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The Role of Education for Amenity Based Sorting in British Cities

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Abstract
This paper investigates the relation between amenities and skills by looking at the sorting behavior of skilled individuals across neighbourhoods within British cities. Using a detailed micro dataset on housing transactions we recover a composite measure of local amenities that captures the level of attractiveness of each neighbourhood. By combining the amenity measure with data on British individuals we analyse how the cost associated with the consumption of amenities is distributed across education groups and across neighborhoods within cities defined as integrated labour markets. Results show that, holding constant the availability of job opportunities, high skilled individuals exhibit a moderate preference bias towards amenity consumption as they tend to sort into more attractive neighborhoods than lower skilled individuals with the same income.

Keywords: Neighborhood characteristics, sorting amenities, skills, local labour markets, hedonic pricing
JEL Classifications: R23; R22; J24

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1. Introduction

In recent years increasing attention has been paid to differences in the level of amenities across places and their importance for the location decision of skilled individuals. The topic has gained momentum, as the level of human capital is an important determinant of the future economic success of a place (Lucas, 1988). On the one hand, policy makers around the world have attempted to spur demographic change by promoting large scale investments in leisure spaces (Carlino and Saiz, 2008; Moretti, 2012). On the other hand, scholars have increasingly emphasized the role of cities as centers of consumption that attract skilled labour by offering a wide range of amenities (Adamson et al., 2004; Partridge, 2010; Glaeser et al., 2001; Glaeser, and Gottlieb, 2006; Carlino and Saiz, 2008).

The rationale behind the link between amenities and skills is that skilled individuals have a higher preference towards amenity consumption and that they are willing to forgo a higher portion of their wages to live in more attractive places (Lee, 2010, Black et al, 2009). Indirect support for this evidence comes from the fact that skilled individuals sort disproportionally into more expensive locations characterised by higher costs of housing. It is, however, also possible that the concentration of skilled individuals in expensive places responds primarily to differences in the demand for skilled jobs rather than to changes in the supply of local amenities (Moretti, 2013).

Disentangling the role of amenities from the concurrent role of the availability of better job opportunities is therefore controversial due to the interdependence of the two dimensions (e.g. Storper, 2009; Moretti, 2013). It is undeniable that places with a solid economy are often also lively and culturally vibrant. In these contexts skilled individuals are more productive, receive higher nominal wages and have the possibility to enjoy a greater variety of consumption and leisure (Brueckner et al, 1999; Florida, 2002, Glaeser et al, 2001; Carlino and Saiz, 2008). Whether given the accessibility to better job opportunities, they still exhibit a higher preference towards amenity consumption than their lower skilled counterpart remains, however, under scrutiny.

We seek to contribute to the debate on the relation between amenities and skills by analyzing the sorting behavior of skilled individuals in UK cities. We test whether they show a higher preference towards amenity consumption when controlling for differences in individual income and access to job opportunities. Large part of the existing literature has investigated this topic by looking at the migration behavior of skilled individuals across cities and interpreting their mobility toward high amenity locations as evidence of a skill bias preference for amenity consumption (Arntz, 2006, Mathur and Stein, 2004, Chen and Rosenthal, 2008, Niedomysl and Hansen, 2010, Dorfman et al, 2011). There are several limitations to this approach. First, cities attracting skilled individuals may also disproportionally attract unskilled workers (e.g. Eeckhout et al, 2014). The geographical concentration of high skilled individuals induces a higher demand for low skilled services leading to significant inflows of unskilled labour (e.g. Moretti, 2012; Gagliardi, 2014). This implies that the relative magnitude of flows may be a poorly informative proxy. Second, mobility increases with education (e.g. Machin et. al, 2012). As such, the mobility of high skilled individuals across cities may also capture differences in individual attitudes towards migration (Moretti, 2011). Finally, disentangling the correlation between supply (in terms of local amenities) and demand conditions (in terms of availability of better jobs) across cities remains highly controversial. Skilled people may move either because of changes in the supply of local amenities or because of better job opportunities and higher nominal wages, which in turn stimulate a higher demand for amenity consumption (Duranton and Puga, 2013).

We aim at overcoming the limitations of previous studies by proposing a novel empirical approach that draws from the existing literature looking at the distribution and evaluation of specific amenities (such as for instance school quality or crime rates) within cities. As it is difficult to separate the role of labour market factors from that of differences in the level of amenities when looking at mobility across cities, we exploit the variation in amenity consumption across education groups and across neighbourhoods within cities defined as integrated labour markets. We therefore test whether within the same labour market individuals with higher education achievement sort into areas characterized by higher amenity levels assuming that job market opportunities are equally accessible to all

individuals living in the city regardless of their residential neighbourhood[1]. As such, this analysis does not aim at testing whether cities became attractive because they succeeded in building a solid economic base or vice versa. Instead, by exploiting the within city heterogeneity in the level of amenities it sheds light on whether, controlling for job accessibility, those places that offer a larger set of amenities have a significant advantage in attracting skilled workers. In this view our research, while trying to address the limitations of previous contributions exploiting the variation in amenity levels across cities, also provides generalizable implications for the longstanding debate on the link between amenities and skills.

The empirical strategy employed in this paper 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 who live in the same labour market area, but belong to different education groups. Exploiting data on the residential location of individual workers within the city and adopting the amenity measure derived from the hedonic regression as the dependent variable, we test whether skilled individuals are disproportionally sorted into neighbourhoods characterized by higher amenity levels. This sorting behavior is interpreted as evidence for a preference bias towards amenity consumption.

We find 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 exhibit a higher tendency to sort into more expensive locations. In

[1] Although we use a city definition that is based on commuter flows, the assumption of cities as integrated labour markets may neglect the role that congestion and preferences towards shorter commuting times may play in the spatial job search behaviour of different individuals within each city, which in turn may drive their residential choice (see Manning and Petrongolo, 2012 and Ahlfeldth et al. 2015). We account explicitly for this limitation by testing the robustness of our results against differences across neighbourhoods in job density and occupational composition. Additional details are reported in paragraph 4.2.

the framework of our analysis this evidence is interpreted as a signal for the existence of an education biased preference towards amenity consumption. Results are robust to a number of checks including differences in job market accessibility within cities, differences in the demographic composition of local neighborhoods and differences in individual wealth (non-labour income).

Our research design improves upon existing studies in several ways. Besides controlling for the accessibility of better job opportunities at city wide level by means of city fixed effects in the second stage, we also include in all our specifications a control for individual wage. The existing literature suggests that amenity consumption rises sharply with income (e.g. Brueckner, 1999; Gyourko, Mayer, and Sinai 2013) implying that part of what we interpret as a preference bias towards amenities may indeed be the reflection of differences across individuals in their wages. Nonetheless, differences in non-labour income, due for instance to intergenerational transfers, may also influence the amenity consumption (e.g. Albouy, 2008). Unfortunately, individual non-labour income is not available in our data. To limit the concern that our results are driven systematically by this dimension, we re-estimate our model on renters rather than home owners. Housing wealth is, in fact, one of the major assets that may be subject to intergenerational transfer and the focus on renters should reasonably alleviate the potential bias coming from differences across individuals (additional details are provided in section 4.1). Our main results remain consistent across subsamples of renters and renters and mortgage holders.

Finally, we take carefully into account the potential endogeneity between amenities and the local skill level due to sorting. Previous evidence for England and Wales has shown that home-owners 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. It may also be the case that the presence of a skilled workforce raises the demand and the level of local amenities (Diamond, 2013). As such, more educated neighborhoods may also develop better amenities. Although Glaeser and Saiz (2004) and Shapiro (2006) only find limited support for the relevance of amenities created by the presence of a skilled workforce, differing views may suggest an additional channel through which endogeneity concerns may arise. To control for this dimension we include

an extensive set of variables that capture the demographic structure of an area in our second stage regression in both the baseline cross sectional specification, where amenities are estimated as time unvarying neighborhood characteristic in the first stage, and in a more demanding specification which allows to exploit variation in amenities over time (additional details are provided in section 4.1 and 4.2).

The remainder of the paper is organized as follows. The next section presents the related literature. Section 3 describes the data and Section 4 the empirical strategy. Section 5 discusses the key results and presents several robustness checks. Section 6 concludes.

2. Related Literature

Our research contributes to an emerging body of literature, which originates from a striking stylized fact: the share of skilled workers varies significantly across local labour markets and it tends to be higher in large expensive cities.

The rationale behind this evidence rests on the standard Roback (1982) framework where wages and prices are determined by the location decision of individuals, further extended to accommodate heterogeneous preferences across workers. The spatial equilibrium in this context requires that mobility equalizes utility across places such that differences in real wages (i.e. nominal wages corrected by housing costs) are offset by differences in local amenities (Duranton and Puga, 2013). In this context cities with higher amenities become more attractive and grow in population. However, an alternative possibility, which brings along important implications, is that some demographic changes might be at play. In equilibrium workers are indifferent across locations but heterogeneous preferences towards amenity consumption may lead skilled individuals to forgo a higher portion of their nominal wages to live in amenity places. Under this circumstance, skilled individuals flow into higher amenity areas and they may accept a lower wage premium or also a wage discount to live in more attractive locations (Adamson et al, 2004; Lee, 2010).

Several theoretical studies support this rationale. Lee (2010) develops a 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. For instance, Lee (2010) looks at the example of the health care sector to document educational 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). The authors 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. In this context supply (local availability of better amenities) and demand conditions (local availability of better job opportunities) both affect the sorting behaviour of skilled individuals into more expensive locations.

Despite the broad support for the conceptual link between amenities and skills the empirical evidence linked to the above theoretical contributions remains still limited and controversial. Unlike existing studies exploiting information on the mobility behavior of skilled individuals across cities characterized by different amenity levels, our analysis looks at their residential sorting across neighborhoods within the same city.

The residential mobility within a city is less dependent on individual attitudes toward migration and it is likely to capture differences in the preference towards amenities rather than differences in job market opportunities, which in an integrated labour market should be equally available independently on the neighborhood of residence. We therefore draw 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). Although addressing a different question they employ an appealing methodological framework that

is particularly suitable for our investigation. Similarly to these studies we adopt a composite amenity indicator derived from the hedonic regression approach and we exploit within city variations in the level of amenities to test for the existence of a skill biased preference towards amenity consumption across cities. Unlike these studies, however, we do not focus on the role a specific amenity limiting the concerns associated with the strong correlation between different typologies of amenities in the same geographical area.

3. Data

For the purpose of this study we combine information from several datasets. Data 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 and information from the 2001 Census for the socio-demographic composition of each neighbourhood. Neighbourhoods are defined as wards, which coincide with electoral districts in the United Kingdom. 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 amenity 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[2]. Our sample comprises individuals in employment from 1994 to 2010 for whom wage information and educational attainment are available[3]. 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. Our wage measure is taken from wave 1 and

[2] There are c. 9500 wards in the UK. Wards as electoral districts have an average size of 20 square km.
[3] 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.

5, in cases in which wages differ between the two waves of the same year we use the average level. 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 assuming that the value of amenities is capitalized into housing prices (details on the estimation procedure are given in the next section). Data on house price transactions is provided by the Nationwide Building Society. The Nationwide Building Society is the most comprehensive database on housing transactions in the United Kingdom and, crucially for this study, it is the one source that provides more detailed information on housing characteristics. Between 1995 and 2011 Nationwide recorded the price and geographical location of the property (at seven digit postcode) as well as a large set of housing features, 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. 9.500 wards leaving us with on average c. 130 transactions per ward across the full time period. The yearly sample size lies between 30,000 and 127,000 observations.

From the Census 2001 we derive the socio-demographic composition of residents in each ward. The variables derived from the Census include the share of female and highly qualified residents, the share of households with children, age, ethnic and marital composition, the share of unemployed individuals and different occupation groups.

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].

[4] www.police.uk/data

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 organizations 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 adopt 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. 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 Table1.

[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.

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 the individual's education level.

I. Estimating the neighbourhood amenity level

Our amenity measure is calculated according to the 1998 definition of electoral wards, which represents electoral districts within each city. Cities are defined as integrated, self-containing labour markets where the majority of people live and work in the same area. Local labour markets in Britain coincide with Travel to Work Areas (TTWAs)[9]. Among the full sample of British TTWA this analysis focuses on those defined as primary urban. We assume that workers living in different neighborhoods of a TTWA insist the same local labour market and thus have access to similar job opportunities.

To estimate the level of neighborhood amenities we run a hedonic regression according to Equation 1 using OLS techniques.

$$\ln(p_{j\omega t}) = x'_j\beta + a_\omega + \tau_t + \varepsilon_{j\omega t} \quad (1)$$

The log price per square metre $p_{j\omega t}$ for the transaction of house j located in ward ω 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 effect a_ω. The coefficient vector β contains marginal effects for all housing characteristics and $\varepsilon_{j\omega t}$ denotes the error term. We recover the ward fixed effects a_ω from the regression which we interpret as the level of amenities consumed by an individual living in the specific ward.

The main advantage of this strategy lies in the possibility of recovering a composite measure of amenities. This overcomes the limitations associated with the direct inclusion of a large set of amenities. The list of available amenities is often not exhaustive and the

[9] The 2001 definition of TTWA in Britain includes 232 TTWA, 79 of those being defined as primary urban. Within each TTWA at least 75% of the area's resident workforce work in the area and at least 75% of the people who work in the area also live in the area. The area must also have a working population of at least 3,500. However, for areas with a working population in excess of 25,000, self-containment rates as low as 66.66% are accepted. TTWA boundaries must be non-overlapping and contiguous, covering the entire UK between them. TTWAs are permitted to cross national boundaries (ONS, 2007).

strong correlation between different kinds of amenities leads to very imprecise estimates (Duranton and Puga, 2013). 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 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 1 controls for 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 an important caveat since a detached house, for instance, gives access to the same local amenities as the neighbouring flat in an apartment block.

We also tested the plausibility of our amenity measure by checking how well traditional measures of local amenities (such as crime incidents, listed buildings and parks, restaurants, cafes, bars, public houses and clubs as well as libraries and museums) perform in explaining the variation in our aggregate measure of amenities. By regressing the aggregate value on a number of individual amenity variables we therefore analyse the contribution of each single amenity to the overall attractiveness of an area. Further information and the result for the plausibility check are reported in Appendix A.

II. Estimating preferences toward amenities

Our second stage is aimed at testing whether preferences toward amenity consumption vary with the level of education. As in the standard Roback (1982) framework we postulate that 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 2.

$$a_{\omega i} = \delta y_i + \varphi qual_i + z'_i\gamma + \delta'_\omega\sigma + \rho_k + \mu_{\omega i} \quad (2)$$

The amenity consumption $a_{\omega i}$ of individual i living in ward ω 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 travel to work area fixed effects, which factor out the role played by differences in job opportunities across cities, and the term $\mu_{\omega i}$ captures all variation in the amenity measure that is not explained by the control variables[10].

Our preferred specification also includes the vector δ, which controls for the socio-demographic structure of each neighbourhood. Whereas it is plausible to expect that skilled individuals sort into better places 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 independently on other locational attributes. This implies that places with a high concentration of skilled individuals may both attract additional skilled workers and endogenously develop better amenities. 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

[10] Note that equation 2 is estimated at individual level despite our dependent variable varies across wards rather than individuals. The motivation behind this choice is twofold. First, by estimating equation 2 at individual level we have the possibility to control in a more detailed manner for differences in individual characteristics that may affect their location decision across wards. Second, the individual level regression allows to control in our second stage also for the demographic composition of each ward, including the share of skilled individuals. In our framework this is a relevant control since, together with individual preferences toward amenity consumption, the share of skilled individuals captures also preferences toward the local demographic composition, which in turn may correlate with local amenity. Estimating equation 2 at ward level and focusing on the share of skilled individual by ward as key regressor to investigate the link between amenities and skills would therefore introduce an upward bias in our estimation.

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. We also add the occupational composition at neighbourhood level to address possible cross-ward differences in the typology of local jobs.

III. Further discussion on the identification approach

Equation 2 allows investigating the link between amenities and skills while controlling for a number of features that have proven to be concerning aspects in previous research. First of all, our empirical setting includes TTWA fixed effects to control for differences across cities in job market opportunities, thus factoring out the role of demand side factors from the estimation of individual location preferences. This approach relies to the hypothesis that cities can be considered as integrated labour markets and that job accessibility does not change across neighbourhoods within the same city.

Recently, however, Manning and Petrongolo (2015) suggest that labour markets are intrinsically local and workers tend to search disproportionally in their closer neighbourhoods. They base their analysis on a continuous geographic space, as opposed to a collection of non-overlapping administrative units. Similarly, Ahlfeldth et al (2015) argue that congestion and preferences towards shorter commuting times may affect the spatial job search behaviour of different individuals also within each city. We test for the robustness of our results with respect to the assumption of cities as integrated labour markets by including controls for employment density at the local neighbourhood level as proxy for local job market opportunities and accessibility in our regressions.

Secondly, our framework allows to account for differences in the socio-demographic composition of each neighbourhood by including a vector of area characteristics in our preferred specification. It may be argued, however, that by estimating Equation 2 in cross section and constructing socio demographic controls based on 2001 Census data we underexploit the interdependence between the two dimensions. A bias may therefore arise if housing prices in more attractive locations already internalize higher expectations about the willingness of skilled workers to pay for local amenities. In order to strengthen our identification we re-estimate Equation 1 to recover a time varying composite amenity

measure[11]. The time varying structure of our dependent variable now allows in Equation 2 to include both ward fixed effects, which control for time invariant amenities and socio-demographic characteristics of each neighbourhood, and time varying controls for the local demographic composition. This more demanding specification exploits the time-varying variation in local amenities only. Changes in the amenity level induced by the concurrent evolution of the local demographic composition. Our regressor of interest, the high skill dummy, now captures the individual preference toward amenity consumption net of the time invariant component in the level of attractiveness of each neighbourhoods, in terms of both neighbourhhood specific amenity features and demographic structure, and the pull effect induced by chnages in the local demographic composition.

Finally, Equation 2 includes individual wage in all specifications, thus capturing the preference towards amenities that is driven by differences in individual income rather than the educational status. Nonetheless, even though we control for individual earnings, the estimation of the education coefficient φ might still be biased upwards by unobserved differences in non-labour income or wealth across education groups.

We believe that this is not 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[12]. 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[13], many workers holding a university degree today are likely to have parents with lower educational attainment than themselves. This implies that the majority of skilled individuals in our

[11] Details on the approach employed to recover a time varying composite amenity indicator are reported in Appendix B.

[12]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.

[13] 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).

sample may have experienced, on average, similar intergenerational transfers than non-degree holders.

To underline the validity of the above reasoning we deal explicitly with the potential bias stemming from differences in individual wealth levels and re-estimate our regression using renters and renters and mortgage holders only. [14] In the UK housing wealth accounts for c. 60% of total wealth and is highly correlated with wealth from other sources such as financial wealth and physical wealth (Office for National Statistics, 2014). Focusing on individuals with different housing tenures thus provides a possibility to test whether the results from the mail specification are biased by the lack of individual wealth controls.

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 1 are shown in Table 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 explain 57% of the variation in square metre prices, the inclusion of TTWA fixed effects increases the R2 to 80% and the inclusion of ward fixed effects (column 3) further increases the R2 to 87%. This evidence suggests

[14] Information on housing tenure is recovered from the Labour Force Survey, which allows to identify renters, mortgage holders and owners. There are 93,744 renters in our sample representing the about the 20% of the total population. An additional 300,054 individuals are mortgage holders, which cover almost the 65% of the total sample.

two key considerations. First, housing characteristics explain slightly more than half of the variation in prices while 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 R2 further increases, which suggests that variation in prices within cities is also non-negligible. Figure 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 A, confirms that the composite amenity measure is able to capture actual amenities at a local scale.

Our second stage regression is reported in Table 3. It shows the baseline results of Equation 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.[15]

In column (4) we include the neighbourhood composition as additional control variables.[16] 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 argue that the composition of the neighbourhood in terms of socio-demographic characteristics

[15] 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.

[16] Demographic controls include the share of female and highly qualified residents, the share of households with children, age, ethnic and marital composition and the share of unemployed and occupation groups.

makes up a substantial part of overall perceived neighbourhood quality and is especially valued by the high skilled. This finding is consistent with previous studies for Great Britain showing that skilled individuals reward the possibility to live close to similar people (Gibbons 2003). Notwithstanding this evidence, the results in Table 3 still indicate that high skilled workers consume a higher amenity level than low skilled workers with the same income level, as they choose to live in places characterised by a higher neighbourhood quality. Our findings suggest that on average high skilled individuals have an amenity consumption that is 0.19% higher than that of lower skilled workers earning a similar income. 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)).

I. Robustness Checks

As discussed in section 4.2 reverse causality between the share of highly qualified residents and the local amenity level is a key concern in the context of this analysis.

A 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. Previous studies found a moderate support for the relevance of amenties created by the presence of a skilled workforce in specific locations (e.g. Galeser and Saiz, 2004). Yet Diamonds (2013) has recently stressed this channel as key to explain the great divergence in the skill composition of U.S. cities.

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 4. 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 25th percentile and below the median. Similarly, columns (3) and (4) show results for the third and fourth quartiles. For three out of four quartiles we find a significant and positive difference in the amenity consumption for workers with different educational attainments. It ranges from 0.17% in the third and fourth quartile to 0.25% in the lowest quartile. In the second quartile the effects is weaker and at 0.09% not significant. If anything, the amenity preference is stronger in areas that have a lower concentration of high skilled workers. As such, the endogenous creation of amenities by high skilled workers does not seem to be driving our results.

A second channel through which reverse causality between amenities and skills may take place is the preference of skilled individuals towards neighbourhoods with specific demographic characteristics. High skilled individuals may value, for instance, the local educational composition or exhibit a higher preference for more diverse and multicultural environments when making their residential choice. Changes in level of local amenities may therefore be simultaneous to the location decision of skilled individuals. Failing to account for this concurrency and interdependence may lead to an overestimation of the role of amenities as pull factor.

We re-estimate our second stage by employing a time varying composite amenity measure to capture both changes in the amenity level over time and changes in the socio-demographic composition[17]. A time varying amenity measure allows a second stage estimation that includes both neighborhood fixed effects to account for time invarying differences in amenities and socio-demographic characteristics and a large set of indicators to capture changes in the demographic structure of each area[18]. This specification, which is very demanding and restricts the available variation in the data considerably, exploits the time varying component associated with changes in local amenities only. The results of this estimation procedure are shown in column (1) of Table

[17] Additional information on the data and the methodology to compute the time varying amenity measure is reported in Appendix B.

[18] We use information from the Census 2001 and 2011 for the socio-economic composition of the neighbourhood. As we do not have this information on a yearly basis we estimate a first difference regression. We pool LFS data from 2008 to 2010 and from 1999 to 2001 in order to get a larger sample size for the Census years.

5. Although the coefficient is significantly lower than in our baseline estimation, as a consequence of the very stringent specification, the main result that the level of amenity consumption is higher for highly qualified individuals holds also in this case. Unfortunately, no comparable estimates are available in existing studies to relate the magnitude of the coefficient. However its size should be interpreted bearing in mind the limited variation exploited in this latter specification.

Additional robustness checks on our main results are also reported in table 5. As mentioned in the earlier discussion differences in unobserved wealth levels are a concern in our estimation. In Table 5, columns (2) and (3), we show results for the subsample of renters and mortgage holders and renters respectively. Renters and mortgage holders are in fact less likely to have accumulated large assets as investments in housing represent one of the major form of individual wealth in Great Britain. The main result still holds across both categories suggesting that unobserved wealth is not the main driver of the preference effect.

A recently debated aspect also regards differences in job accessibility within the city. Our identification approach builds on the idea that cities operate as integrated labour markets where job opportunities are equally available to all residents independently on the neighbourhood. This is a reasonable assumption given that our definition of cities is based on self-containing labour market areas. Still, as discussed in section 4.2 individuals may be disproportionally willing to search for jobs in their closers areas such that the tightness of the very local labour market may represent an amenity per se. In column (5) in Table 5 a control for employment density at the local neighbourhood level is included as proxy for local job market opportunities. As this variable is only available for England and Wales, column (4) shows results of the baseline specification for these areas. The comparison of columns (4) and (5) shows that differences in very local job opportunities are not confounded with the amenity preference effect.

Finally, Table 6 presents several additional robustness checks for our main finding. In column (1) we show results for full-time workers only. High skilled individuals in full-time 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 0.14% 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 primary urban, respectively, non-primary urban TTWA. The indirect amenity measure derived from the hedonic regression approach is likely to capture different typologies of amenities in the two contexts. Results are shown in columns (2) and (3). On average highly skilled individuals in main cities choose to live in neighbourhoods offering an amenity level that is 0.17% higher than that of individuals with lower educational attainment. For non-primary urban areas the difference amounts to 0.20%.

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 (e.g. 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 0.30% higher than that of younger, less educated workers. For older workers the difference is not significantly different from zero. Given the same level of wages, 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 identifies professionals and managers as highly skilled. The amenity preference effect resembles that based on the education based classification and amounts to 0.66%.

6. Conclusion

The worldwide increase in the number and amount of resources spent in "beautification" programs has been justified in the light of the expected economic returns. In this context amenities are in fact considered as key mechanism to spur demographic change, to attract skilled individuals and to foster development.

The view that cities have turned into places for consumption where skilled individuals seek for a wide range of opportunities to spend their leisure time has gained increasing popularity and has been supported by a number of consistent arguments.

First, high skilled individuals tend to sort into more expensive cities. Second, in these places they are willing to forgo a higher portion of their income to enjoy local amenities.

These empirical regularities have been interpreted as a signal for a higher preference towards amenities consumption by skilled individuals with respect to their lower skilled counterpart earning a similar income.

This paper develops an investigation of the link between amenities and skills investigating whether differences in the level of neighbourhoods amenities drive the sorting of skilled individuals within British cities. Our empirical framework allows to test for the existence of a skill biased preference toward amenity consumption when controlling for differences in the availability of job opportunities across and within cities and for the interdependence between changes in local amenities and the evolution in the demographic composition of each neighbourhood. As such our investigation does not attempt an analysis on the role of amenities against that of labour market factors in explaining the sorting behaviour of skilled individuals. On the contrary it embraces the idea that job market opportunities are a necessary condition for city growth testing whether differences in amenity levels are key pull factors in the residential choice of skilled individuals when factoring out differences in job accessibility. In this view our research, despite adopting a different approach with respect to previous studies exploiting variations in amenities between cities, while addressing some important limitation of existing contributions also provides generalizable implications for the longstanding debate on the link between amenities and skills.

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. These findings correlate with recent studies supporting the role of local amenities in the location choice of skilled individuals, although the intensity of this preference bias is not as relevant as in previous contributions employing different research designs.

In this view an additional caveat applies to our findings. Though, we find evidence that skilled individuals show a higher preference for amenity consumption, the magnitude of this effect (although non-negligible) is smaller than the preference bias highly educated workers show with respect to the possibility to live close to similar people. As such the level of amenities and the demographic composition of a place play a concurrent and interdependent role in shaping the sorting behaviour of skilled individuals and in turn its development prospects.

This conclusive statement raises relevant implications for the evolution of urban areas, which also bring along a number of open questions. Large metropolitan areas where investments in beautification and local amenities are reflected in higher housing prices and cost of living might experience significant changes in their demographic composition. In the short run this may exacerbate phenomena of residential segregation of disadvantaged education groups in low amenity neighbourhoods. Over time cities may evolve into communities that are affordable only by rich, well educated people. Is such a scenario sustainable? Do cities risk to lose the diversity and openness that make them unique?

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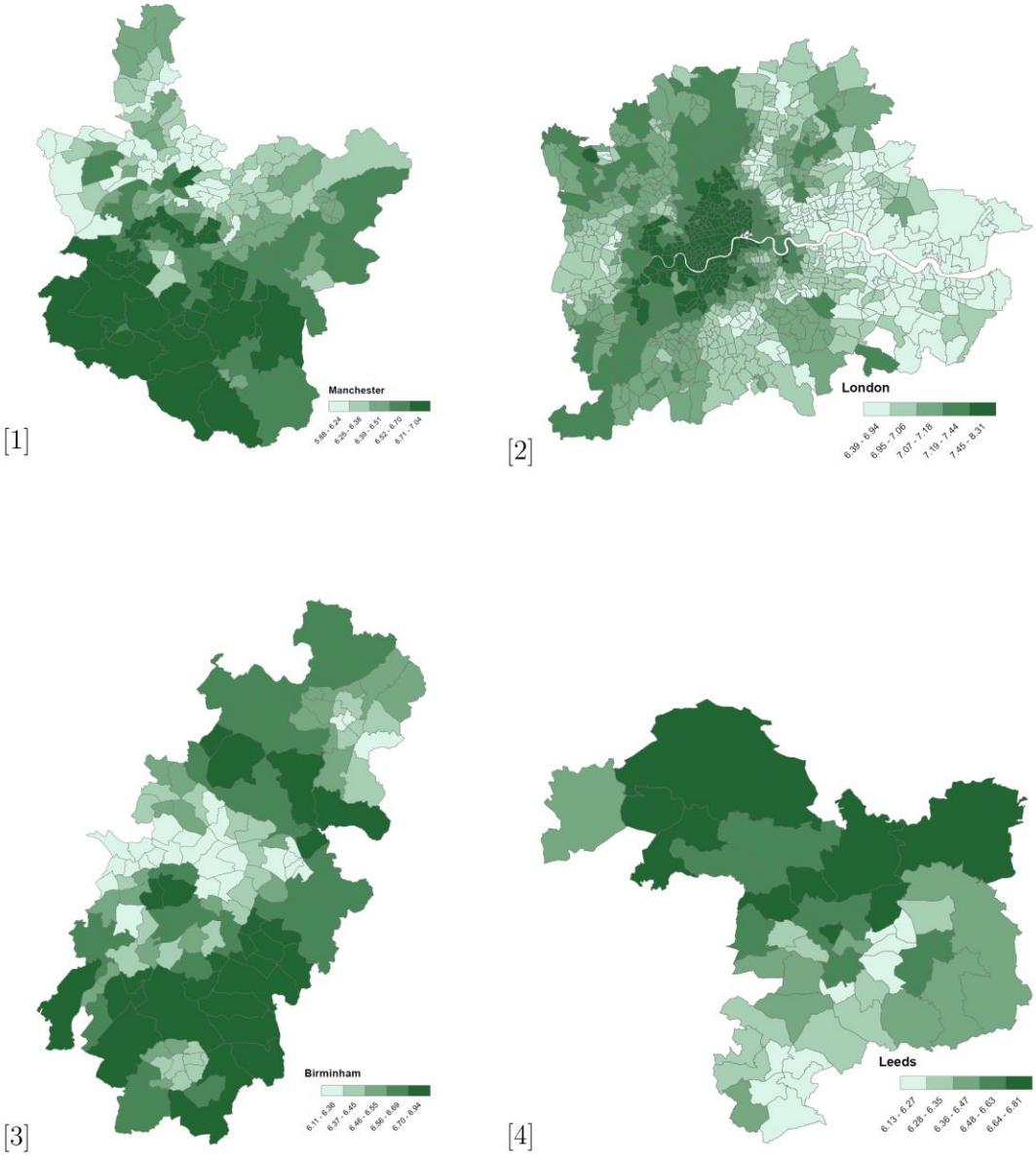

Figure 1: Amenity measure in selected cities: [1] = Manchester, [2] = London, [3] = Birmingham, [4] = Leeds.

Table 1: Variable description.

Variable	**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, 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 2: Hedonic regressions.

	(1)		(2)		(3)	
Dep.Var.	Ln(price/sqm)		Ln(price/sqm)		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: Baseline regression to test for the amenity preference bias.

Dep.Var.	(1) Amenity level	(2) Amenity level	(3) Amenity level	(4) Amenity level
Skill dummy based on qualification	0.0960***	0.0651***	0.0563***	0.00157***
	(0.0161)	(0.0109)	(0.00554)	(0.000547)
Weekly net wage	0.0808***	0.170***	0.0472***	0.00661***
	(0.0240)	(0.0424)	(0.00805)	(0.000875)
Constant	6.076***	5.860***	6.381***	7.864***
	(0.0656)	(0.0823)	(0.0242)	(0.752)
Observations	463,455	463,455	463,455	463,455
R-squared	0.046	0.157	0.801	0.935
TTWA FE	NO	NO	YES	YES
Controls	NO	YES	YES	YES

Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Dep Var: Amenity level = 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, 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, and occupational shares are added.

Table 4: Sample split according to the level of skill concentration in each neighbourhood.

Dep.Var	(1) p25- Amenity level	(2) p25 - p50 Amenity level	(3) p50 - p75 Amenity level	(4) p75+ Amenity level
Skill dummy based on qualification	0.00248***	0.000960	0.00172**	0.00171***
	(0.000702)	(0.000632)	(0.000673)	(0.000582)
Weekly net wage	0.00499***	0.00351***	0.00329***	0.00712***
	(0.000617)	(0.000751)	(0.000929)	(0.00138)
Constant	5.149***	5.828***	6.980***	9.337***
	(1.210)	(0.969)	(0.837)	(0.500)
Observations	115,875	117,883	102,889	112,576
R-squared	0.910	0.915	0.915	0.928
TTWA FE	YES	YES	YES	YES
Controls	YES	YES	YES	YES

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. All columns include individual level controls, 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, TTWA fixed effects and neighbourhood level controls, 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 and a variable measuring the geographical distance from the ward centroid to the TTWA centre.

Table 5: Robustness checks I.

	(1)	(2) Renters and Mortgage	(3) Renters only	(4)	(5)
Dep.Var.	Time varying Amenity level	Amenity level	Amenity level	Amenity level	Amenity level
Skill dummy based on qualification	0.000590**	0.00156***	0.00279***	0.00144***	0.00152***
	(0.000280)	(0.000600)	(0.000943)	(0.000526)	(0.000512)
Weekly net wage	0.000450*	0.00721***	0.00955***	0.00688***	0.00680***
	(0.000254)	(0.001000)	(0.00199)	(0.000878)	(0.000834)
Job density					0.00985***
					(0.00177)
Constant	13.39***	7.858***	8.254***	7.878***	7.700***
	(0.518)	(0.759)	(1.004)	(0.816)	(0.780)
Observations	281,168	393,798	93,744	418,165	418,165
R-squared	0.991	0.936	0.940	0.937	0.937
TTWA FE	NO	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES
WARD FE	YES	NO	NO	NO	NO

Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Dep Var: Amenity level = ward level fixed effect derived from a hedonic price regression. Column (1) uses time varying wards fixed effects, constructed using Land Registry data, as dependent variable. It includes time varying demographic characteristics from Census 2001 and 2011. In the regression we pool individual data from years 1996 to 2000 and 2006 to 2010. Column (2) focuses on renters and mortgage only while Column (3) looks at the subsample of renters only. Column (4) includes a control for job density at ward level. Data are available for England and Wales only, therefore results in Column (5) need to be compared with baseline estimates in Column (3).

Table 6: Robustness checks II.

	(1) Full time employees	(2) Primary Urban TTWAs	(3) Non-primary Urban TTWAs	(4) Individuals aged 25 - 40	(5) Individuals aged 40 - 55	(6) Occupation based skill measure
Dep.Var.	Amenity level	Amenity level	Amenity level	Amenity level	Amenity level	Amenity level
Skill dummy based on qualification	0.00138*** (0.000507)	0.00168*** (0.000609)	0.00205*** (0.000776)	0.00295*** (0.000491)	-0.000292 (0.000942)	
Weekly net wage	0.00857*** (0.00102)	0.00756*** (0.000842)	0.00244*** (0.000707)	0.00845*** (0.00132)	0.00574*** (0.000613)	0.00655*** (0.000916)
Skill dummy based on occupation						0.00167** (0.000665)
Constant	7.998*** (0.761)	8.164*** (0.817)	6.551*** (0.709)	8.034*** (0.758)	7.641*** (0.733)	7.862*** (0.752)
Observations	350,152	357,380	106,075	222,027	187,046	463,331
R-squared	0.936	0.936	0.910	0.938	0.933	0.935
TTWA FE	YES	YES	YES	YES	YES	YES
Controls	YES	YES	YES	YES	YES	YES

Standard errors are clustered on travel to work areas. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

Dep Var: Amenity level = ward level fixed effect derived from a hedonic price regression. Control variables are the same as in Table x Column (3). Column (1) shows results for the subsample of full-time workers only, Column (2) and (3) shows results for the subsample of primary urban respectively non-primary urban workers. In Column (4) and (5) the sample is split into workers aged 25-40 respectively 40-55.

Appendix A: Plausibility check for amenity measure

We interpret the neighbourhood fixed effect estimated in Equation 1 as an aggregate measure of local amenities. In order to check whether this interpretation is reasonable and whether 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 aim at checking the plausibility of our aggregate amenity measure by looking at the correlation with neighbourhood characteristics that are commonly used in the literature to measure historical, architectural or consumer amenities. Second, we want to look at the contribution of each component to the total amenity level.

Equation 3 is estimated using OLS where $a_{\omega k}$ is our amenity measure, $z_{\omega k}$ is a vector of the listed neighbourhood characteristics and $v_{\omega k}$ are TTWA fixed effects.

$$a_{\omega k} = z'_{\omega k}\vartheta + v_{\omega k} + \varphi_{\omega k} \qquad (3)$$

The results of Equation 3 are shown in Table A.1 in Appendix A. 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 and not

necessarily correlated with distance from home[19]. 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.

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 the whole labour market area. When cross-city variation is accounted for the effect of restaurant and bars becomes highly significant as would be expected. Consumer amenities are, in fact, more likely to be strongly correlated with local economic conditions and to differ significantly across cities.

[19] 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 A.1: *Plausibility check for the amenity measure*

Dep.Var.	(1) Amenity level	(2) Amenity level
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)
Observations	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 B: Time varying amenity measure

We also estimate a measure of time varying amenities for British neighbourhoods. Such an estimation puts very high requirements onto the data, as a sufficiently large number of housing transactions for every ward and every year is needed. As there are too few observations in the Nationwide data for such a detailed estimation procedure we use transaction price information from the Land Registry.

The land registry tracks all residential property sales and their location in England and Wales between 1995 and 2011 and the number of sales recorded ranges form 1.31 million in 2006 to 0.62 million in 2009. The Land Registry offers the largest available sample size, however information on housing characteristics are limited, which is the reason why we use the Nationwide Building Society data in the main specification. 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.

A time varying amenity measure is calculated in a similar way as in Equation 1.1. Rather than using transactions of the entire time period, amenity levels are estimated using a moving three year window for every year. For instance, to estimate the local amenity level in 2001 transactions from 2000, 2001 and 2002 are pooled together, to estimate the local amenity level in 2002 transactions from 2001, 2002 and 2003 are pooled toghether and so forth. Due to the large number of observations available in the Land Registry dataset and the fact that we pool several years it is possible to get an amenity estimate for c. 9200 wards in all years between 1996 and 2010.

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