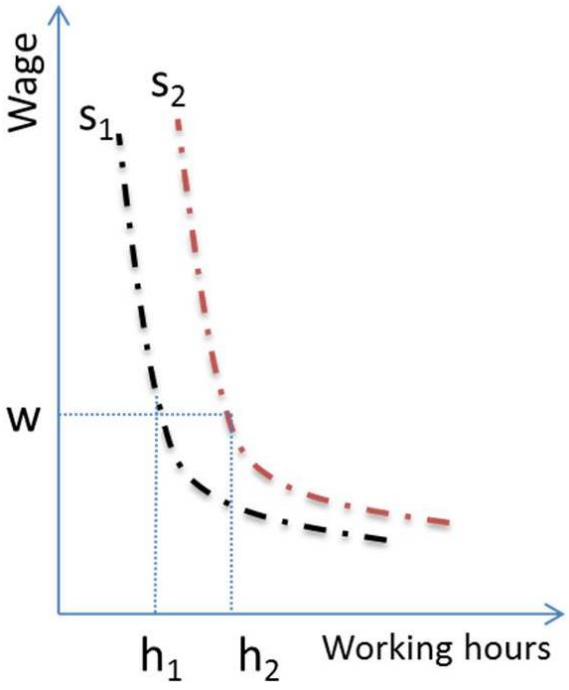

Figure 2.2: Hour wage combinations denoting the local subsistence level.

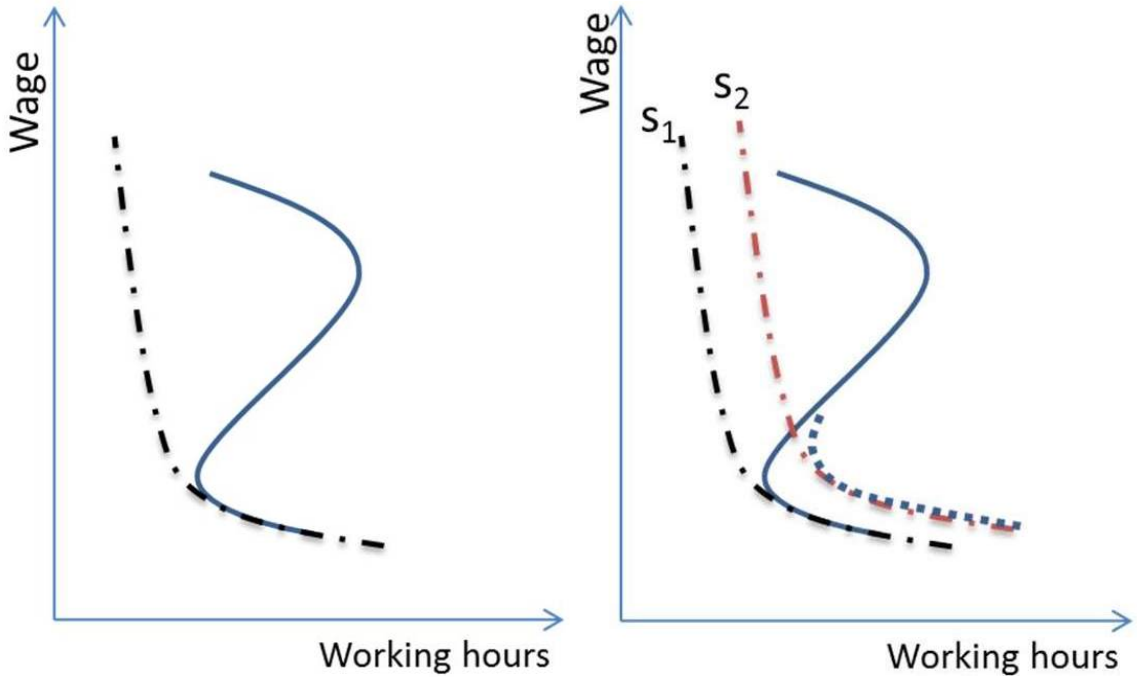

Figure 2.3: Labour supply and subsistence line.

Table 2.1: Basic weekly working hours for full-time workers.

female	urban		rural		male	urban		rural	
	high	low	high	low		high	low	high	low
min	36.25	36.96	36.76	37.18		37.74	38.50	38.01	38.55
10 %	37.38	37.42	37.21	37.60		38.25	39.00	38.36	39.24
25 %	37.59	37.63	37.62	37.78		38.39	39.34	38.74	39.43
50 %	37.70	37.83	37.90	37.98		38.68	39.69	39.07	39.75
75 %	37.83	37.97	38.13	38.20		38.84	39.93	39.33	40.25
90 %	37.96	38.09	38.41	38.39		39.17	40.32	39.62	40.52
max	38.21	38.24	38.78	38.61		39.98	41.32	39.93	41.62

Notes: Information on basic hours is taken from the ASHE.

Table 2.2: Basic weekly working hours for part-time workers.

female	urban		rural		male	urban		rural	
	high	low	high	low		high	low	high	low
min	21.28	19.24	20.97	18.63		21.68	21.83	20.78	19.99
10 %	23.14	19.92	22.59	19.82		25.12	22.68	23.64	21.29
25 %	23.81	20.34	23.53	20.27		26.36	23.48	24.64	22.71
50 %	24.59	20.77	24.30	20.80		27.33	24.13	26.43	23.62
75 %	25.15	21.28	25.24	21.25		27.95	24.83	27.59	24.91
90 %	25.81	20.08	25.74	21.86		29.03	25.77	28.61	25.72
max	26.74	22.96	27.38	23.03		30.05	27.08	30.86	26.82

Notes: Information on basic hours is taken from the ASHE.

Table 2.3: Variable description

	Movers			Non-Movers		
Variable	Obs	Mean	Std. Dev.	Obs	Mean	Std. Dev.
Working hours	312151	34.5	8.6	810353	33.1	9.6
Real wage	312151	11209	995.4	810353	11192	1025.3
Weekly pay	312151	439.58	382.16	810353	374.63	350.99
Female	312151	0.431	0.495	810353	0.510	0.500
Age	312151	39.2	10.0	810353	40.9	11.0
Low skill	312151	0.465	0.499	810353	0.572	0.495
Part-time	312151	0.250	0.433	810353	0.330	0.470
Public sector	312151	0.365	0.575	810353	0.414	0.612
Collective agreement	312151	0.586	0.493	810353	0.597	0.490
Firm Size	312151	22612	46946	810353	14762	36217
Population density	312151	934	937	810353	1116	1082
Urban	312151	0.776	0.417	810353	0.807	0.394
Distance (m)	159075	16978	19551	418342	8628	11391

Notes: Variables are taken from the ASHE.

Table 2.4: Regressions of working hours on the real wage Index.

Variables	(1) OLS I ln(hours)	(2) OLS II ln(hours)	(3) OLS II mover ln(hours)	(4) FE I ln(hours)	(5) FE II ln(hours)	(6) FE II int ln(hours)
I^{re}	-0.0623	0.00197	0.0353	-0.0331***	-0.0416***	-0.000133
	(0.0534)	(0.0416)	(0.0279)	(0.0123)	(0.0120)	(0.0134)
Low skill*I^{re}						-0.0849***
						(0.0253)
N	1,122,504	1,122,504	312,151	1,122,504	1,122,504	1,122,504
Individuals	231,955	231,955	49,878	231,955	231,955	231,955
R-squared	0.000	0.242	0.235	0.769	0.776	0.772
Controls	NO	YES	YES	NO	YES	YES

Notes: Bootstrapped standard errors in parentheses (100 repetitions). Significance levels *: 10% **: 5% ***: 1%, Dep Var: ln(hours) = log of basic working hours. I^{re} denotes a real wage index that has been derived using information on area level wages and house prices. The skill indicator is derived from the 3-digit SOC2000 classification. Results in column 1 - 3 are estimated using OLS, column 4 - 6 are estimated using fixed effect refressions. Control variables include age, age^2, firm size, indicators for the public sector, rural areas, collective agreements and years as well as 2 digit occupation and industry fixed effects.

Table 2.5: Regressions of working hours on amenities and amenities interacted with skills.

	(1) Amenities	(2) Amenities and I^{re}	(3) Amenities	(4) Amenities and I^{re}
VARIABLES	ln(hours)	ln(hours)	ln(hours)	ln(hours)
I^{re}		-0.00944		0.0199
		(0.0140)		(0.0157)
Low skill*I^{re}				-0.0639**
				(0.0294)
Sunshine	0.00462**	0.00399*	0.000419	0.00178
	(0.00188)	(0.00212)	(0.00218)	(0.00246)
Rain	-0.00509***	-0.00501***	-0.00673***	-0.00695***
	(0.00163)	(0.00163)	(0.00185)	(0.00186)
Elevation	0.00481**	0.00454**	0.00185	0.00241
	(0.00209)	(0.00213)	(0.00243)	(0.00250)
Coast length	-0.000217	-5.27e-05	0.00274	0.00242
	(0.00149)	(0.00151)	(0.00169)	(0.00170)
wind	-0.00775***	-0.00768***	-0.00446**	-0.00465**
	(0.00173)	(0.00173)	(0.00203)	(0.00204)
Low skill*sun			0.00625	0.00202
			(0.00389)	(0.00440)
Low skill*rain			0.00312	0.00366
			(0.00340)	(0.00341)
Low skill*elevation			0.00451	0.00277
			(0.00435)	(0.00443)
Low skill*coast length			-0.00615**	-0.00505
			(0.00308)	(0.00311)
Low skill*wind			-0.00751**	-0.00699**
			(0.00355)	(0.00356)
N	1,122,504	1,122,504	1,122,504	1,122,504
Individuals	231,955	231,955	231,955	231,955
R-squared	0.776	0.776	0.772	0.772
Controls	YES	YES	YES	YES

Notes: Bootstrapped standard errors in parentheses (100 repetitions). Significance levels *: 10% **: 5% ***: 1%, Dep Var: ln(hours) = log of basic working hours. I^{re} denotes a real wage index that has been derived using information on area level wages and house prices. The skill indicator is derived from the 3-digit SOC2000 classification. The amenities sun, rain, elevation, coast length and windspeed denote the average sun shine duration in hours per day, the average rainfall in mm per year, the average altitude of an area above sea level, the length of the coast line of an area in km and average wind speed at a height of 10 m above ground level in knots. All variables are standardized and have mean zero and a variance of one. Control variables include age, age^2, firm size, indicators for the public sector, rural areas, collective agreements and years as well as 2 digit occupation and industry fixed effects.

Table 2.6: Robustness checks for the regressions of working hours on real wage Index with interaction terms.

VARIABLES	(1) ln(hours)	(2) ln(hours)	(3) ln(hours)	(4) ln(hours)	(5) ln(hours)
	female	male	age 30-50	age 25-40	age 41-60
I^{re}	0.0401	-0.0153	0.00975	-0.00168	0.00632
	(0.0313)	(0.0136)	(0.0135)	(0.0179)	(0.0235)
Low skill*I^{re}	-0.137***	-0.0536*	-0.0558**	-0.0680*	-0.0883**
	(0.0439)	(0.0304)	(0.0268)	(0.0384)	(0.0383)
N	548,050	574,454	998,051	560,883	561,621
Individuals	115,022	116,933	134,157	147,439	118,756
R-squared	0.749	0.704	0.780	0.786	0.815
	LFS	Commuting	urban	rural	rural + Census
I^{re}	0.0360	0.0358	-0.0225	0.154*	0.0419
	(0.0310)	(0.0309)	(0.0151)	(0.0797)	(0.147)
Low skill*I^{re}	-0.155***	-0.157***	-0.0607**	-0.145	-0.147
	(0.0551)	(0.0551)	(0.0299)	(0.119)	(0.218)
N	577,379	577,379	896,364	226,140	117,158
Individuals	177,104	177,104	195,121	54,031	38,708
R-squared	0.840	0.840	0.780	0.802	0.865
	no London	population density	no Industry codes	total hours	4 skill groups
Real wage	0.0475**	0.0122	0.00608	-0.00300	-0.0105
	(0.0188)	(0.0142)	(0.0134)	(0.0138)	(0.0215)
Low skill*I^{re}	-0.113***	-0.0658**	-0.0753***	-0.0796***	
	(0.0345)	(0.0266)	(0.0256)	(0.0258)	
Medium high skill*I^{re}					0.0267
					(0.0319)
Medium low skill*I^{re}					-0.0740**
					(0.0334)
Lowest skill*I^{re}					-0.111**
					(0.0549)
N	909,463	1,122,504	1,122,504	1,122,504	930,041
Individuals	184,827	231,955	231,955	231,955	200,688
R-squared	0.775	0.772	0.770	0.770	0.797
Controls	YES	YES	YES	YES	YES

Notes: Bootstrapped standard errors in parentheses (100 repetitions). Significance levels *: 10% **: 5% ***: 1%, Dep Var: ln(hours) = log of basic working hours. I^{re} denotes a real wage index that has been derived using information on area level wages and house prices. The skill indicator is derived from the 3-digit SOC2000 classification. Control variables include age, age^2, firm size, indicators for the public sector, rural areas, collective agreements and years as well as 2 digit industry fixed effects. In the middle panel of column 1 and 5 census information on the output area shares of married households and households with children are included. In the middle panel of column 2 controls for distance between home and work postcode as well as an interaction of distance with gender are included. In the lower panel of column 2 the log of population density is included as additional control.

Table 2.7: Regressions of working hours on real wages for full-time and part-time workers.

VARIABLES	(1) full-time ln(hours)	(2) part-time ln(hours)
I^{re}	0.00396	0.0185**
	(0.00357)	(0.00757)
Low skill*I^{re}	-0.0342***	-0.0348***
	(0.00810)	(0.0125)
N	570,724	206,292
Individuals	121,176	57,441
R-squared	0.730	0.719
Controls	YES	YES

Notes: Bootstrapped standard errors in parentheses (100 repetitions). Significance levels *: 10% **: 5% ***: 1%, Dep Var: ln(hours) = log of basic working hours. I^{re} denotes a real wage index that has been derived using information on area level wages and house prices. The skill indicator is derived from the 3-digit SOC2000 classification. Control variables include age, age^2, firm size, indicators for the public sector, rural areas, collective agreements and years as well as 2 digit industry fixed effects. Columns 1 and 2 show results for the sample of full-time workers, columns 3 and 4 show results for the sample of part-time workers.

Chapter 3

The role of education for amenity based sorting in British cities

3.1 Introduction

High and lower skilled workers increasingly choose to live in different areas (see Chapter I). There is a lively discussion on whether sorting across cities is driven predominantly by job opportunities or by the quality of life that differ across space. While a branch of the literature emphasizes the role of cities as centres of consumption that attract skilled labour by offering a wide range of amenities (Glaeser et al., 2001; Glaeser and Gottlieb, 2006; Partridge, 2010) an alternative view focuses first of all on the availability of jobs in a city in order to attract labour (Storper and Scott, 2009; Moretti, 2013). The debate on whether jobs follow people or people follow jobs (see for instance Steinnes (1982); Gottlieb (1995); Deitz (1998) and Brueckner (2001)), therefore, lies at the core of existing research. As the level of human capital is an important determinant of the future economic success of a place (Lucas, 1988), it is crucial to understand which factors drive individual location choices.

This paper investigates the relation between amenities and skills. It proposes an empirical test for the existence of education biased preferences for amenities in UK cities. As it is difficult to separate labour market factors from differences in the local amenity level, we conduct the analysis at a more detailed geographical scale and look at differences in the amenity consumption of education groups across neighbourhoods. The empirical strategy consists of a two-stage estimation approach. In the first stage, we estimate a standard hedonic regression assuming that the value of

amenities is capitalized into housing prices. From this regression we derive a composite amenity measure that captures all unobserved neighbourhood characteristics, such as, for instance, crime levels, proximity to green areas, restaurants and cafes. In the second stage, we analyse how the amenity consumption is distributed across individuals belonging to different education groups. Here, the amenity measure derived from the hedonic regression is used as the dependent variable. Differences in the level of amenity consumption for individuals that earn a similar income but belong to different education groups are interpreted as evidence of a preference bias. The empirical investigation exploits a novel dataset that combines micro-data on individual workers and house prices at a small geographical scale.

Our approach contributes to the existing literature in several ways. First, by constructing our amenity measure at neighbourhood level we are able to account for unobserved characteristics at city level. This has proven to be a substantial limitation in previous studies that could not fully separate differences in the level of local amenities from labour market opportunities (a more detailed discussion is provided in the literature section). Second, by using price data per square metre we are able to derive an amenity measure that does not depend on differences in the level of housing consumption. Our hedonic regression exploits micro-data on house prices and controls for a detailed set of housing features that influence local prices. Third, we take into account the potential endogeneity between amenities and the local skill level due to sorting. Previous evidence on Britain has shown that home-owners in England and Wales are prepared to pay a substantial premium to avoid educationally poor neighbourhoods (Gibbons, 2003). This suggests that highly educated individuals may primarily value the neighbourhood educational composition when making their residential choice. We account for the fact that the demographic composition of local neighbourhoods may be considered an amenity per se by including an extensive set of variables that capture the demographic structure of an area in our second stage regression.

The results of the analysis suggest that highly educated individuals consume a higher level of amenities than lower educated individuals earning a similar income. Holding everything else constant highly educated individuals have a higher valuation of neighbourhood amenities indicating the existence of an education biased preference towards amenity consumption.

The remainder of the paper is organized as follows. The next section presents the

literature and findings related to our analysis. Section 3 describes the data and Section 4 the empirical strategy. Section 5 discusses the key results. Section 6 presents several robustness checks and Section 7 concludes.

3.2 Related Literature

Our research contributes to an emerging body of literature which starts from the observation that the share of skilled workers varies across labour markets and that it tends to be highest in large expensive cities. Several studies have linked the sorting of highly skilled workers across labour markets to differences in the local level of amenities. Other studies have focussed on the link between amenities and differential population growth.

Lee (2010) provides a theoretical model predicting that the wage premium paid in large urban areas is relatively lower for high skilled workers. Large cities offer a higher consumption variety which induces high skilled workers to accept lower wages. As consumption amenities drive up land prices in large cities relative to small cities, low-skill individuals require a wage premium while high-skill individuals might accept a lower premium or even a wage discount in these areas. Lee (2010) looks at the example of the health care sector to document ability sorting across local labour markets and finds empirical evidence in line with the consumption amenity hypothesis. Black et al. (2009) show that not only do wage levels differ across locations but so do returns to schooling (education-wage-gradients). They develop a model predicting that high skilled workers tend to experience a lower real wage premium to live in amenity cities than low skilled individuals and show that the returns to education are relatively lower in expensive high-amenity locations. Other studies focus on location decisions of individual movers to analyse the link between amenities and skills and conclude that the level of local amenities plays a significant role in the migration decision of skilled workers (Arntz, 2010; Mathur and Stein, 2005; Chen and Rosenthal, 2008; Niedomysl and Hansen, 2010; Dorfman et al., 2011).

It is, however, difficult to separate the impact of amenities on an individual's location choice from labour market characteristics, such as, for instance, differences in the local productivity level. As Moretti (2013) notices high skilled workers might choose to live in expensive cities because these cities are more attractive or because

of the availability of highly specialized jobs. While in the former case higher costs of living represent the price to pay for the consumption of desirable amenities in the latter case they account for differences in productivity across space. Moretti (2013) uses an IV strategy to distinguish between localized shocks in demand for skilled workers and a change in the local level of amenities as the underlying reasons for differential increases in the share of skilled workers between 1980 and 2000 in US cities. The results point towards the predominant role of job opportunities for the location choices of high skilled individuals and he concludes that expensive areas in the US became more skilled due to the availability of highly specialized jobs generated by localized skill biased technological change.

Therefore, when performing the empirical analysis at city level, distinguishing between demand side factors (availability of job opportunities) and supply side factors (availability of amenities) remains key to explain the sorting behaviour of high skilled workers. Existing studies present evidence for both effects and have not yet come to a final conclusion on their relative importance.

Further insights come from the related literature looking at the distribution and evaluation of amenities within cities. The majority of contributions in this area focus on a specific local amenity, such as school quality, crime or environmental factors and use data on housing expenditures to recover their implicit prices (see for example Graves et al. (1988) for the case of air pollution, Gibbons and Machin (2003, 2006); Bayer et al. (2007) for school quality and Black and Machin (2011) for a review on school quality, Gibbons (2004); Linden and Rockoff (2008) for crime and Van Praag and Baarsma (2005) for airport noise).

The willingness to pay for amenities is, however, not necessarily homogeneously distributed across population groups. Theoretical papers often make the assumption that amenity consumption rises sharply with income (e.g. Brueckner et al. (1999)) and there is empirical evidence that the consumption of amenities depends on the life cycle and family composition (Chen and Rosenthal, 2008). Our study contributes to this literature by assessing the variation of amenity consumption across individuals focussing on individuals of different educational attainments.

3.3 Data

For the purpose of this study we combine information from several datasets. Information on individual wage and education levels is taken from the Labour Force Survey (LFS). We use house price transaction data from the Nationwide Building society in order to derive a local amenity measure. Finally, we exploit a wide range of additional data sources to recover information on various kinds of natural, cultural and consumption amenities to check the plausibility of our composite indicator.

The LFS is the largest regular labour market survey in the United Kingdom. It allows research on a fine spatial scale as it records geographic information down to the ward level.[1] Our sample comprises individuals in employment from 1994 to 2010 for whom wage information and educational attainment are available.[2] The sample size amounts to 460,000 individuals, 30% of whom hold a university degree. Individuals remain in the sample during five consecutive quarters, referred to as wave 1 to 5. To avoid non-responses the earnings question was initially only asked in the final wave. From spring 1997 onwards earnings questions were asked in wave one and five in order to increase the sample size and reduce sampling error.[3] Apart from weekly wage and education, the LFS records information on the type of work, such as occupation, full time status and public sector indicators as well as personal characteristics, such as age, gender, ethnicity, marital status and the number of children.

We derive a measure of local amenities using a hedonic price regression. Details on the estimation procedure are given in the next section. Data on house price transactions is provided by the Nationwide Building Society. Between 1995 and 2011 Nationwide recorded the price and geographical location of the property (seven digit postcode) as well as a large set of housing characteristics, such as floor size, the age of the building, number of bathrooms and bedrooms, heating and security type for about 1.3 million housing transactions. Using the National Statistics Postcode Directory, which provides a lookup from postcodes to higher level administrative geographies in the UK, we add 1998 ward definitions to the transaction data. In Britain there are c. 10.000 wards leaving us with on average 130 transactions per

[1] Wards have an average size of 20 km^2 which is equal to 4.5 km x 4.5 km.

[2] Questions about individual earnings were introduced in winter 1992. We exclude information for 1992 and 1993 as the quality of wage data in the very first years is low.

[3] If wages differ in wave one and five we use the average wage.

ward across the full time period. The yearly sample size lies between 30,000 and 127,000 observations.

To check the plausibility of the hedonic amenity measure, we also collected data on local amenities at the ward level. We constructed an amenity database from several sources. The Home Office holds a detailed register on crime incidents in England and Wales. In 2010 it created a website that made street level crime data freely available for download.[4] Using the software ARCMap and geographical ward boundaries provided by the data centre EDINA[5], we identify the number of crime incidents in 2010.[6] We use the Business Structure Database (BSD) to identify business organisations that have an amenity value. All businesses that are liable for VAT and/or have at least one member of staff registered for the PAYE tax collection system appear on the BSD. We use the 2007 Standard Industry Classification to identify restaurants, cafes, bars, public houses and clubs as well as libraries and museums in the database.[7] The BSD provides detailed information on the location of each business using seven digit postcodes. Businesses with an amenity value have then been allocated to British wards through the National Statistics Postcode Directory which matches British geographies from postcodes to higher geographical levels. Additional data come from English Heritage, which holds an online database providing information on all nationally designated heritage assets, including listed buildings, registered parks and gardens and monuments.[8] Using ARCMap and exploiting information on the spatial coordinates of each record included in the database we calculated the number of listed buildings within each ward. We also use the software to calculate the share of the ward area that is covered by a listed park or garden.

A detailed description of all variables used in the analysis is reported in Table 3.1.

[4]www.police.uk/data

[5]http://edina.ac.uk/

[6]These include antisocial behaviour, robbery, violent crime, damage and arson, public order and weapons and vehicle crime. We use incidents that happened in 2012.

[7]We use business in 2010 with SIC07 codes 56.10/1 for licensed restaurants, 56.10/2 for unlicensed restaurants and cafes, 56.30/1 for licensed clubs, 56.30/2 for public houses and bars, 91.01/1 for library activities, and 91.02/0 for museum activities.

[8]Data are available for download at http://www.english-heritage.org.uk.

3.4 Empirical Strategy

Our empirical strategy follows a two-step estimation procedure. In the first step we derive an amenity measure using a hedonic regression. In the second step we use this measure to analyse differences in amenity consumption according to an individual's education level.

3.4.1 Estimating the neighbourhood amenity level

We estimate a measure of amenities for British neighbourhoods where neighbourhoods are defined according to 1998 definitions of electoral wards. Workers living in different neighbourhoods of a TTWA face the same local labour market and thus have access to similar job opportunities. To estimate the level of neighbourhood amenities we run a hedonic regression according to Equation 3.1 using OLS techniques.

$$ln(p_{jwt}) = x'_j\beta + a_w + \tau_t + \epsilon_{jwt} \tag{3.1}$$

The log price per square metre p_{jwt} for the transaction of house j located in ward w at time t is regressed on a vector of housing characteristics x_j, a time dummy τ_t for each year between 1995 and 2011 and ward fixed effects a_w. The coefficient vector β contains marginal effects for all housing characteristics and ϵ_{jwt} denotes the error term. We recover the ward fixed effects a_w from the regression and interpret them as the level of amenities consumed by an individual living in the specific ward. A plausibility check for this interpretation is provided in Appendix C.1.

The main advantage of this strategy lies in the possibility of recovering a composite measure of amenities. This overcomes the problems associated with the use of a large set of amenities in regression analyses. The list of available amenities is often not exhaustive and the strong correlation between different kinds of amenities leads to imprecise estimates. It also avoids the aggregation of a set of amenities to an index choosing arbitrary weights (Diener and Suh, 1997; Lambiri et al., 2007).

Equation 3.1 addresses two common problems that arise in the hedonic estimation of amenity levels. First, it controls for a long list of variables that describe the type of the housing stock and its quality. Both factors are likely to differ systematically across neighbourhoods (e.g. suburbs with free standing housing versus inner

city apartment blocks). Not controlling for these factors would result in biased neighbourhood fixed effects as they would capture not only local amenities but also unobserved housing characteristics. Given the detailed information available in our housing data, we are able to factor out the bias due to the type of the house (detached, semi-detached, terraced, flat,), tenancy type (freehold, leasehold, feuhold), age of the structure, heating type (e.g. gas, electric, oil) as well as the number of garages, bedrooms and bathrooms. Second, the estimation strategy shown in Equation 3.1 rules out differences in housing consumption. Using square metre prices as the dependent variable guarantees that the neighbourhood fixed effects capture the part of the price that is explained by differences in locational attributes rather than the size of the house. This is important as, for instance, a detached house gives access to the same local amenities as the neighbouring flat in an apartment block.

3.4.2 Estimating preferences toward amenities

Our second stage is aimed at testing whether preferences toward amenity consumption vary with the level of education. Individuals determine their amenity consumption through their location choice. Their sorting behaviour across neighbourhoods with different amenity levels may thus reflect heterogeneous preferences toward them. Using the amenity measure derived from the hedonic regression we estimate Equation 3.2.

$$a_{wik} = \delta y_i + \phi qual_i + z'\gamma + \rho_k + \eta_{wik} \tag{3.2}$$

The amenity consumption a_{wik} of individual i living in ward w in city k depends on the individual's net income y_i, qualification status $qual_i$, and a vector of control variables z containing age, gender and the number of children as well as job characteristics, such as whether the individual works full-time or part-time or in the public sector. It also contains a dummy on whether the worker receives any housing subsidy. The term ρ_k denotes a travel to work area fixed effect and the term η_{wik} captures all variation in the amenity measure that is not explained by the control variables.

As highly educated individuals tend to earn higher wages, it is important to include information on individual wages. Controlling for individual after tax wage nets out the income effect that may potentially drive the amenity consumption. Similarly,

other individual characteristics might have an effect on preferences towards amenity consumption. The willingness to pay for amenities may, for example, depend on family structure, age, gender and job characteristics. We include controls for these factors in our regression as they are likely to influence an individual's location choice. The inclusion of travel to work area dummies controls for all amenities that are specific to the labour market, such as employment possibilities, a nice climate or the availability of cultural venues. These factors might determine sorting across labour markets, such that differences in the consumption of amenities between education categories may instead be the result of differences in employment possibilities across cities. A city, such as London, for example, is characterized by high wages as well as high prices due to localized productivity advantages. The amenity measure derived in Equation 3.1 will, therefore, be higher for London than for other cities. As a result, university graduates would be systematically found to consume a higher amenity level than similar individuals without a university degree if they were over-represented in labour markets like London. All individuals living in the same TTWA have per definition access to the same level of TTWA amenities.

While it is plausible to expect that skilled individuals sort into better neighbourhoods because of a higher amenity level, it is also possible that this sorting behaviour influences the amenity level of a given place. The educational composition of local neighbourhoods may constitute an amenity per se meaning that individuals are prepared to pay a substantial premium to avoid educationally poor neighbourhoods independent of other locational attributes. To account for these aspects we augment Equation 3.2 by a vector of control variables κ that capture the socio-demographic structure of the neighbourhood.

$$a_{wi} = \delta y_i + \phi qual_i + z'\gamma + \kappa'\lambda + \rho_k + \eta_{wi} \tag{3.3}$$

Using information from the 2001 Census we calculate the share of university degree holders, the age and family structure (i.e. the share of married households, households with children etc.) and the ethnic composition of each ward. By including these additional controls we capture the amenity value that individuals place on the characteristics of their immediate neighbours.

Though, we are able to control for a long list of variables, unobserved non-labour income or wealth may bias our estimates. The skill coefficient ϕ in Equation 3.3

would be estimated with an upward bias if high skilled workers built up more wealth through savings or received larger intergenerational transfers.

We do not believe that this is a major concern to our analysis for several reasons. First, to the extent that wealth is built up from savings from labour income and that the propensity to save does not differ across education groups, accrued wealth will be independent from the level of education once labour income is controlled for.[9] Second, although it can be suggested that people from a more favourable family background inherit larger personal assets and that university graduates today tend to come from equally well educated families, we believe this issue is not the main driver of our results. In fact, as the share of university degree holders expanded rapidly during the last 40 years[10], many workers holding a university degree today are likely to come from a family background with lower educational attainment than themselves. This implies that the majority of skilled individuals in our sample are likely to have experienced, on average, similar intergenerational transfers than non-degree holders. For younger graduates, for whom intergenerational transfers are likely to differ, the introduction of student fees offsets their initial advantage towards the accumulation of personal wealth. Average debt on entry into repayment in England amounted to £15.000 in 2010 (Student Loans Company, 2014). At the pre-2012 fee regime, graduates were expected to pay off their debts only by their late 30s (Crawford and Jin, 2014). Recent graduates might, therefore, be even less wealthy than non-graduates earning a similar income.

Another issue that might introduce a bias into the results is the potential reverse causality between the share of highly qualified residents and the local amenity level. The inclusion of the neighbourhood skill level in Equation 3.3 accounts for the possibility that the neighbourhood composition is seen as an amenity per se but it is also possible that high skilled individuals first make their residential choices and then directly influence the local amenity level. We further address this possibility in the robustness section.

[9]The best-known economic theories of saving are the permanent income hypothesis (Friedman, 1957) and the life cycle hypothesis (Ando and Modigliani, 1963). These theories suggest that individuals save to smooth available income at different stages of their life. Alternative theories underline the importance of institutional factors, such as institutionalized saving mechanisms and targeted financial education (Beverly and Sherraden, 1999). These theories emphasise the importance of age as well as institutional factors as determinants of the saving rate, which are similar for both across education groups.

[10]Participation in higher education increased from 8.4% in 1970, 19.3% in 1990 (Robertson and Hillman, 1997), 33% in 2000 and 46% in 2010 (Ilochi, 2014).

3.5 Results

The first stage of our estimation approach is aimed at recovering an indirect measure of amenity by wards through the hedonic regression. The results of the hedonic regression of Equation 3.1 are shown in Table 3.2. In column (1) the log price per square metre is regressed on a set of housing characteristics, in column (2) TTWA fixed effects are included as additional controls and in column (3) ward fixed effect are included instead of TTWA fixed effects. Results in column (1) show that, as expected, detached houses are more expensive than semi-detached and terraced houses, freehold properties are more expensive than leasehold properties, buyers pay a premium for new and very old buildings and the sqm price decreases with the number of rooms. The positive sign for flats and maisonettes reflects the fact that flats are more common in expensive urban areas. In fact, once TTWA fixed effects are controlled for (column 2) the average price for flats is lower with respect to detached houses.

Differences in housing characteristics are able to explain 57% of the variation in square metre prices, the inclusion of TTWA fixed effects increases the R^2 to 80% and the inclusion of ward fixed effects (column 3) further increases the R^2 to 87%. This evidence suggests two key considerations. First, housing characteristics explain slightly more than half of the variation in prices and the remaining proportion is explained by other factors. Once TTWAs fixed effects are controlled for our hedonic regression increases its explanatory power substantially implying that a significant share of variation in prices depends on citywide characteristics. Finally, when we account for ward fixed effects the R^2 further increases which shows that there is substantial variation in prices both across and within cities. Figure 3.1 illustrates the within city variation of the amenity measure for four large cities: London, Birmingham, Leeds and Manchester. The areas correspond to TTWA boundaries. In the example of London the highest level of amenities, as measured by the index, is found in Westminster, an area known for its cultural life and concentration of historical buildings. Equally high values are found at the outskirts of London, for instance in Richmond. This outer borough of London is known for its large number of parks and open spaces and many protected conservation areas. The visual analysis as well as the plausibility check in Appendix C.1 imply that the composite amenity measure is able to capture actual amenities at a local scale.

Our second stage regression is reported in Table 3.3. It shows the baseline results of Equation 3.2 where the ward level amenity measure derived from the hedonic regression is used as dependent variable to analyse the link between the amenity level and skills.

The correlation between the skill dummy based on qualification and the amenity level is positive as shown in column (1). On average high skilled individuals have an amenity consumption that is 10% higher than that of lower skilled workers with a similar income. Including individual level controls in column (2) and TTWA fixed effects in column (3) reduces the difference to 7% and 6%, respectively.[11]

In column (4) we include the neighbourhood composition as additional control variable as described in Equation 3.3. The inclusion of these controls substantially reduces the size of the preference effect from 6% to 0.19% but the difference in the consumption of amenities between high and low skilled workers remains significant at the 5% level. We conclude that the composition of the neighbourhood in terms of socio-demographic characteristics makes up a substantial part of overall perceived neighbourhood quality and is especially valued by the high skilled.

The results in Table 3.3 indicate that for each income level high skilled households consume a significantly higher amenity level than low skilled households, as they choose to live in places characterised by a higher neighbourhood quality. Results remain consistent when we include individual and neighbourhood controls as well as travel to work area fixed effects. On average high skilled individuals have an amenity consumption that is 0.19% higher than that of lower skilled workers earning a similar income. In the case that the socio-demographic composition of the neighbourhood is considered as an amenity the difference amounts to 6%. Also, the consumption of amenities increases with income, implying that amenities are normal goods, which is in line with the assumptions made in urban economic theory (see for instance Brueckner et al. (1999)).

3.6 Robustness Checks

In Table 3.4 we present several robustness checks for our main finding. In column (1) we show results for full-time workers only. High skilled individuals in full-time

[11] As the difference in the amenity level is derived from a semi-log equation, the coefficients can be interpreted as approximate percentages. For small numbers the difference between the coefficient and the exponent of the coefficient on the graduate dummy is negligible.

employment might put more emphasis on job related location characteristics, such as proximity to their work place or good transport links rather than on neighbourhood amenities. Nonetheless, results show that the level of amenity consumption is 0.15% higher for high skilled workers in full-time employment relative to lower skilled workers in full-time employment.

We also split our sample into individuals living in urban, respectively, rural TTWA. The indirect amenity measure derived from the hedonic regression approach is likely to capture different typologies of amenities in urban and rural areas. Results are shown in columns (2) and (3). On average highly skilled individuals in cities choose to live in neighbourhoods offering an amenity level that is 0.2% higher than that of individuals with lower educational attainment. For rural areas the difference amounts to 0.25%.

Finally, we check whether the skill related preference for amenities holds across all age groups. Existing studies suggest that the preference towards amenities may depend on the stage of the life cycle (Chen and Rosenthal, 2008). We show results for prime aged workers between 25 and 40 in column (4) and for workers aged 40 to 55 in column (5). Younger highly educated workers tend to live in neighbourhoods offering an amenity level that is 0.32% higher than that of younger, less educated workers. For older workers the difference is not significantly different from zero. Over the lifecycle university graduates and non-graduates become more similar in terms of their preferences for amenities.

In column (6) we substitute the measure of skills that is based on qualification with a measure of skills based on occupation. Following the classification proposed by Elias and McKnight (2001) the standard occupational classification 2001 (SOC03) is used to derive a skill classification that classifies professionals and managers as highly skilled. The amenity preference effect is similar in size as for the education based classification and amounts to 0.22%.

We also run additional robustness checks to analyse the relevance of the potential reverse causality between the share of highly qualified residents and the local amenity level. This bias might arise as, for instance, a high share of high skilled residents might endogenously increase school quality in an area through peer effects. Parents who have a university degree tend to put more importance on formal education and might spend more time helping their children with school work. A similar reasoning applies to the case in which high skilled residents are more involved in improving

the quality of their neighbourhood, e.g., through the organization of neighbourhood watch schemes.

To control for this potential bias we split our sample according to the level of skill concentration in each neighbourhood. If collective action of high skilled residents endogenously increased the local amenity level we would in fact expect this mechanism to be strongest in neighbourhoods that have a high share of highly educated residents. Results are shown in Table 3.5. Column (1) shows results for individuals that live in neighbourhoods with a share of high skilled residents below the 25^{th} percentile with respect to the total number of wards. Column (2) shows results for individuals that live in neighbourhoods with a share of high skilled residents above the 25^{th} percentile and below the median. Similarly, columns (3) and (4) show results for the third and fourth quartile.

For all four quartiles we find a significant and positive difference in the amenity consumption for workers with different educational attainments. It ranges from 0.14% in the second quartile to 0.29% in the lowest quartile. If anything, the amenity preference is stronger in areas that have a lower concentration of high skilled workers, the endogenous creation of amenities by high skilled workers does not seem to be driving our results.

3.7 Conclusion

This paper contributes to the debate on factors that determine the location decision of highly qualified workers. It looks at the relation between amenities and skills and tests whether preferences for the consumption of amenities differ across education groups in UK cities. The empirical strategy relies on a two-stage estimation approach which is implemented using detailed micro-data on workers and local house prices.

Our results suggest that high skilled individuals consume a higher level of amenities than lower skilled workers who earn a similar income and that the consumption of amenities increases with income. This relation holds irrespective of unobserved cross-city characteristics and differences in the demographic composition of the neighbourhood, though, we find evidence that part of the preference bias can be explained by highly educated workers choosing to live close to similar people.

Our results are interesting for policy makers as they explain residential choices of

high skilled individuals and demonstrate a mechanism that may exacerbate segregation phenomena of disadvantaged education groups in low amenity neighbourhoods. Also, if the same sorting mechanism that we observe across neighbourhoods works in a similar way across cities it suggests that the availability of job opportunities is not the single most important factor for individual location decisions. Individuals tend to sort into cities that offer a wide range of amenities and the higher is the skill level the more important become local conditions in terms of quality of life. Finally, it is likely that demand for amenities will increase over time as they are normal goods and as households get richer they want to consume more of them. Policy makers can address this demand by improving local conditions, such as school and environmental quality, local green areas and a city's cultural life.

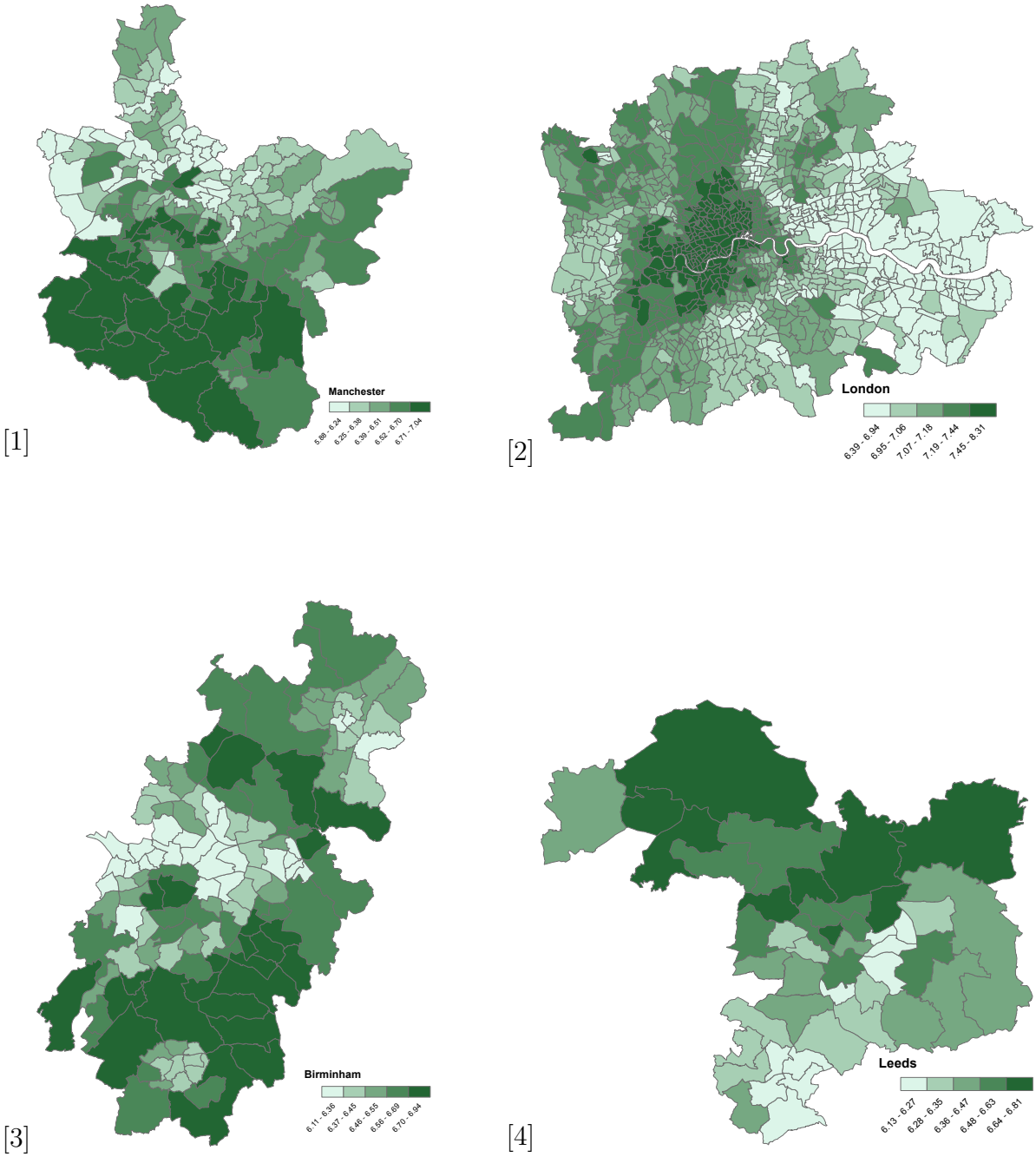

Figure 3.1: Amenity measure in selected cities: [1] = Manchester, [2] = London, [3] = Birmingham, [4] = Leeds.

Table 3.1: Variable description.

VARIABLES	Description	Source
Amenity level	Ward fixed effect derived from a hedonic regression of house prices on housing characteristics	Nationwide Building Society
Skill dummy based on qualification	Equals one if the individuals has a university degree	LFS
Skill dummy based on occupation	Equals one if the individual belongs to SOC00 11 or 21 - 24, or SOC90 1a or 2a - 2d (corporate managers and professionals) see Elias and McKnight (2001)	LFS
Weekly net wage	After tax weekly income from labour	LFS
Gender	Equals one for males	LFS
Marital status	Indicates whether the individual is single, married, re-married, separated, divorced or widowed	LFS
Age bands	Indicate whether the individuals is aged 20-29, 30-44 and 45-60	LFS
Country of birth	Indicates the individual's country of birth	LFS
Number of children	Indicates the individual's number of children under 19	LFS
Housing tenure	Indicates whether the individual owns or rents	LFS
Housing subsidy dummy	Equals one of the individual receives any housing subsidies	LFS
Full-time dummy	Equals one if the individual is in full-time employment	LFS
Survey years	Year when the individual was surveyed	LFS
Distance from the ward centroid to the TTWA centre	Distance refers to the geometric distance, the TTWA centre is defined as the output area with the highest population density in 2011	Census 2001, Edina
Share of female residents	Ward level shares of female residents	Census 2001
Share of highly qualified residents	Ward level shares of residents with a university degree	Census 2001
Share of households with children	Ward level shares of households with children	Census 2001
Age composition	Ward level shares of residents aged 0-19, 20-29, 30-44, 45-64 and 65+	Census 2001
Ethnic composition	Ward level shares of white, mixed, Asian, black and other ethnic residents	Census 2001
Marital composition	Ward level shares of single, married (married, re-married) and separated (separated, divorced, widowed) residents	Census 2001
Share of unemployed	Ward level share of unemployed residents	Census 2001
Listed buildings	number of listed buildings per ward (standardized with mean of zero and variance one)	English Heritage
Crime incidents	crime incidents per ward including antisocial behaviour, robbery, violent crime, damage and arson, public order and weapons and vehicle crime (standardized with mean of zero and variance one)	Home Office 2012
Restaurants and bars	number of establishments per ward with SIC07 equal to 56.10/1, 56.10/2, 56.30/1 or 56.30/2 (standardized with mean of zero and variance one)	BSD 2010
Share of park area	the share of the ward area that is covered by a park classified as listed park by the English Heritage	English Heritage
Library dummy	Equal to 1 if an establishments with SIC07 equal 91.01/1 is located in the ward	BSD 2010
Museum dummy	Equal to 1 if an establishments with SIC07 equal 91.02/0 is located in the ward	BSD 2010

Table 3.2: Hedonic regressions.

VARIABLES	(1) Ln(price/sqm)		(2) Ln(price/sqm)		(3) Ln(price/sqm)	
Semi-detached	-0.0674***	[0.0184]	-0.101***	[0.00319]	-0.0948***	[0.00218]
Terraced	-0.0949***	[0.0361]	-0.199***	[0.00545]	-0.172***	[0.00505]
Cottage	-0.0597	[0.0400]	-0.000391	[0.0361]	0.00698	[0.0323]
Detached-bungalow	0.0739***	[0.0138]	0.117***	[0.00678]	0.110***	[0.00305]
Semi-bungalow	0.0380*	[0.0230]	0.0498***	[0.00627]	0.0579***	[0.00402]
PB Flat	0.176**	[0.0861]	-0.130***	[0.0172]	-0.182***	[0.00986]
PB Maisonette	0.0902	[0.0571]	-0.276***	[0.0153]	-0.305***	[0.0135]
Conv Flat	0.332***	[0.105]	-0.037	[0.0449]	-0.145***	[0.0218]
Conv Maisonette	0.164	[0.101]	-0.138***	[0.0260]	-0.196***	[0.0163]
Feuhold	-0.0308	[0.0505]	-0.00659	[0.0166]	-0.0161	[0.0136]
Leasehold	-0.330***	[0.0833]	-0.0307*	[0.0161]	-0.0164	[0.0114]
bedrooms==2	-0.124***	[0.0136]	-0.0719***	[0.00749]	-0.0647***	[0.00754]
bedrooms==3	-0.214***	[0.0250]	-0.161***	[0.0118]	-0.152***	[0.00941]
bedrooms==4	-0.247***	[0.0374]	-0.215***	[0.0166]	-0.222***	[0.0116]
bedrooms==5	-0.255***	[0.0563]	-0.244***	[0.0260]	-0.268***	[0.0163]
bathroom==2	0.0438***	[0.0108]	0.00231	[0.00761]	-0.0170***	[0.00123]
bathroom==3	-0.000484	[0.00635]	-0.0329***	[0.00478]	-0.0413***	[0.00209]
double garage	0.0543***	[0.0137]	0.0539***	[0.00853]	0.0444***	[0.00359]
parking space	-0.0289***	[0.00665]	-0.0217***	[0.00373]	-0.0122***	[0.00206]
no garage	-0.0782**	[0.0391]	-0.0964***	[0.0219]	-0.0953***	[0.00709]
New property	0.0329***	[0.00407]	0.0586***	[0.00255]	0.0705***	[0.00274]
Age <1906	0.0681**	[0.0344]	-0.0298***	[0.00874]	0.00383	[0.00331]
Age [1906, 1930]	0.0520**	[0.0234]	-0.0195	[0.0138]	0.0178***	[0.00501]
Age [1931, 1944]	-0.0131	[0.0338]	-0.0635***	[0.0193]	-0.0308***	[0.00874]
Age [1945, 1970]	0.0423	[0.0389]	0.0216	[0.0145]	0.0618***	[0.00845]
Age [1970, 2011]	0.0438	[0.0362]	0.0707***	[0.0151]	0.128***	[0.00872]
First time buyer	-0.106***	[0.00613]	-0.0746***	[0.00510]	-0.0463***	[0.00133]
R-squared	0.567		0.795		0.867	
Ward FE	NO		NO		YES	
TTWA FE	NO		YES		NO	

Notes: Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1 Dep Var: log price per sqm, control include housing type, contract type, number of bedrooms, bathrooms and garages, a dummy whether the property is new at the time of the transaction, bands for the age of the structure and a dummy whether the owner is a first time buyer. Column (2) shows results with TTWA fixed effects, Column (3) shows results with ward fixed effects. Number of housing transactions = 1,283,934.

Table 3.3: Baseline regression to test for the amenity preference bias.

VARIABLES	(1) ward FE	(2) ward FE	(3) ward FE	(4) ward FE
Skill dummy based	0.0960***	0.0651***	0.0563***	0.00188**
on qualification	(0.0161)	(0.0109)	(0.00554)	(0.000869)
Weekly net wage	0.0808***	0.170***	0.0472***	0.00767***
	(0.0240)	(0.0424)	(0.00805)	(0.00109)
Constant	6.076***	5.860***	6.381***	7.761***
	(0.0656)	(0.0823)	(0.0242)	(0.490)
N	463,455	463,455	463,455	463,455
R-squared	0.046	0.157	0.801	0.930
TTWA FE	NO	NO	YES	YES
Individual level controls	NO	YES	YES	YES
Neighbourhood level controls	NO	NO	NO	YES

Notes: Standard errors are clustered by travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Dep Var: ward FE = ward level fixed effect derived from a hedonic price regression. In Column (2) individual level controls are added, namely gender, marital status, age bands, country of birth, number of children, housing tenure, a housing subsidy dummy, a full-time dummy and survey year controls and a variable measuring the geographical distance from the ward centroid to the TTWA centre. Column (3) also controls for TTWA fixed effects. In Column (4) neighbourhood level controls are added, namely the share of female and highly qualified residents, the share of households with children, age, ethnic and marital composition and the share of unemployed.

Table 3.4: Robustness checks of the amenity preference bias.

VARIABLES	(1) full-time ward FE	(2) urban ward FE	(3) rural ward FE	(4) age 25 - 40 ward FE	(5) age 40 - 55 ward FE	(6) Occ. ward FE
Skill dummy based on qualification	0.00150*	0.00200**	0.00252***	0.00321***	-1.32e-05	
	(0.000818)	(0.000928)	(0.000842)	(0.000721)	(0.00120)	
Skill dummy based on occ						0.00217*
						(0.00115)
Weekly net wage	0.0103***	0.00885***	0.00304***	0.00978***	0.00682***	0.00754***
	(0.00129)	(0.00113)	(0.000818)	(0.00175)	(0.000684)	(0.00117)
Constant	7.858***	8.008***	6.674***	7.924***	7.581***	7.760***
	(0.483)	(0.497)	(0.679)	(0.455)	(0.519)	(0.490)
N	350,152	357,380	106,075	222,027	187,046	463,331
R-squared	0.932	0.931	0.899	0.933	0.928	0.930
TTWA FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES

Notes: Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1 Dep Var: ward FE = ward level fixed effect derived from a hedonic price regression. Column (1) shows results for the subsample of full-time workers only, columns (2) and (3) shows results for the subsample of urban respectively rural workers. In columns (4) and (5) the sample is split into workers aged 25-40 respectively 40-55. Column (6) shows results for an alternative skill measure based on occupation. Control variables are the same as in Table 3.3 column (4).

Table 3.5: Sample split according to the level of skill concentration in each neighbourhood.

VARIABLES	(1) p25- ward FE	(2) p25 - p50 ward Fe	(3) p50 - p75 ward FE	(4) p75+ ward FE
Skill dummy based on qualification	0.00287*** (0.000732)	0.00140** (0.000706)	0.00197*** (0.000663)	0.00167* (0.000918)
Weekly net wage	0.00598*** (0.000673)	0.00450*** (0.000825)	0.00393*** (0.000946)	0.0108*** (0.00218)
Constant	5.759*** (1.425)	6.640*** (0.928)	7.457*** (0.776)	8.189*** (0.416)
N	115,875	117,883	102,889	112,576
R-squared	0.902	0.906	0.906	0.912
TTWA FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES

Notes: Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1 Dep Var: ward FE = ward level fixed effect derived from a hedonic price regression. Column (1) shows results for the subsample of individuals living in neighbourhoods with a skill concentration below the 25^{th} percentile. Column (2) shows results for individuals that live in neighbourhoods with a share of high skilled residents above the 25^{th} percentile and below the median. Column (3) and (4) show results for the third and fourth quartile. Control variables are the same as in Table 3.3 column (4).

Chapter 4

Local multipliers in local labour markets - A case study of the move of the German government to Berlin

4.1 Introduction

Substantial differences in economic performance exist across local labour markets within a country. Governments frequently use relocation programmes of public sector workers as a tool to address employment problems in declining regions. The main argument is that job relocation triggers local multiplier effects and, therefore, boosts regional economic performance. Each additional public sector job may increase demand for locally-produced goods and services. This increase in demand may trigger additional jobs in the private non-tradable sector. On the other hand, the new jobs might merely crowd out existing ones. Higher rents and wages increase local production costs which impede new business formation or hamper existing businesses' competitiveness. These general equilibrium effects may offset the multiplier effects. Evidence on their impact is, however, limited.

This project uses the move of the German government from Bonn to Berlin between 1999 and 2001 in order to investigate what effect prevails when jobs are relocated into local labour markets. We conduct the analysis at a fine geographical scale and use variation of employment changes within the city of Berlin to test for local mul-

tiplier effects. We use information from the German Establishment History Panel that comprises a 50% sample of Berlin establishments with at least one employee from 1992 to 2010. The dataset provides detailed information on employment at the postcode level.

Analyses of this kind are complicated by two factors: (1) the geographical spread of the effect is unknown a priori; (2) the locations are not randomly chosen. To solve these issues, we construct a set of treatment intensity measures that capture the geographical spread of the effect adapting from Gibbons et al. (2011a). Secondly, we control for a large set of initial economic and demographic characteristics and run robustness checks using locations that were chosen for historical reasons only. Our empirical strategy is a form of difference-in-difference estimation that takes the possibility of local spill-over effects into account. We compare employment changes in areas close to a relocation site with those further away for the year right before the start of the government move to the year when a majority of job moves had been realised.

Until now empirical evidence on the interaction between public and private sector employment is scarce and the existing evidence of the impact of public sector employment on labour markets finds contradictory results. Whereas Edin and Holmlund (1997) find that public sector employment reduces unemployment, Algan et al. (2002) find the opposite effect as public sector employment in the long run destroys private sector jobs. Both are macro-economic studies that use OECD country data. There are three studies that look at the experience of single countries using micro-data. Faggio and Overman (2014) made a first attempt to look at the impact of public sector employment on local labour markets. Analysing changes in total public sector employment for 352 English Local Authorities during the period 2003-2007 they find that public sector growth does not have any impact on total private sector growth. However, it changes the local composition of private sector jobs by increasing the share of private services. Similarly to our project, Becker et al. (2013) use the move of the government to Bonn after World War II as a source of exogenous variation. In line with the predictions of a standard economic geography model they find that an increase in public employment puts downward pressure on private sector employment. Micro level studies have only very recently become feasible due to high data requirements. Faggio (2013) is the first to analyse the effect of a public sector relocation programme on a very detailed geographical scale using Census

2001 Output Areas. She finds that in the UK the implementation of a public sector relocation initiative labelled the 'Lyons Review' has highly localised effects which disappear at a distance of two to three km from the relocation site.

Our work is also related to studies that look at spill-over effects from the tradable sector on the non-tradable sector. Moretti (2010) quantifies the long-term change in the number of jobs in a city's tradable and non-tradable sector generated by an exogenous increase in the number of jobs in the tradable sector. He finds that in the US 100 additional jobs in the tradable sector increase employment in the non-tradable sector by 160 jobs, whereas it has no effect on employment in other parts of the tradable sector. A similar study compares these figures to Sweden; here the multiplier effect amounts to 48 jobs for 100 additional jobs in the tradable sector (Moretti and Thulin, 2013).

Our study is of considerable interest for policy makers. It gives evidence on the suitability of public sector relocation programmes for addressing local employment problems. Despite the fact that governments frequently use these policies, evidence of their impact is scarce. The project also helps understanding uneven spatial impacts of changes in public sector employment, which are relevant for both public sector job creation and destruction – another highly debated topic. Furthermore, our project is highly relevant as a case study. The 1994 Bonn-Berlin Act specified that 50% of government employees have to remain in Bonn. Whether the law should be changed is frequently debated. This study helps to shed light on the possible impact for Bonn and Berlin should the German government decide to move the remaining ministries.

The rest of the paper is structured as follows. In Section 2 we give an overview of the historical setting and provide details on the relocation. In Section 3 we describe the empirical strategy. Section 4 presents the data used in the analysis. Results are shown in Section 5. Section 6 concludes.

4.2 Short description of the historical setting

When Germany lost WWII the country was divided into four sectors administered by the Four Powers, USA, Russia, UK and France. Similarly, the city of Berlin, which was the capital of Germany between 1871 and 1945, was jointly occupied. The cooling of the political climate between the Western powers and Russia led to

the division of Germany in 1949 into the Federal Republic of Germany (FRG) and the German Democratic Republic (GDR). Berlin was claimed by both states resulting in the situation shown in Figure 4.2 [L]: though Berlin was located in the GDR c. 130 km away from the West German territory, the West-Berlin zones occupied by the US, the UK and France became part of the FRG. The East-Berlin zone occupied by Russia became part of the GDR. From the West-German perspective the former capital was isolated and, therefore, unsuitable for government functions. Under the promise that Berlin would be made capital again as soon as the political situation changed, Bonn was chosen as new capital and seat of the government of the FRG. This 'provisional' situation lasted until reunification in 1990. A clause in the Unification Treaty (1990) signed by the German Democratic Republic (GDR) and the Federal Republic of Germany (FRG) agreed on making Berlin once again capital of united Germany. A year later it was decided to move the seat of the government back from Bonn to Berlin. The decision was unpopular and could only be reached by making large concessions to the city of Bonn, to compensate for the loss of status and economic power. Part of the agreement was a 'fair division of labour' between Berlin and Bonn implying that core government functions should take their seat in Berlin but the majority of government jobs should remain in Bonn. Additionally, Bonn should receive financial compensation as well as new functions and institutions of national and international significance. The initial plan was to move the government to Berlin within four years and to fully complete the move within at most twelve years (Deutscher Bundestag, 1991a).

Details on the implementation of the move where left open. By 1992 it became clear that moving the core government functions within four years was not feasible. What followed was a long discussion about the timing of the move and its costs. One motion proposed to stop any further government related investments in Berlin until the financial situation of the FRG had improved. Another proposed to postpone the move until 2010. Furthermore, a mass petition was organized to suspend a decision about the date of the move until the government had full knowledge of the costs and the financial situation of the state (Bund) and federal states (Länder) had improved (Deutscher Bundestag, 2010). This dispute created uncertainty among private companies that had started to invest in Berlin. In November 1993 40 national and international companies pointed at the breach of trust should the government cease its effort to press ahead with the move (Hoffmann, 1998, p. 213).

The passing of the Berlin-Bonn Act (1994) provided statutory security about the move to Berlin. Though it did not specify a concrete moving date, the act determined important details of the implementation of the move such as the definition of a 'fair division of labour' between Berlin and Bonn and concrete compensatory measures for the former capital. Six ministries should keep their first seat in Bonn[1] and get a second seat in Berlin; nine ministries should take their first seat in Berlin and keep their second seat in Bonn. Additionally, it was decided that the majority of ministerial positions were to remain in Bonn. It was only by November 1997 that the Federal Parliament (Bundestag) announced a moving date. The government was to take up its work in Berlin in September 1999. Until then the timing had remained heavily debated.[2]

A timeline summarizing the core events of the decision making process is shown in Figure 4.1.

The magnitude of the relocation

Parliament and government officially started their work in Berlin in September 1999. Table 4.1 gives an overview of the number of relocated jobs from Bonn to Berlin. In total c. 15.000 government related jobs were relocated. An additional 10.000 positions related to foreign representations, the media, political parties and interest groups followed suit. At the same time Berlin experienced significant outflows of public sector jobs. A commission that had been established shortly after reunification to make recommendations on the redistribution of federal offices across those federal states, that used to be part of the GDR (new Länder), decided to relocate several Berlin based institutions. Berlin also lost several of its institutions to compensate Bonn for its employment losses. This situation is depicted in Figure 4.2 [R]. Adding up positive and negative job movements, results in a net gain of c. 18.000 jobs for Berlin. Those jobs did not correspond to the number of relocated workers as employees were given the choice whether they would like to follow their job to Berlin or take on a position in one of the federal institutions that were relocated to

[1] Federal Ministry of Defence (BMVg), Federal Ministry of Health (BMG), FM of Food, Agriculture and Consumer Protection (BMELV), FM of Economic Cooperation and Development (BMZ), FM for the Environment, Nature Conservation and Nuclear Safety (BMU), FM of Education and Research (BMBF)

[2] For instance, in the September 1996 50 MoP of SPD and BÜNDNIS 90/DIE GRÜNEN brought in the motion to postpone the move by at least 5 years.

Bonn as part of the compensation measures.[3]

The timing of the relocation

The relocation period was spread across several years, though the majority of jobs had moved by the official relocation date or shortly after as can be seen in Figure 4.3. Government employees essentially moved in 1999 and 2000. By the end of 2000 more than 8000 ministerial employees as well as c. 5300 employees of the administration of the federal parliament, parliamentary groups and deputies and their assistants were located in Berlin. Since the Federal Assembly (Bundesrat) had revised its decision to stay in Bonn in September 1996 all federal states equally established a representation in Berlin. The majority of embassies chose to be present in Berlin when the German government took up its work in 1999 and many more arrived in the following years. Some of them had made short term arrangements to accommodate their staff such as renting offices and using facilities of their consulate generals and branch offices as well as former military missions until they could rebuild or construct a suitable building for their representation (Gehrcken, 2013). The relocation of institutions out of Berlin is comparatively spread, taking place mainly between 1996 and 2004.

The choice of location within the city of Berlin

The location decision for the government institutions was heavily debated. While the airport of Tempelhof was proposed as a possible site for parliament due to the availability of unbuilt land the final site was chosen for historical reasons. To keep the costs of the move as low as possible many ministries were accommodated in existing housing stock. Embassies used the facilities of their consulate generals and branch offices as well as former military missions. Though, the diplomatic building stock in Berlin-West had been almost entirely destroyed between 1939 and 1945[4] many countries still owned a parcel of land in Berlin that they had purchased almost a century ago. The former embassies in the GDR located in Berlin-East had closed in 1990 or were used as consulates. Some reopened later on as representations in the

[3]Approximately 34% of government employees decided to stay in Bonn, most of them were public sector workers of lower or middle grade.

[4]In the course of the construction works for the NS capital 'Germania' several embassies had been demolished. For some the planned reconstruction never materialized as diplomatic relations broke off during WWII. Severe bomb attacks destroyed a large number of buildings in the Tiergartenviertel (Fleischmann, 2005)

FRG. Today 163 states are represented in Berlin by 158 embassies and five honorary consulates. It were therefore mainly historical factors that determined the location pattern of the government and related institutions.

4.3 Empirical Analysis

We are interested in the change in private sector employment after the relocation of public sector jobs to Berlin. A change in private sector jobs can either arise through existing firms hiring or laying off workers or firms entering or leaving an area within the labour market. To capture both channels the analysis is done on the postcode level rather than the firm level. Studies that look at the effect of job relocations are complicated by two factors. First, the geographical spread of the policy is unknown a priori. To solve this issue, we construct a measure of treatment intensity that is a non-parametric function of the distance to a relocation site following Gibbons et al. (2011a). For the construction of the treatment intensity variables we measure the number of relocated jobs in each postcode as well as the number of relocated jobs in 1 km wide distance bands starting from the postcode boundary. This approach allows the relocation of public sector institutions and public sector jobs into an area to affect surrounding areas and the impact to differ by distance. For instance, local businesses such as restaurants or other local services might benefit from a higher number of customers in the area and thus hire more workers. It might also be the case that firms such as consulting or law services decide to relocate after the intervention in order to benefit from proximity to the public sector. As a consequence the number of jobs would increase in areas close to the public sector institutions.
Second, when implementing relocation programmes of public sector jobs that aim at improving local employment conditions, locations are not randomly chosen. We argue that this concern is much weaker in our analysis than in related studies as the relocation of the government from Bonn to Berlin was not aiming at improving local economic conditions in specific neighbourhoods. As discussed in the historical section the location choice of government institutions was largely determined by historical factors. The seat of the government was chosen to be located next to the former Reichstags building, embassies still owned representations or parcels of land dating back to the time of the German empire or in the former East back

to the 70s when the GDR was internationally acknowledged. The Federal institutions selected to compensate Bonn for its loss of employment were chosen to allow government employees who did not want to move to Berlin to keep a similar job in Bonn (Bornhöft et al., 2001)[5]. Their specific location in Berlin was not a factor in the decision making process. Still due to the sheer size of the relocation one of the necessary conditions was the availability of a sufficiently large number of offices or buildings suitable to be converted into offices and land suitable for the construction of the main government buildings. In our empirical strategy we address these issues by controlling for time-invariant postcode characteristics, and for differences in pre-existing employment trends.

We apply a difference-in-difference strategy where we compare employment changes in postcodes receiving relocations at different distances with postcodes further away from any relocation. We include treatment intensity variables for six distance bands. A standard difference-in-difference strategy would not allow for the possibility of employment spill-overs as it compares areas that were directly treated with those not receiving any direct treatment. Equation 4.1 shows the specification to analyse the effect of public sector relocations at varying distances from an area on local private sector employment in the specific area.

$$\Delta \text{priv}_{pt} = \beta_1 \Delta \text{pub}_{pt} + \sum_{d=1}^{6} \gamma_d \Delta \text{pub}_{pt}^{d} + \sum_{j=1}^{J} \delta_j x_{p,t-n}^{j} + \Delta^{*} \text{priv}_{p,t-n-1} + \Delta \epsilon_{pt} \quad (4.1)$$

Δ denotes a long lag operator, i.e. $\Delta \text{priv}_{pt} = \text{priv}_{pt} - \text{priv}_{pt-n}$. $\Delta \text{priv}_{p,t}$ is the change in private sector employment between time t-n and t in postcode p, Δpub_{pt} denotes the number of public sector jobs received by postcode p between time t-n and t and $\sum_{d=1}^{6} \gamma_d \Delta \text{pub}_{pt}^{d}$ denotes the number of public sector jobs that relocated within a certain distance of postcode p between time t-n and t. The equation is augmented by a set of control variables denoted by the vector $x_{p,t-n}^{j}$. For each postcode p the log of total employment as well as the share of part-time employees, different age, gender, occupation and education groups are included using levels at time t-n. Δ^{*} denotes another lag operator. $\Delta^{*} \text{priv}_{p,t-n-1}$ refers to private sector employment changes prior to the relocation period and $\Delta \epsilon_{pt}$ denotes the error term.

In our analysis we take differences of private employment between 1998 and 2002,

[5]The Federal Cartel Authority (Bundeskartellamt) for instance was moved to Bonn to provide an alternative possibility of employment for employees of the ministry of economics. All these decisions were independent of the local employment situation in Berlin

i.e. t-n=1998 and t=2002. As shown in Figure 4.3 net job turnover in Berlin was highest in 1999, 2000 and 2001. The chosen years correspond to the time just before and after the highest treatment intensity. A short differencing time span is of advantage, especially in the case of Berlin which was going through a time of structural change, making it less likely that ongoing trends confound the estimates.

$\sum_{d=1}^{6} \gamma_d \Delta \text{pub}_{pt}^{d}$ refers to a set of spatially lagged treatment intensity variables. They measure all public sector employment that has been relocated outside a given postcode up to a distance d.[6] Using ArcMap we construct five one kilometre wide rings from the postcode boundary and an additional ring ranging from five kilometres to 15 km.[7] As we know the exact geographical location of each institution that received public sector employees we can count the number of jobs that fall into each ring. The spatially lagged treatment intensity variables are constructed in a cumulative way. $\Delta \text{pub}_{pt}^{1}$ refers to all relocations within a 0-1km distance band from the postcode boundary, $\Delta \text{pub}_{pt}^{2}$ refers to all relocations within a 0-2km distance band from the postcode boundary (including relocations considered in the 0-1km ring), $\Delta \text{pub}_{pt}^{3}$ refers to all relocations within a 0-3km band (including relocations considered in the 0-1km and 1-2km rings), and so forth. The outer ring $\Delta \text{pub}_{pt}^{6}$ refers to all relocations within a 0-15km band from the postcode boundary. Including separate 1km wide rings would give the same results, however, the cumulative definition of the treatment intensity variables simplifies the comparison of the coefficients and thus the interpretation of the results. In the cumulative specification the coefficients capture the total effect of all relocations within the given distance ring, whereas in the case of separate 1km wide rings all coefficients would have to be added up to get an estimate of the total effect. If relocated institutions are likely to engage more frequently with surrounding private businesses we expect the multiplier effect to be strongest in the closer rings.

Table 4.2 compares 1998 levels of the employment structure for postcodes receiving relocated jobs and postcodes not directly receiving relocated jobs. While age shares for employees are similar for postcodes receiving a relocation and those not receiving a relocation, there are significant differences in the number of total em-

[6] We treat the two central postcodes as 'seed' locations which are not affected by employment relocations into surrounding postcodes to avoid multicollinearity problems in the treatment intensity variables. Given the intensity of direct treatment these postcodes received it is less likely that spill-overs accounted for employment growth within these postcodes

[7] We use the 'buffer' tool in ArcMAP to construct the rings.

ployees and the share of full time employees between the two groups. Occupation and qualification shares are comparable apart from the share of workers in professional occupations and highly qualified workers. The inclusion of the employment structure variables controls for their potential impact on changes in employment. For instance, postcodes that had a large number of employees might have experienced faster employment growth than postcodes with fewer employees. We take 1998 levels of these variables which correspond to a year prior to the start of the relocation.

In Equation 4.1 we estimate the effect of changes in the number of public sector jobs on changes in the number of private sector jobs, considering changes that occur simultaneously. In the robustness section we explore the possibility of long term effects by looking at differences over a longer time span.

4.4 Data

Information on employment is taken from the weakly anonymous Establishment History Panel (EHP) (see Gruhl et al. (2012)). The dataset is assembled by the Institute for Employment Research (IAB) and holds information on a 50% random sample of all German establishments employing at least one worker on the social security records. The time span of the panel ranges from 1975 - 2010 for former West-Germany and from 1991 - 2010 for the New Länder. Variables include the number of employees of each firm and the number of employees in each of the following categories: age bands, gender, qualification class, occupation (1 digit) and nationality each split further down into full and part time workers. Information on wages include the median wage at firm level for full time workers, as well as the 25^{th} and 75^{th} quartile. The same quartiles are provided for female workers, and workers holding different level of qualification (high, medium, low, unknown). Additional variables include the date of market entry and exit as well as a time consistent industry classification code (3 digits).

For this project, we restricted the data to Berlin only and, in cooperation between LSE and IAB, enhanced it by postcode information which is not part of the EHP.[8] All Berlin establishments were linked with one of 190 Berlin postcodes, which are

[8]The enhanced dataset is not part of the standard data portfolio of the Research Data Centre. Access for replication studies is possible after successful application. Contact the RDC at iab.fdz@iab.de for further advice.

the main unit for our spatial analysis. While the data is generally available at the establishment level there is one complication. A firm owning several establishments of the same 5-digit industry code within one municipality has to register them under a single ID and address. We further discuss possible implications for our results in the robustness section. Observations for two postcodes had to be dropped out of confidentiality reasons as the specific postcodes contained less than 20 establishments.

The official start of government activities in Berlin was the 1^{st} September 1999. Estimates of the total number of jobs that were destined to relocate were frequently cited in the media as well as in the general discussion in parliament. For our analysis this information are indicative but of little concrete use as the relocation of the government and related institutions along with their employees was spread over a much longer time span and information on the spatial distribution of these jobs within Berlin was not provided. Due to the lack of official sources on public sector employment we collected information on the number of jobs of each relocating institution, the year the institution moved in or out of Berlin and the new address of the institution in Berlin respectively the former address in Berlin of those institutions that were relocated to Bonn and the New Länder.

We were able to collect the numbers of government employees working in Berlin in 1997, 1999, 2001, 2004 which were taken from official documents (BT-Drucksache) and an issue of the 'Spiegel', a weekly newspaper (Bornhöft et al., 2001). The number of relocated jobs of federal institutions was also taken from official documents (BT-Drucksache). The 'Berliner Zeitung', a daily newspaper based in Berlin published information on the number of employees in the federal administration and parliamentary groups, as well as the number of deputies and their employees in 1999. We attributed 1998 employment levels to the Länder representations which were published in the Generalanzeiger, a local newspaper in the Bonn region. The Ministry of Foreign affairs (Auswärtiges Amt) publishes each year a list of diplomatic staff in foreign embassies that have a representation in Germany. From these documents we took the number of diplomatic staff in Germany in 1996. As the documents do not contain any information on members of the embassy administration and technical support staff we assume that their number is proportional to the number of diplomatic staff and estimate the total number of workers in each embassy based on the number of people registered at the Ministry of foreign affairs

in 1998.

We attribute the number of jobs to a Berlin postcode by checking the address of the institution receiving employment in the specific year. Addresses were taken from registers that publish information on all public institutions in Germany. These address registers are published every year. In the case of an institution having multiple sites we attribute all employment to the main address.[9] An overview of the sources of the number of relocated jobs, the address and relocation timing is provided in the appendix.

Figure 4.4 shows the distribution of the number of jobs relocated between 1999 and 2001 across 190 postcodes in Berlin. The map shows aggregate numbers of relocated jobs for each postcode. Although, we have exact addresses for the relocated institutions, we perform the analysis at the postcode level, as this is the smallest spatial unit available in the EHP. Postcodes differ in size, the median postcode measures about 3 km^2, the smallest postcodes is about 0.4 km^2, the largest is about 35 km^2. 30 out of 190 postcodes received a positive public sector employment shock; eight postcodes received a negative shock. Relocated employment per postcode ranges from -813 employees in postcodes that lost an important federal institution to c. 5200 employees in a postcode in Berlin 'Mitte', the most centrally located district in Berlin, where several ministries and embassies are clustered. The number of treated postcodes in Western Berlin is higher than in the East. The total employment that the areas west and east of the former line of the Berlin Wall received is balanced, though, as the postcode with the highest number of received public sector workers lies in the east. All federal institutions that were moved out of Berlin were geographically spread across West-Berlin as they fulfilled administrative tasks for the FRG during the time of division. The eight postcodes that lost public sector workers are therefore spread across western postcodes of the city.

We first undergo a plausibility check to verify the addresses and employment data we collected from independent sources. Instead of using the change in private sector employment as the dependent variable we regress the change in employment in the public administration (SIC code 75) and foreign organisations (SIC code 99) on the number of relocated jobs related to the move of the government. If the Establishment History Panel comprised all employment we would expect that each relocated

[9]Latitude and longitude are added to the data using the online georeferencing tool provided at http://www.gpsvisualizer.com/geocoder/.

government and embassy job would increase employment in these industries by one. The results in Table 4.3 column (1) indicate that postcodes to which we attribute public sector jobs experienced a significant increase in employment in the public administration and international organizations. The correlation of the employment changes that were measured using two independent sources amounts to 0.81. As public servants and embassy employees are not subject to German social security and thus do not appear in the EHP, it is reasonable to find a coefficient smaller than one.

The plausibility check indicates that public sector employment as measured by employees in the public administration and foreign organisations increased in those areas that received government institutions. Receiving public sector workers in the surrounding buffers has, as expected, no impact on employment changes as shown in column (2). The fact that we attribute relocated employment to an institutions primary address does not seem to introduce any spatial measurement error. This suggests that the majority of jobs are located at the primary location. The data we collected is still likely to suffer from measurement error, as for instance, the estimate of jobs in each embassy is based on several assumptions. This error will bias our estimates towards zero and the presented evidence is therefore likely to be a lower bound of the true impact.

We also use Equation 4.1 to analyse the effect of the government relocation on private organizations that are directly linked to government activities such as lobbying organisations and trade unions. Through the industry classification code 911 and 912, these organizations can be identified in the EHP.[10] From other sources it is known that most interest groups moved from Bonn to Berlin along with the government. Table 4.3 shows that there is a positive effect of a change in public sector worker employment on the number of employees working for interest groups within the same postcode. The relocation of 100 government workers let on average to the move of 5.5 lobbyists as shown in column (3). The inclusion of the non-parametric treatment effects slightly decreases the main effect but none of the spatial spill-over coefficients is significant. These findings indicate that interest groups locate in direct proximity to government institutions rather than in areas further away. Given the aim of lobbying organization to influence the political process, this finding is as

[10]This classification encompasses activities of business, employers' and professional organizations, activities of trade unions and activities of other membership organizations

expected.

Those postcodes to which we attributed public sector jobs from the historical sources experienced employment growth in the public sector relative to those postcodes to which we didn't attribute any jobs. We don't find any correlation between public sector jobs relocating near the postcode boundary on employment in the public administration. We are thus confident that the data we collected and the addresses we attributed to each institution give a realistic description of the spatial distribution of the actual employment shock.

4.5 Results

Table 4.4 shows estimation results of Equation 4.1 for the change in total private sector employment between 1998 and 2002. In column (1) private sector employment change is regressed on the relocation within the same postcode as well as the treatment intensity variables only, column (2) includes postcode level controls and column (3) also controls for pre-trends in private sector employment growth between 1995 and 1997. The table shows that public sector jobs generate jobs in the private sector in areas close to the relocation site. 100 new public sector jobs create on average 54 private sector jobs in the postcode receiving the relocation. The effect is significant at the 10% level. We also find a significant effect of public sector jobs moving into proximity of private sector firms. The relocation of 100 public sector jobs into a 1 km wide distance ring around the postcode boundary increases private sector employment in that postcode by approximately 33 workers. This spatial spill-over effect is significant at the 1% level. Job relocations more than 1 km away have no additional effect, relative to areas at a distance of 5 to15 km away from any relocation site. A variable capturing the distance to the former Berlin wall as well as the inclusion of a dummy that takes value one for former West-Berlin postcodes in columns (4) and (5) do not alter the results.

The results in Table 4.4 show that a significant multiplier effect exists. The relocation of public sector workers generates additional jobs in the private sector. This effect is highly localised but reaches further than the postcode boundary. Postcode sectors have been drawn to facilitate the delivery of mail and do not necessarily correspond to local clusters of economic activity. The non-parametric specification provides a flexible approach. It takes into account that postcodes are not self-contained

units while it is able to identify the spatial reach of the employment shock. This also explains why the effect is more significant for employment relocations in a 1 km wide ring, as this ring might result in a better approximation of the local concentration of employment than the actual postcode boundary.

The effect comes entirely through job creation in the service sector. Table 4.5 shows results for the split of total private employment into manufacturing and services. Postcodes directly receiving or in close proximity to public sector relocations did not experience a change in manufacturing employment significantly different from changes in postcodes located further away as shown in column (1). Job changes in private services were much more pronounced in and around the receiving areas as shown in column (2).

To understand which service sectors grew due to the relocation of public sector employment, the partition is refined in Table 4.6. The interaction might be the result of interactions between public institutions and private businesses, or it might be the case that it is the result of newly arrived employees consuming local services and goods.

We find evidence for both channels: the relocation of public sector institutions increases employment in private businesses and trade (comprising retail and wholesale activities) as well as employment in the real estate sector and personal services. The most important channel for the employment multiplier are business to business activities. Out of the total of 53 jobs that are created in the immediate proximity to a relocation site of 100 public sector workers 25 are created in the private business sector as shown in column (6). Government institutions demand services from consulting or law firms which increases employment in these specific sectors.

Furthermore, three additional jobs for 100 public sector workers are created in the real estate sector (column (5)), 4.6 in trade (column (1)) and 1.5 in the personal service sector (column (8)). The arriving government employees might provide the customer basis for local restaurants, cafes or retail shops. Also, as noted in the data section, mainly high skilled workers decided to move to Berlin along with their job. These workers might favour proximity to work and are more likely to substitute housework through professional services. Workers might therefore look for apartments close to their work place, which increases retail activity in areas close to government institutions. Similarly, these workers might have a high demand for personal services, such as laundry services or hair dressers which explains the sig-

nificant results for these industry sectors.

The hotel and restaurant industry might be expected to increase employment in response to the relocation, as well. Business clients visiting public institutions might stay overnight and the greater local workforce might increase local demand for catering. We do not find any significant employment increase in areas close to relocation sites in these sectors. The reason is most likely that both sectors have been growing rapidly in the years prior to the relocation, as becomes evident when looking at the large and highly significant pre-trend coefficient.

4.5.1 Falsification test

Berlin has experienced several dramatic changes during the last decades. The fall of the Berlin Wall in 1989 and the subsequent reunification of East- and West-Germany had a strong effect on the Berlin economy. The move of the government took place less than 10 years after these events during which Berlin went through a phase of economic and social transformation. We therefore undertake additional checks to show that the employment multiplier effect we find is due to the relocation of the government and not to ongoing transformation processes that were triggered by the reunification. To rule out the possibility that the effect we find is due to spatially differentiated employment growth that happens to coincide with the sites of the government we apply Equation 4.1 to the time period before the move of the government took place. Ideally we would like to use a time period before the decision of the move of the government was made. However, as shown in Figure 4.1 this date coincides with the reunification and before 1991 there are no data available for East-Berlin.[11]

As discussed in the historical section, the timing of the move was very uncertain until the last moment due to the strong opposition against the relocation project by politicians as well as the general public. It was only in 1997 that a final moving date was announced. We therefore use the period before the decision on the final moving date for our falsification test, i.e. we use private sector employment growth between 1995 and 1997 as the dependent variable in our specification. This specification still allows us to control for pre-existing trends in employment changes and we include 1993 to 1994 differences as a control.

[11] We exclude years 1991 and 1992 from the analysis because of data problems relating to the introduction of the employment notification procedure in the federal states of eastern Germany.

Results for private sector employment, manufacturing and services are shown in Table 4.7. We do not find evidence for stronger employment changes in postcodes that were to receive public sector institutions in later years. Before the move of the government to Berlin the treatment intensity variables had no effect on changes in the private, manufacturing or service sector. As for the main multiplier effect we split the service sector according to different industries shown in Table 4.8. The positive effects on employment changes in trade, real estate, business and personal services in the postcodes receiving the relocation are not present in the years prior to the relocation. These results suggest that ongoing transformation processes that were triggered by the reunification do not drive the employment multiplier, as the effect only shows up after the relocation of the government.

4.5.2 Further robustness checks

As an additional robustness check we assess the role of the bandwidth for our results. In the baseline specification we opted for 1km distance bands. If the distance band is chosen to be very wide, localised effects are not captured. If the distance bands are very narrow it might be the case that no additional relocations occur at the specific distance. In Table 4.9 we assess the robustness of our results when we use 1.5km, 2km, 2.5km and 3km wide distance bands instead of 1km wide bands. The choice of the width of the distance band does not change the size of the effect of relocations within the postcode boundary on changes in total private employment within the postcode. The coefficients in columns (1) to (3) are very close to the baseline coefficient of 0.53 estimated in Table 4.4. The wider the choice of the bandwidth, the weaker is the effect of relocation sites located within the first distance band from the postcode boundary. Whereas the effect is around 33 private sector jobs for 100 relocated public sector jobs at a distance of 1km it decreases to 12.8 for a 1.5km wide distance band, to 9.8 for a 2km wide distance band and goes down to 5.3, respectively 2.5, when a 2.5km or 3km wide distance band is chosen.

As an alternative to distance bands of different widths we also experimented with parametric weighing functions, which allocate a weight based on the inverse distance measured from each postcode to each postcode that receives a relocation. In Function 1 we use the absolute inverse distance, in Function 2 we use the squared inverse distance. We calculate the treatment intensity of a postcode as

$treat_p = \sum_{i=1}^{190} \frac{1}{dist_{ij}+1} \cdot \Delta emp_j^{reloc}$ respectively $treat_p = \sum_{i=1}^{190} \frac{1}{(dist_{ij}+1)^2} \cdot \Delta emp_j^{reloc}$ and use this variable as the independent variable in Equation 4.1. Results for private sector employment as well as the industrial split are presented in Table 4.10. For each industry sub-sample we contrast the effect of the treatment variable according to distance Function 1 and distance Function 2 on changes in employment between 1998 and 2002 with the effect of the treatment variable on changes in employment between 1995 and 1997 as a falsification test.

The same industries that react to the public sector relocation using the non-parametric specification show significant employment growth when using the treatment intensity according to a distance weighing function. For each 100 public sector employees weighted by the inverse of their absolute distance to the postcode private sector employment increases by 32 workers and by 50 workers if the weight is chosen as the inverse of squared absolute distance. The effect is very similar for private service employment. As in the case of the non-parametric regression significant effects are found for the real estate sector, private businesses and personal services. Using the weighing function we also find a significant effect on employment in finance whereas we fail to replicate the effect on trade. In the falsification test all significant effects disappear.

As mentioned in the data section, another concern that might impact our finding is that we attribute addresses of multi-site firms to the headquarter address. There might be a tendency that this address is in the centre of Berlin, where the public employment shock is largest. As a result private sector employment increases in proximity to public sector institutes might seem larger than they actually are, given that the true change is spread across multiple sites. We do not think that this form of measurement error drives our results for two reasons. First, since the error is symmetrical, a shrinking multi-site firm would induce a measured employment decline in the centre that is stronger than the true one. Since overall employment was declining in Berlin throughout the study period, this negative bias would arguably outweigh any positive ones. In this case, our positive local employment effects would constitute a lower bound to the true effect. Second, since the measurement problem for multi-site firms also existed during the placebo period before the government move, any strong bias into one direction should show up in our falsification test. This is not the case. We therefore conclude that the measurement problem is unlikely to have a significant impact on our results.

4.6 Conclusion

We quantify the local multiplier effect of a public sector shock on private employment using the move of the German government from Bonn to Berlin as a natural experiment. We find a significant positive effect of public sector employment that relocated into the postcode or within a distance of 1 km from the postcode boundary on private sector jobs. The relocation of 100 public sector workers into a postcode results in an employment gain of 53 in the private sector. We find evidence of spatial spill-over effects: public sector employment relocation into a 1km wide distance ring measured from the postcode boundary increases private sector employment within the postcode by an additional 33 jobs for each 100 public sector jobs. Separating private sector employment into services and manufacturing we find that the effect comes through job creation in the service sector only. For manufacturing jobs we find neither evidence for a multiplier nor for a crowding out effect.

We find no such effect on private sector employment during the years leading up to the relocation. Employment changes between 1995 and 1997 are not correlated in any significant way with the future relocation. The results are furthermore robust to the choice of the width of the distance band as well as parametric weights for the relocation sites impacting postcode level employment at different distances.

Our results help understanding the geographical spread of employment multipliers. Similarly to the literature on external economies of agglomeration (see Rosenthal and Strange (2008b); Arzaghi and Henderson (2008)) we find that employment spill-over effects attenuate with distance. This indicates that job relocation can be used as a very local economic development policy.

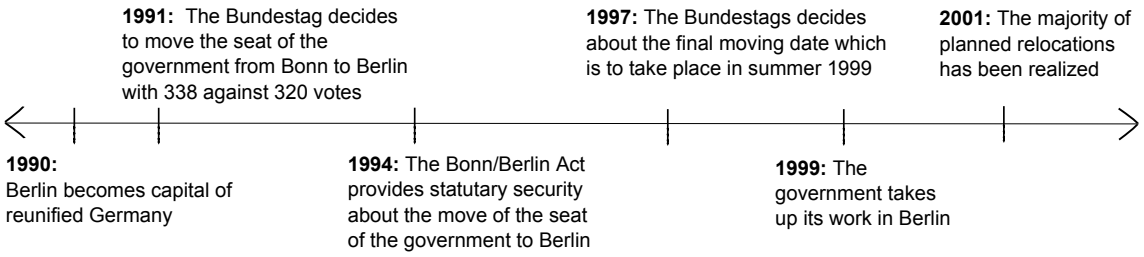

Figure 4.1: Timeline of the decision making process.

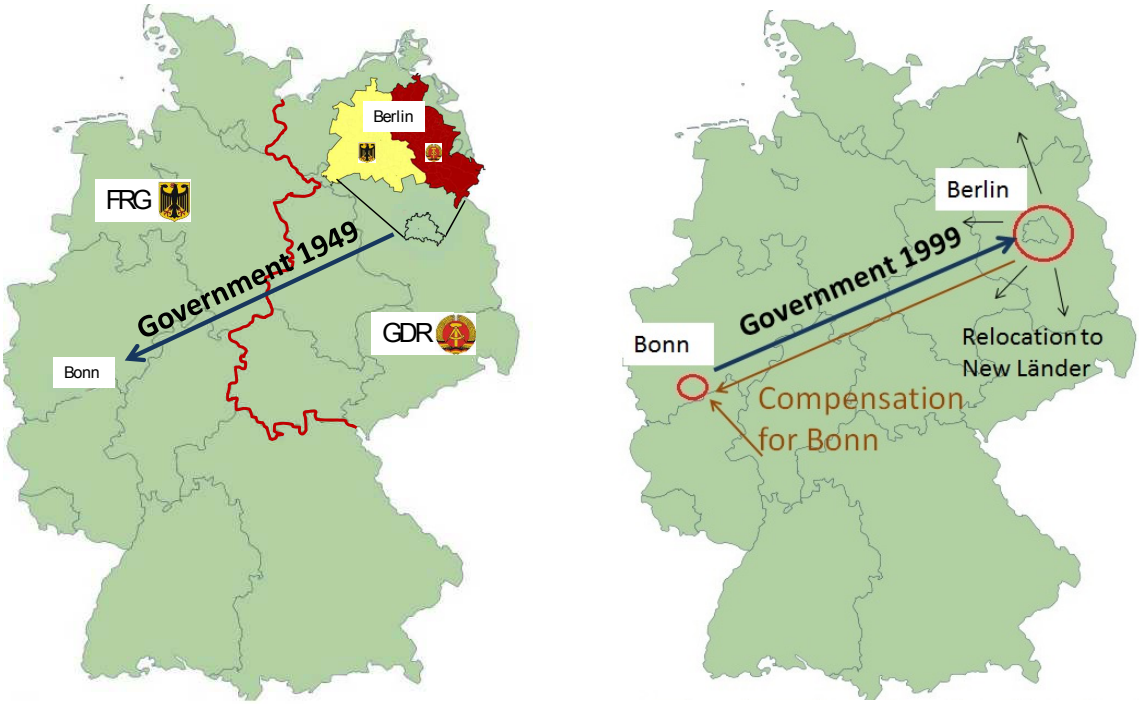

Figure 4.2: Historic setting - [L] Period of division lasting from 1949 to 1990. [R] Implementation of the move of the government from Bonn to Berlin.

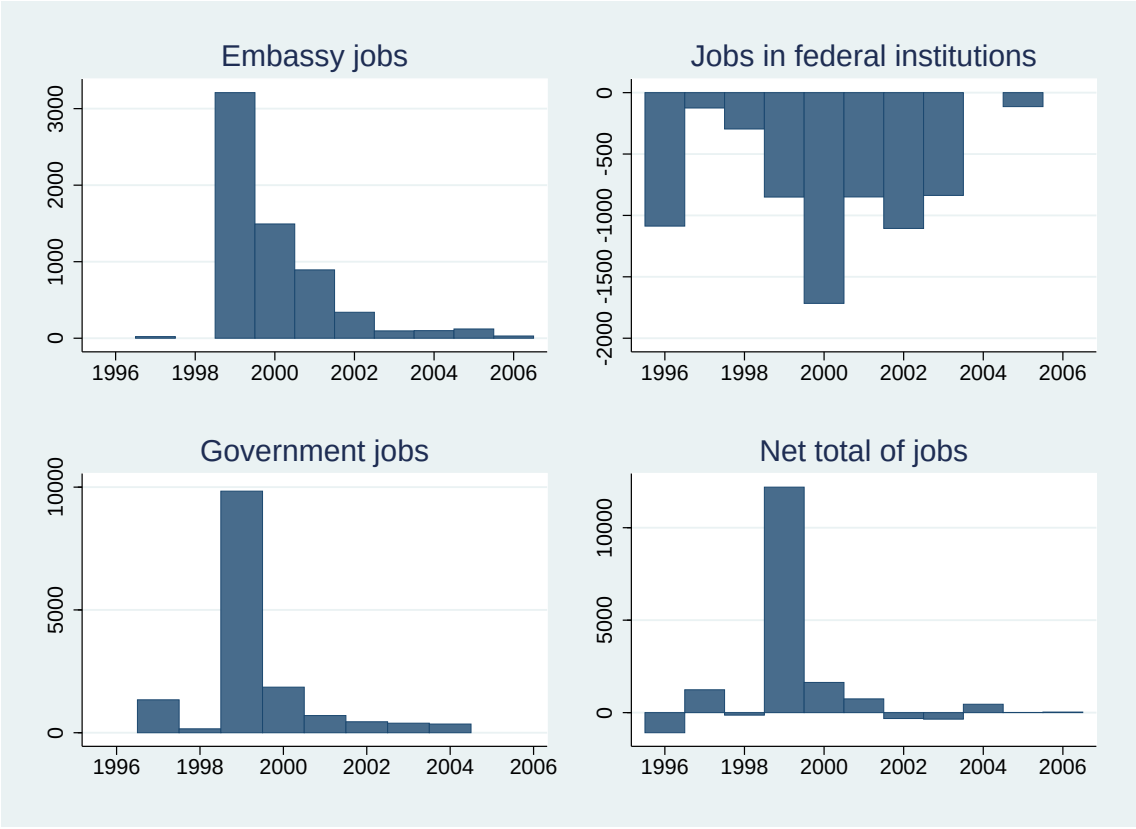

Figure 4.3: Timing of the relocation

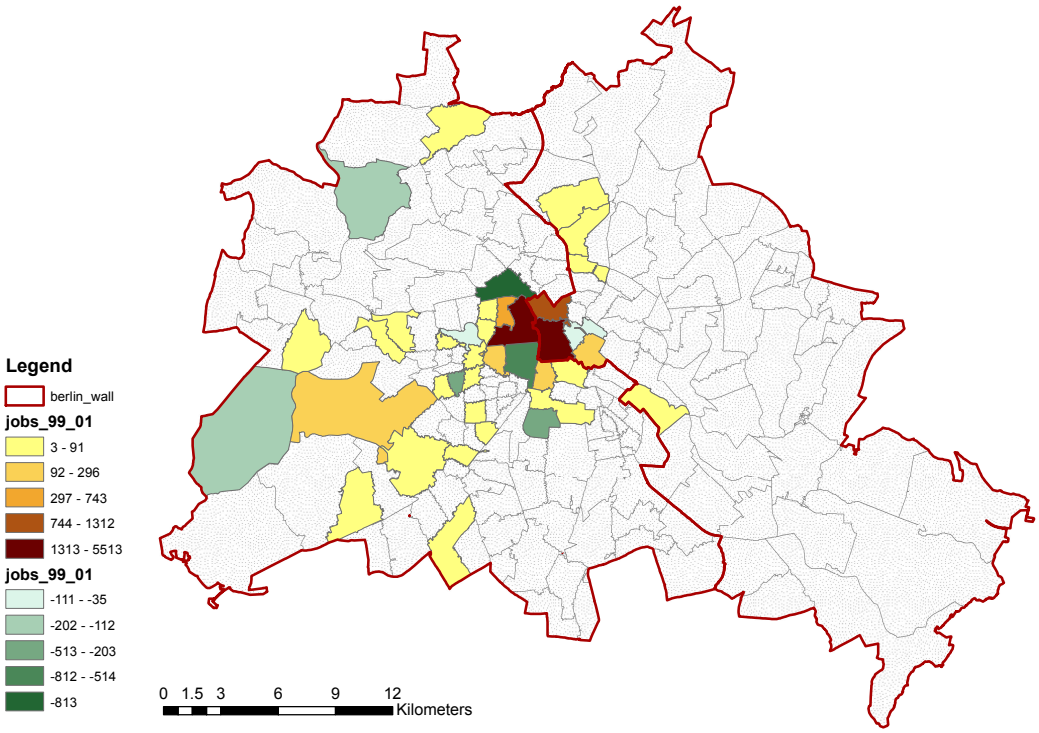

Figure 4.4: Concentration of employees in ministries , Länder representations and embassies by postcode sector. (Source of shapefile: Statistical Office for Berlin-Brandenburg (Amt fÃ¼r Statistik Berlin-Brandenburg))

Table 4.1: Overview about the relocated institutions and related jobs.

Institution	Number of jobs moved
Positions moved from Bonn to Berlin	
Ministries	9,075
Bundestag, -rat, -präsidialamt	5,276
Representations of the Länder	626
Foreign representations	6,300
Media, parties and interest groups	3,700[1]
Positions moved from Berlin to Bonn	
Federal and other institutions	-4,054
Positions moved from Berlin to new Länder	
Federal Institutions	-2,927[2]
Total	24,977 - 6,981 = 17,996[3]

[1]According to Deutscher Bundestag (1992) 10,000 jobs in foreign representations, media companies, parties and interest groups would move from Bonn to Berlin.
[2]Germany as a federal country tries to balance the distribution of federal institutes across all federal states. Initially is was planned to move 4700 jobs out of Berlin to the New Federal States but some relocations never materialized.
[3]The DIW estimates a net gain of 18,159 positions for Berlin(Geppert and Vesper, 2006), the Prognos AG (2003) estimates a net gain of 14,500 positions.

Table 4.2: Descriptive statistics.

	Postcodes not receiving jobs		Postcodes receiving jobs		Difference in means
Variables	Mean	Std.	Mean	Std.	
log total employment	7.47	0.824	8.11	0.875	-0.647***
% full time employment	77.9%	0.081	74.5%	0.082	3.4%***
% female employment	46.1%	0.130	53.6%	0.079	-7.5%***
% low qualificed employment	13.0%	0.063	11.5%	0.052	1.5%
% medium qualificed empl.	53.8%	0.095	53.4%	0.085	0.4%
% high qualificed employment	9.1%	0.060	13.5%	0.093	-4.4%***
% other qualificed employment	24.1%	0.107	21.6%	0.104	2.5%
% workers in unskilled occ	33.6%	0.094	28.9%	0.096	4.8%***
% workers in skilled occ	42.7%	0.088	42.3%	0.126	0.4%
% technicians	5.0%	0.031	4.3%	0.028	0.7%
% semi-professionals	9.1%	0.095	11.6%	0.110	-2.6%
% engineers	3.4%	0.038	3.6%	0.040	-0.2%
% professionals	1.5%	0.016	3.9%	0.064	-2.4%***
% managers	3.3%	0.021	3.8%	0.022	-0.5%
% employees aged 16 - 24	11.6%	0.048	10.6%	0.033	1.0%
% employees aged 25 - 39	42.5%	0.045	42.8%	0.040	-0.3%
% employees aged 40 - 54	33.9%	0.040	34.3%	0.038	-0.4%
% employees aged 55 - 65	11.9%	0.028	12.2%	0.027	-0.3%
Number of postcodes	150		38		

Notes: All variables refer to 1998 levels.

Table 4.3: Regression of difference in employment in the public administration and international organisations on difference in public sector employment.

VARIABLES	(1) Δpub_{9802}	(2) Δpub_{9802}	(3) Δpub_{9802}	(4) Δpub_{9802}
treat	0.815***	0.812***	0.0545***	0.0451*
	[0.0617]	[0.0667]	[0.0155]	[0.0238]
0-1km		-0.00189		0.0449
		[0.0386]		[0.0392]
1-2km		-0.00729		0.00231
		[0.0407]		[0.00643]
2-3km		0.0407		-0.00384
		[0.0386]		[0.00270]
3-4km		-0.0292		0.00107
		[0.0461]		[0.00223]
4-5km		0.00313		-0.00089
		[0.0232]		[0.00153]
5-15km		0.00117		-0.00284
		[0.0160]		[0.00235]
N	188	188	188	188
R-sq	0.52	0.527	0.347	0.56
Controls	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1% Dep. Var.: Δpub_{9802} = change in employment in the public administration and international organisations (1) and (2) and change in employment in special interest groups (3) and (4) between 2002 and 1998. Column (2) and (4) include employment relocations into the six distance bands. All columns include initial (1998) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees. Column 3 and 4 include trends in the sectors employment growth between 1995 and 1997 a distance measure of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.4: Regression of difference in private sector employment on difference in public sector employment.

VARIABLES	(1) $\Delta priv_{9802}$	(2) $\Delta priv_{9802}$	(3) $\Delta priv_{9802}$	(4) $\Delta priv_{9802}$	(5) $\Delta priv_{9802}$
treat	0.497	0.543*	0.540*	0.524*	0.526*
	[0.332]	[0.277]	[0.279]	[0.279]	[0.280]
0-1km	0.325**	0.324***	0.329***	0.331***	0.331***
	[0.130]	[0.123]	[0.124]	[0.124]	[0.123]
1-2km	-0.012	-0.0197	-0.0185	-0.0199	-0.0201
	[0.0415]	[0.0368]	[0.0380]	[0.0383]	[0.0384]
2-3km	-0.0195	-0.00652	-0.00656	-0.00681	-0.0071
	[0.0388]	[0.0364]	[0.0369]	[0.0370]	[0.0368]
3-4km	0.0163	0.00188	-0.00117	-0.000712	-0.000548
	[0.0333]	[0.0338]	[0.0337]	[0.0338]	[0.0339]
4-5km	-0.00567	-0.0083	-0.00695	-0.00999	-0.00975
	[0.0205]	[0.0210]	[0.0215]	[0.0219]	[0.0217]
5-15km	-0.0117	0.000341	-0.000286	-0.00351	-0.00307
	[0.00724]	[0.00966]	[0.00988]	[0.0106]	[0.0116]
$\Delta priv_{9597}$			-0.0743	-0.0754	-0.075
			[0.126]	[0.126]	[0.127]
Distance to wall				-9.363	-8.873
				[11.13]	[11.72]
W-Berlin					-15.87
					[115.3]
N	188	188	188	188	188
R-sq	0.345	0.461	0.463	0.464	0.464
Controls	NO	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1% Dep. Var.: $\Delta priv_{9802}$ = change in private sector employment between 2002 and 1998. Columns (2) to (5) include initial (1998) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees. Columns (3) to (5) include trends in the sectors employment growth between 1995 and 1997. Columns (4) and (5) also includes a variable that measures the distance of the postcode centroid to the Berlin wall as well as a west Berlin dummy in column (5).

Table 4.5: Regression of difference in private sector employment on difference in public sector employment.

	(1)	(2)
	Manufacturing	Services
VARIABLES	Δmnf_{9802}	Δsrv_{9802}
treated	-0.00705	0.538**
	[0.0149]	[0.263]
0-1km	0.00645	0.316**
	[0.00572]	[0.129]
1-2km	0.00192	-0.00716
	[0.00485]	[0.0406]
2-3km	0.0036	-0.021
	[0.00590]	[0.0353]
3-4km	-0.00505	0.00322
	[0.00612]	[0.0288]
4-5km	0.00193	-0.00818
	[0.00421]	[0.0185]
5-15km	-0.00708**	0.00401
	[0.00282]	[0.0104]
N	188	188
R-sq	0.118	0.473
Controls	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%. Dep. Var.: Δ mnf = change in manufacturing employment between 2002 and 1998. Δ srv = change in service employment between 2002 and 1998. Include are initial (1998) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, trends in the sectors employment growth between 1995 and 1997, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.6: Regression of changes in private sector employment in different industrial sectors on changes in public sector employment.

VARIABLES	(1) Trade $\Delta priv_{9802}$	(2) Hotels $\Delta priv_{9802}$	(3) Restaurants $\Delta priv_{9802}$	(4) Finance $\Delta priv_{9802}$	(5) Real Estate $\Delta priv_{9802}$	(6) Business $\Delta priv_{9802}$	(7) Media $\Delta priv_{9802}$	(8) Personal Services $\Delta priv_{9802}$	(9) Tourism $\Delta priv_{9802}$
treat	0.0459*	-0.00353	0.00295	0.0325	0.0304***	0.255*	0.0778	0.0150***	0.0104
	[0.0238]	[0.00454]	[0.0170]	[0.0486]	[0.0111]	[0.154]	[0.0506]	[0.00511]	[0.0262]
0-1km	0.00628	0.0131	0.00483	0.105	-0.00551	0.0673	-0.00295	0.00465**	-0.00197
	[0.0125]	[0.00820]	[0.00844]	[0.0926]	[0.00936]	[0.0740]	[0.0183]	[0.00183]	[0.0292]
1-2km	-0.0129	-0.00385	-0.0169	-0.00468	0.0072	0.00382	0.00946	-0.00272	-0.0173
	[0.0103]	[0.00246]	[0.0126]	[0.0177]	[0.0113]	[0.0187]	[0.00962]	[0.00262]	[0.0107]
2-3km	0.00665	0.000937	0.00585	0.0107	-0.00882	0.00337	-0.00357	-0.00139	0.00564
	[0.00805]	[0.00173]	[0.00590]	[0.0119]	[0.00557]	[0.0139]	[0.00671]	[0.00534]	[0.00675]
3-4km	0.00678	0.0000527	0.00265	-0.0176	0.00788*	-0.0143	-0.00127	0.000705	-0.00151
	[0.00858]	[0.00157]	[0.00564]	[0.0107]	[0.00440]	[0.0129]	[0.00378]	[0.00480]	[0.00596]
4-5km	-0.0117	-0.00000273	-0.000516	0.00556	-0.00184	0.00384	-0.000636	0.00168	0.00224
	[0.00783]	[0.000731]	[0.00211]	[0.00704]	[0.00246]	[0.00798]	[0.00230]	[0.00249]	[0.00301]
5-15km	0.00283	-0.000906	0.00121	-0.00505	0.000506	-0.0093	-0.000617	0.00189	-0.00477
	[0.00346]	[0.000719]	[0.00149]	[0.00542]	[0.00135]	[0.00675]	[0.00141]	[0.00121]	[0.00293]
$\Delta priv_{9597}$	0.547	0.167***	1.288***	-0.025	-0.063	-0.793***	0.311	-0.059	0.583
	[0.375]	[0.0475]	[0.401]	[0.0949]	[0.127]	[0.181]	[0.387]	[0.145]	[0.415]
N	188	188	188	188	188	188	188	188	188
R-sq	0.25	0.321	0.238	0.286	0.132	0.558	0.385	0.171	0.274
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%. Dep. Var.: $\Delta priv_{9802}$ = change in service employment between 2002 and 1998. Included are initial (1998) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.7: Falsification test: Regression of difference in private sector employment on difference in public sector using 1996 - 1998 differences.

	(1)	(2)	(3)
	Total Private	Manufacturing	Services
VARIABLES	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$
treat	-0.0192	0.00993	0.0163
	[0.0477]	[0.0123]	[0.0392]
0-1km	0.0467	0.000671	0.0333
	[0.0405]	[0.00590]	[0.0357]
1-2km	0.00567	0.00547	0.0225
	[0.0360]	[0.00493]	[0.0310]
2-3km	-0.00456	-0.000504	-0.0107
	[0.0252]	[0.00565]	[0.0260]
3-4km	-0.0293	-0.00379	-0.0269
	[0.0204]	[0.00707]	[0.0219]
4-5km	0.0129	0.00385	0.012
	[0.0133]	[0.00516]	[0.0149]
5-15km	0.00234	-0.000874	0.00657
	[0.00938]	[0.00318]	[0.00759]
N	188	188	188
R-sq	0.345	0.144	0.257
Controls	YES	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%. Dep. Var.: $\Delta priv_{9597}$ = change in employment between 1997 and 1995. Included are initial (1995) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.8: Regression of changes in private sector employment in different industrial sectors on changes in public sector employment using 1996 - 1998 differences.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Trade	Hotels	Restaurants	Finance	Real Estate	Business	Media	Personal Services	Tourism
VARIABLES	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$	$\Delta priv_{9597}$
treat	-0.00238	0.0273	0.00766	-0.00776	0.00838	-0.000325	0.000561	0.0000835	0.0187
	[0.0123]	[0.0165]	[0.00665]	[0.0151]	[0.0102]	[0.0263]	[0.00386]	[0.00166]	[0.0131]
0-1km	0.0118*	-0.00607*	0.00292	-0.00666	0.00162	-0.000768	-0.00918**	-0.000528	0.0242**
	[0.00674]	[0.00349]	[0.00366]	[0.0135]	[0.00631]	[0.0163]	[0.00385]	[0.00125]	[0.0119]
1-2km	0.000334	-0.00255	-0.000127	0.0261	-0.0000531	0.000231	0.00293*	-0.000438	-0.00671
	[0.00546]	[0.00274]	[0.00179]	[0.0167]	[0.00450]	[0.0108]	[0.00176]	[0.000961]	[0.00480]
2-3km	-0.00428	-0.000312	0.000649	-0.0153	-0.00265	0.0106	-0.00181	0.0011	0.0019
	[0.00535]	[0.00154]	[0.00210]	[0.0108]	[0.00288]	[0.0112]	[0.00125]	[0.00168]	[0.00301]
3-4km	0.00866	0.00162	-0.000751	-0.000584	-0.00138	-0.0249*	0.00102	-0.000394	0.000386
	[0.0105]	[0.00202]	[0.00189]	[0.00336]	[0.00263]	[0.0131]	[0.00121]	[0.00135]	[0.00332]
4-5km	-0.00606	-0.00158	0.000153	0.00116	0.00202	0.0147*	-0.000488	-0.00022	-0.00146
	[0.00889]	[0.00141]	[0.000761]	[0.00199]	[0.00224]	[0.00788]	[0.000827]	[0.000573]	[0.00206]
5-15km	0.0035	0.00125**	0.000609	0.00145	-0.000676	0.000267	0.000758*	0.000238	0.00403**
	[0.00351]	[0.000560]	[0.000448]	[0.00176]	[0.000708]	[0.00267]	[0.000442]	[0.000476]	[0.00180]
N	188	188	188	188	188	188	188	188	188
R-sq	0.172	0.659	0.431	0.422	0.189	0.17	0.624	0.567	0.287
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%, Dep. Var.: Δ priv = change in service employment between 1997 and 1995. Included are initial (1995) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.9: Robustness checks using different band widths.

	(1)		(2)		(3)		(4)
Var.	$\Delta priv_{9802}$	Var.	$\Delta priv_{9802}$	Var.	$\Delta priv_{9802}$	Var.	$\Delta priv_{9802}$
treat	0.539*	treat	0.545*	treat	0.549**	treat	0.584**
	[0.282]		[0.279]		[0.270]		[0.269]
0-1.5km	0.128	0-2km	0.0978*	0-2.5km	0.053	0-3km	0.025
	[0.0822]		[0.0573]		[0.0437]		[0.0230]
1.5-3km	-0.00788	2-4km	-0.0234	2.5-5km	-0.0183		
	[0.0214]		[0.0151]		[0.0150]		
3-15km	0.00155	4-15km	0.001	5-15km	0.00323	3-15km	0.00603
	[0.0126]		[0.0127]		[0.0132]		[0.0133]
N	188	N	188	N	188	N	188
R-sq	0.393	R-sq	0.382	R-sq	0.349	R-sq	0.334
Contr.	YES	Contr.	YES	Contr.	YES	Contr.	YES

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%, Dep. Var.: $\Delta priv_{9802}$ = change in private sector employment between 1998 and 2002. Included are initial (1995) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

Table 4.10: Robustness check: Distance functions.

	Private		Manufacturing		Service	
	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$
Fct. 1	0.316**	-0.0639	0.0122	0.0186*	0.308**	-0.066
	[0.147]	[0.0494]	[0.00944]	[0.00980]	[0.140]	[0.0453]
Fct. 2	0.498**	-0.0597	0.015	0.0159	0.487**	-0.0487
	[0.218]	[0.0522]	[0.0102]	[0.0115]	[0.205]	[0.0468]
	Trade		Hotel		Cafes	
	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$
Fct. 1	0.0113	0.00547	0.00245	0.00123	-0.00107	-0.00175
	[0.0180]	[0.00976]	[0.00346]	[0.00461]	[0.0134	[0.00348]
Fct. 2	0.0318	-0.000775	0.00311	0.0126	-0.00237	0.00157
	[0.0220]	[0.0103]	[0.00470]	[0.00903]	[0.0169]	[0.00602]
	Finance		Real Estate		Business	
	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$
Fct. 1	0.0492*	0.0123	0.0158*	-0.000591	0.134*	-0.0152
	[0.0282]	[0.0113]	[0.00946]	[0.00466]	[0.0796]	[0.0182]
Fct. 2	0.0673**	0.00211	0.0222**	0.00136	0.231*	-0.0204
	[0.0300]	[0.0143]	[0.00990]	[0.00672]	[0.121]	[0.0279]
	Media		Personal Services		Tourism	
	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$	$\Delta priv_{9802}$	$\Delta priv_{9597}$
Fct. 1	0.0389	-0.00598	0.00635**	-0.00197	-0.000155	0.00325
	[0.0266]	[0.00516]	[0.00257]	[0.00189]	[0.0199]	[0.00862]
Fct. 2	0.0656	-0.00411	0.00727**	-0.00133	0.00904	0.00571
	[0.0413]	[0.00560]	[0.00321]	[0.00156]	[0.0269]	[0.0122]

Notes: Robust standard errors in parentheses. Significance levels *: 10% **: 5% ***: 1%, Dep. Var.: $\Delta priv_{9802}$ = change in private sector employment between 1998 and 2002 weighted by its distance to the postcode centroid. Fct. 1 and Fct. denote different weighing functions. Included are initial (1995) postcode level controls: log of total employment, shares of female and part-time workers; age, education and occupation structures; share of R&D employees, distance of the postcode centroid to the Berlin wall and a West-Berlin dummy.

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Appendix A

Real wage inequality in Britain

A.1 Data description

ASHE

Wage information are taken from the Annual Survey of Hours and Earnings. The data is a 1% sample of workers on the PAYE register and is considered as the most reliable dataset on wages and earnings in the UK. There are 90,836 observations available in 2001 and 89,177 in 2011. Control variables include personal characteristics such as age, gender and occupation as well as the work postcode.

Census

The UK census is published every ten years and provides the most detailed information about demographic characteristics available in the UK.[1] The smallest spatial unit for which census data are published are Census output areas which have a target size of 125 households. The 2011 Census tried to change the area definition of the 2001 output areas as little as possible. I aggregate all Census variables to 2001 travel to work area definitions.

For the 2001 statistics I use the Census variable CS032 which has information on the number of economically active individuals aged 16 to 74 with no qualifications or level unknown, lower level qualifications and higher level qualifications. The term 'higher level' refers to qualifications of levels 4 and above i.e. first degrees, higher degrees, National Vocational Qualification levels 4 and 5, Higher National Diploma, Higher National Certificate and certain professional qualifications. For the 2011

[1]The person response rate was approximately 94 percent in England and Wales in 2001 and 2011.

statistics I use the Census variable LC5601 which has information on the number of economically active individuals aged 16 to 64 with no qualifications, other qualifications, currently in apprentenship and qualification level one to four. To calculate shares of highly qualified individuals that are consistent over time I group level 4 qualifications and above against all other qualification groups and divide both numbers by the total of economically active individuals aged 16 to 74 in 2001, respectively 16 to 64 in 2011.

Landregistry data

The land registry tracks all residential property sales and their location in England and Wales. In 2001 a total of 1.23 million sales were recorded, in 2011 this number amounted to 0.65 million. Recorded are the full address of the property, the price paid for the property, the date of transfer, the property type (Detached, Semi, Terraced or Flat/Maisonette), whether the property is newly built or not and whether the property is freehold or leasehold.

Nationwide Building Society data

The second source of house price data comes from the Nationwide Building Society. The transactions are those for which the Nationwide provided mortgages in 2001 and 2011. In 2001 there are c. 70,000 transactions, in 2011 c. 47,000 transactions. Recorded are the price paid for the property as well as a large set of structural characteristics. These include the tenancy type (freehold, leasehold, feuhold), the structural type (detached, semi-detached,terraced, flat) floor size, the construction year, the number of bathrooms and bedrooms, the type of parking (none, space, garage, double garage) and an indicator whether the property is newly built.

A.2 Calculation of regional expenditure shares

The ONS publishes detailed household expenditure by UK countries and regions derived from the Living Costs and Food Survey of the respective year. From 2001-02, the Classification Of Individual COnsumption by Purpose (COICOP) was introduced as a new coding frame for expenditure items. COICOP is the internationally agreed classification system for reporting household consumption expenditure. Total expenditure is made up from the total of the COICOP expenditure groups

(1 to 12) plus 'Other expenditure items (13)'. Other expenditure items are those items excluded from the narrower COICOP classifications, such as mortgage interest payments, council tax, domestic rates, holiday spending, cash gifts and charitable donations. It should also be noted that rent excluding service charges and benefit receipts associated with housing (net rent) has been used when calculating total expenditure. According to the ONS, this convention ensures that rebates, benefits and allowances are excluded from the calculation of total household expenditure on rent.

To replicated the housing shares used in the construction of the RPI, I sum expenditure on: 4 = Housing costs net of housing subsidy, fuel and power, 5 = Household goods and services, 8 = Communication, 12.5.1 = Moving house, 13.1 = Housing: mortgage interest payments council tax etc., 14.5 = Purchase or alteration of dwellings, mortgages for each region and divide the summed housing related expenditure by the total expenditure. Due to the small sample size in the Living Costs and Food Survey regional expenditures are averaged across several years. I attribute 2001 to 2005 averages to 2001 and 2009 to 2011 averages to 2011. Table A.1 shows the resulting expenditure shares that I use in the construction of the alternative local RPI. The expenditure shares on housing increased for all regions over the decade. In 2011 the expenditure share on housing was highest for London (45.7%) and lowest for Yorkshire and the Humber with (39.1%), confirming that expenditure shares are higher in high cost areas.

Table A.1: Expenditure shares on housing in 2001 and 2011 for English Governemnt Office Regions and Wales.

Region	share 2001	share 2011
North East	0.341	0.382
North West	0.369	0.397
Yorkshire and the Humber	0.354	0.381
East Midlands	0.396	0.404
West Midlands	0.361	0.391
East	0.416	0.417
London	0.415	0.447
South East	0.395	0.433
South West	0.412	0.411
Wales	0.366	0.385

Notes: Derived from the Classification of Individual Consumption by Purpose for Government Office Regions averaged over 2001 to 2005 and over 2009 to 2011.

Appendix B

Real wages, amenities and the adjustment of working hours across local labour markets

B.1 Data

The ASHE is a panel dataset that has information on individual workers for a 1% sample of workers on the PAYE register. Workers are classified into two skill categories based on the procedure proposed in Elias and McKnight (2001) which uses information from the LFS to infer qualification/skill levels from three digit occupation codes. I use all individual workers in the analysis that do not change skill categories over time and for whom none of the control variables (age, age^2, firm size, indicators for the public sector, rural areas, collective agreements, industry and occupation classification) is missing.

The amenity data on elevation and coastal length has been kindly provided by Steve Gibbons. The lengths of coastline is obtained from Ordnance Survey GIS data, elevation is obtained from the Ordnance Survey Panorama Digital Elevation data. The climate amenity variables sunshine duration, rain fall, and wind speed where downloaded from the Met Office website (http://www.metoffice.gov.uk/). Sunshine duration is measured in hours per day, rainfall is measured in mm per year and wind speed is measured in knots at a height of 10 metres above ground level. All variables are based on average climate data for the years 2001 to 2006.

Appendix C

The role of education for amenity based sorting in British cities

C.1 Plausibility check for amenity measure

We interpret the neighbourhood fixed effect estimated in Equation 3.1 as an aggregate measure of local amenities. In order to show that this interpretation is reasonable and that our amenity measure is a reliable indicator of the quality of the neighbourhood we collected information on neighbourhood characteristics such as crime incidents, listed buildings and parks, restaurants, cafes, bars, public houses and clubs as well as libraries and museums for all neighbourhoods. We run a hedonic regression to see how well these characteristics perform in explaining the variation in our aggregate measure of amenities. Our aim in this context is twofold. First, we can check the plausibility of our aggregate amenity measure by looking at the correlation with neighbourhood characteristics that measure historical, architectural or consumer amenities. Second, we can look at the contribution of each component to the total amenity level. Equation C.1 is estimated using OLS where a_{wk} is our amenity measure, z_{wk} is a vector of the listed neighbourhood characteristics and υ_{wk} are TTWA fixed effects.

$$a_{wk} = z'_{wk}\theta + \upsilon_{wk} + \xi_{wk} \tag{C.1}$$

The results of Equation C.1 are shown in Table C.1. In column (1) our measure of neighbourhood quality is regressed on amenity variables only whereas in column (2) TTWA fixed effects are included as additional controls. We find that the number of

historical buildings in a ward significantly increases the amenity measure. A positive correlation is also found for the share of total ward area covered by gardens and parks and the availability of a local library. The number of crime incidences on the other hand significantly decreases our measure of neighbourhood quality. These amenities correlate with the aggregate measure as expected. The presence of a museum in a specific neighbourhood has a positive but insignificant effect on the amenity level. The advantage of living right next to a museum is likely to be small. While people surely value the cultural offer of their city, the frequency of actual museum visits is relatively low.[1]

The sign and significance level of most amenity coefficients remain unchanged when TTWA dummies are included in the regression. TTWA dummies capture cross-city differences in other unobserved amenity components, as for instance differences in climate or physical geography but also the relative importance of access to jobs. The effects of the number of listed buildings and crime incidents on our amenity measure remain relatively stable when TTWA fixed effects are included in the regression. This indicates that they have a localized effect, i.e. determine neighbourhood quality rather than influencing the attractiveness of the city as a whole. The coefficient for libraries and parks are smaller in absolute size when TTWA fixed effect are included. While these amenities are significantly correlated with our aggregate measure they equally increase the overall attractiveness level of a labour market area. When cross-city variation is accounted for the effect of restaurant and bars becomes highly significant as would be expected.

Overall the plausibility test shows that neighbourhood attributes that are considered as amenities increase our measure of neighbourhood quality whereas attributes that are considered as disamenities decrease the measure.

[1]The proportion of adults who visited a museum in the last 12 month was 52% in 2013. The proportion of adults who visited a museum at least once a month during the last 12 month was around 3.5% (Department for Culture Media and Sport).

Table C.1: Plausibility check for the amenity measure.

VARIABLES	(1) ward FE	(2) ward FE
Listed buildings	0.0954***	0.0480***
	(0.0219)	(0.00459)
Crime incidents	-0.0676**	-0.0998***
	(0.0295)	(0.00845)
Restaurants and bars	0.00465	0.0544***
	(0.00950)	(0.00636)
Share of park area	1.119***	0.313***
	(0.264)	(0.0875)
Library dummy	0.179***	0.0506**
	(0.0672)	(0.0202)
Museum dummy	0.0584	0.0498
	(0.0511)	(0.0303)
Constant	6.378***	6.498***
	(0.0366)	(0.00976)
N	10,966	10,966
R-squared	0.127	0.821
TTWA FE	NO	YES

Notes: Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1. Dep Var: ward FE = ward level fixed effect derived from a hedonic price regression. Amenity controls include the number of listed buildings, crime incidents and restaurants and bars per ward, the share of the ward area that is covered by a park and a dummy whether a library or museum is located in the ward. All count variables are standardized, having a mean of zero and a variance of one. 2011 population levels are added as additional control. Column (2) also controls for TTWA fixed effects.

Appendix D

Local multipliers in local labour markets - A case study of the move of the German government to Berlin

D.1 Long description of the historical setting

When the Federal Republic of Germany (FRG) and the German Democratic Republic (GDR) were founded in 1949 it was unclear how long this separation would last. Berlin, German capital between 1871 and 1945, was claimed to be part of both states. In the constitution of the GDR Berlin was declared its capital whereas in the basic law of the FRG (Great-) Berlin was considered as an 11^{th} federal state. As a result the city which geographically fell into the Soviet occupation zone was divided into East-Berlin the sector governed by the USSR and West-Berlin, made up of the three sectors governed by USA, France and Britain.

The two German states did not recognize each other's sovereignty straight away. The FRG saw the division as a temporary state and both the political decision makers as well as the general public advocated a reunified Germany with Berlin as its capital (Süß, 1999). That the situation was widely seen as transitional was also reflected in the discussion about the seat of the government of the FRG. The new capital should have a provisional character and be only of medium importance. It was seen as unlikely that Bonn would concentrate too much power (Dreher, 1979)

to hamper the move of the government back to Berlin once the two German states reunified.

The perception that the division would only be of short duration changed when in August 1961 construction works of the Berlin Wall began. In December 1972 the FRG and the GDR came to terms with the status quo and mutually recognized each other as sovereign states by signing the Basic Treaty. Shortly before, the allies had resolved their dispute on their rights and responsibilities in Berlin in the Quadripartite Agreement. Berlin would continue not to be a constituent part of the Federal Republic of Germany.[1] In his government declaration in 1973 Willy Brandt referred for the first time to Bonn as the federal capital of Germany. Though the ultimate aim of the West German government was still reunification the political discussion about Berlin as capital was muted substantially.

Reunification and the Bonn/Berlin question

Political protest against the East German government began in September 1989 with the so called Monday-demonstrations in Leipzig. With the fall of Berlin Wall in November 1989 it was once again possible to freely move within the Eastern and Western parts of the city. Berlin became capital of united Germany in 1990 when the Unification Treaty (1990) was signed between the newly elected government of the GDR and the FDR. However the decision on the seat of the government was postponed until after the election of the first assembly (Bundestag) of reunified Germany.

The crucial debate about the move of the government to Berlin took place on 20^{th} June 1991. The assembly was divided. The deputies of the ten western federal states had already shown their preference for Bonn during the negotiation of the Reunification Treaty (Süß, 1999). Polls among the total of 662 members of parliament saw Bonn as the clear favourite (Tschirch, 1999). Bonn advocates pointed towards the successful democratic as well as the federalist tradition. European integration had been facilitated by Bonn's proximity to the western allies and the EU seat in Brussels. Integration would slow down if Berlin became the new capital (Salz, 2006). Additionally, large infrastructure investments had turned Bonn into a highly efficient administration. These investments would be lost and the means for setting

[1]This rule was frequently a source of conflict between the FDR and GDR, if for example federal offices of the FDR were established in West-Berlin

up the government in Berlin would be better spend on construction projects in the new federal states (Tschirch, 1999).

The main argument of the pro Berlin faction was that of credibility. Since 1949 when the FRG was founded politicians had repeated again and again that Berlin was the actual capital of Germany. Bonn had become capital with a provisional mandate which would move back to Berlin once East and West Germany were united. Further important arguments were the importance of the move as a sign of solidarity between the old and new federal states and Berlin's potential as a bridge to Eastern Europe. Economically the move of the government was expected to strengthen the weak local economic position of Berlin and the economically underdeveloped east. The city of Bonn on the other hand feared that 'the small Bonn' would lose its political significance as well as economic power (Deutscher Bundestag, 1991b, p. 2736-2738).

The most important arguments in the discussion were linked to rather abstract concepts. Credibility and the future of the reunited Germany stood out for the pro Berlin side whereas Bonn was seen as a symbol of successful democratic tradition (Tschirch, 1999). In the final ballot the assembly decided to move the seat of the government from Bonn to Berlin with 338 against 320 votes (Deutscher Bundestag, 1991b). The feeble majority could only be reached by making large concessions to the city of Bonn. A fair division of labour between Berlin and Bonn should be negociated where core government functions should take their seat in Berlin but the majority of government jobs should remain in Bonn. Bonn should receive financial compensation as well as new functions and institutions of national and international significance. A commission should be appointed to work on proposals for the distribution of national and international agencies across the new federal states, as the constitution of Germany states that each federal state should have some national power. The national parliament (Bundestag) was supposed to take up its function in Berlin within 4 years. Within 10-12 years all government functions should be located in Berlin (Deutscher Bundestag, 1991a). The Federal Assembly decided two weeks later with 38 against 30 votes to remain in Bonn (Deutscher Bundestag, 2010).

Realization of the move

The decision made in 1991 left the details of the move open. While working on a practical concept it became clear by 1992 that a move within four years was not

feasible. What followed was a long discussion about the timing of the move and its costs. One motion proposed to stop any further government related investments in Berlin until the financial situation of the FRG had improved. Another proposed to postpone the move until 2010. Furthermore, a mass petition was organized to suspend a decision about the date of the move until the government had full knowledge of the costs and the financial situation of the state had improved (Deutscher Bundestag, 2010). This dispute created uncertainty among the private companies that had started to invest in Berlin. In November 1993 40 national and international companies pointed at the breach of trust should the government cease its effort to press ahead with the move (Hoffmann, 1998, p. 213).

The uncertainty about the move diminished in 1994 when the Berlin/Bonn Act Berlin-Bonn Act (1994) passed in March 1994. Though it did not specify a concrete moving date, the act provided statutory security that the move was to take place. It also detailed the implementation of the move such as a definition of a fair division of labour between Berlin and Bonn and concrete compensatory measures for Bonn. Six ministries should keep their first seat in Bonn[2] and get a second seat in Berlin; nine ministries should take their first seat in Berlin and keep their second seat in Bonn. Additionally, is was decided that the majority of ministerial position should remain in Bonn. The following years were mostly concerned with the practical implementation of the move. Construction of the new buildings (Jakob-Kaiser-Haus, Paul-Löbe-Haus) began in spring 1997 but it was only by November 1997 that the Federal Parliament announced a moving date. The government was to take up its work in Berlin in September 1999. Until then the timing had remained heavily debated.[3]

Parliament and government officially started their work in Berlin in September 1999. The majority of employees moved in 1999 and 2000 so that by the end of 2000 more than 8000 ministerial employees were located in Berlin. In the subsequent years more jobs were gradually moved from Bonn to Berlin. In 2010 c. 10,000 positions were established in Berlin. Since the Federal Assembly had revised its decision to stay in Bonn in September 1996 also the Federal States established their represen-

[2]Federal Ministry of Defence (BMVg), Federal Ministry of Health (BMG), FM of Food, Agriculture and Consumer Protection (BMELV), FM of Economic Cooperation and Development (BMZ), FM for the Environment, Nature Conservation and Nuclear Safety (BMU), FM of Education and Research (BMBF)

[3]For instance, in the September 1996 50 MoP of SPD and BÜNDNIS 90/DIE GRÜNEN brought in the motion to postpone the move by at least 5 years.

tations in Berlin. In total c. 600 employees moved between 1998 and 2003, plus c. 70 members of the Federal Assembly.

The majority of foreign representations decided to relocate their seats from Bonn to Berlin. Most of the embassies chose to be present in Berlin when the German government took up its work in 1999 and made short term arrangements to accommodate their staff. Besides renting offices and apartments the embassies used the facilities of their consulate generals and branch offices as well as former military missions until they could rebuild or construct a suitable building for their representation (Gehrcken, 2013). Though, the diplomatic building stock in Berlin-West had been almost entirely destroyed between 1939 and 1945[4] many countries still owned a parcel of land in West-Berlin. The former embassies in Berlin-East had closed in 1990 when the GDR became part of the FRG. Some reopened later on as representations in the FRG. Today 163 states are represented in Berlin by 158 embassies and five honorary consulates.

To compensate Bonn for its loss of employment several federal offices were moved from Berlin to Bonn in 1999 and 2000. Berlin also lost several of its prior functions to the New Laender. The recommendations of the federal commision concerned several Berlin based institutions that moved in the subsequent years. Before reunification 28,000 employees had worked for federal offices in Berlin (Guerra, 1999). The two relocation programms concerned c. 7000 positions.

[4]In the course of the construction works for the NS capital 'Germania' several embassies had been demolished. For some the planned reconstruction never materialized as diplomatic relations broke off during WWII. Severe bomb attacks destroyed a large number of buildings in the Tiergartenviertel (Fleischmann, 2005)

D.2 Details on data sources

Relocated institution	Year	Source of employment data	Source of address in Berlin
Federal Ministries	1997	BT-Drucksache 13/9537	OECKL Taschenbuch des öffentlichen Lebens
	1999	BT-Drucksache 14/1601	OECKL Taschenbuch des öffentlichen Lebens
	2001	Spiegel 18/2001 "Die Wacht am Rhein"	OECKL Taschenbuch des öffentlichen Lebens
	2004	BT-Drucksache 16/158	OECKL Taschenbuch des öffentlichen Lebens
Embassies	1996	Liste der diplomatischen Missionen in der Bundesrepublik Deutschland, 1998	Senatskanzlei Berlin, Liste der diplomatischen Vertretungen
Federal Institutes (New Länder)	1999 2003	BT-Drucksache 12/2853	Drucksache 15/875, OECKL Taschenbuch des öffentlichen Lebens
Federal Institutes (Bonn compensation)		Teilungskostenbericht fuer das Jahr 2009	Drucksache 15/875, OECKL Taschenbuch des öffentlichen Lebens
Representations of the Länder	1998	Bonner General-Anzeiger, 09.02.1998, "Verkaufen, vermieten, verwerten: Abschied der Länder"	Presse und Informationsamt der Bundesregierung, OECKL Taschenbuch des öffentlichen Lebens
Deputies and deputee employees, Factions, Federal Parliament (Bundestag) and administration	1999	Berliner Zeitung 05.07.1999, "Die Bonner kommen: Bundestag startet offiziellen Umzug"	Anschriftenverzeichnis des Bundes
Office of the Federal President	1998	Berliner Zeitung 24.11.1998, "Bauminister übergibt Schlüssel für das neue Bundespräsidialamt"	Anschriftenverzeichnis des Bundes
Federal Assembly (Bundesrat)	2000	Handelsblatt 31.07.2000, "Bundesrats-Umzug nach Berlin fast abgeschlossen"	Anschriftenverzeichnis des Bundes