

Inequalities in Access to Employment and the Impact on Wellbeing: A Criterion for Spatial Planning?

Liv Osland

*Stord/Haugesund University College,
Bjørnsonsgt 45, N-5528 Haugesund, Norway
liv.osland@hsh.no*

Gwilym Pryce

*Department of Urban Studies,
University of Glasgow, Glasgow, Scotland G12 8RS
g.pryce@lbs.gla.ac.uk*

and

Nigel Sprigings

*Department of Urban Studies,
University of Glasgow, Glasgow, Scotland G12 8RS
n.sprigings@lbs.gla.ac.uk*

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Abstract: This paper attempts to address three questions: (1) How unequal is access to employment and the wellbeing associated with it? (2) What is the money value consumers place on access to employment? and (3) How does the inequality of access to employment correspond to the geographical pattern of variation in social deprivation? On the basis that house prices, once adjusted for property type and size, reflect variation quality of life across space, econometric estimates of the impact of employment access on house prices can be used to simulate the impact on inequality of wellbeing. With this rationale in mind, we use the Osland and Pryce (2009) house price model to derive an appropriate measure of Access Welfare – the wellbeing associated with locating at a given distance to employment – and to put a money value on that welfare. The model also allows us to incorporate the negative externalities associated with living in close proximity to centres of employment, and the complexities that arise from the existence of multiple employment centres of varying size. We use Gini and Atkinson coefficients and kernel density estimation to analyse the inequalities observed.

Introduction

How can we measure the inequality in wellbeing that arises from unequal access to employment? It is a slippery question because poor access to employment may affect other variables, such as the ability to find work, or at least affect how easy it is to find the job that best matches one's skill sets. And if land prices are higher the better the access to employment, there may be vicious circles at work as those on low wages are screened out of the best placed housing. In the long term, however, how much those on high wages will outbid those on low wages for a house with easy access will reflect the increase in welfare associated with proximity to employment centres. It follows that the value of a dwelling, once other factors have been controlled for (such as property attributes, size, and access to amenities such as good schooling, shopping facilities and leisure), should rise and fall with the value of employment access.

The problem is complicated, as we shall see, by the existence of multiple employment centres of variable size, and negative externalities (pollution, noise and congestion) which diminish the quality of life for residents close to employment centres.

Our goal is to account for such complexities using a gravity based hedonic model with non-monotonic distance effects and derive a measure that captures the wellbeing associated with location at a given distance from employment. We call this "Access Welfare" and attempt to ascribe to it a meaningful scale by placing a money value on it. We also seek to gauge how unequal this form of wellbeing is by applying kernel density estimation techniques and estimating Gini and Atkinson coefficients for the respective measures. Finally, we investigate whether there is any correspondence between Access Wellbeing and social deprivation. Our results show an stark negative relationship between the two, raising important questions about the priorities of

planning policy and whether equality of access (based on models of the kind proposed here) should be an active ingredient of strategic planning decisions.

The paper is structured as follows. Section 1 reviews the existing literature. Section 2 states our research questions. Section 3 summarises the main methodological challenges and how our econometric strategy attempts to address them. We also, in this section, summarise our approach to measuring inequality. Section 5 describes our data and section 6 presents the results of our regression analysis, and our attempts to investigate the three research questions listed above. Section 7 concludes.

1. Literature Review

Unless populations, employment and services were spread evenly across space with no tangible barriers to access (gradients, rivers, borders etc) it seems inevitable that an unequal society will produce inequalities with spatial characteristics. This raises the question of whether the spatial aspect of inequality is simply an attribute or an explanatory factor. In this the various literatures on “space” show parallels with the housing literature on area or neighbourhood effects where the impact of residence in an area is often felt to be detrimental to life chances and life quality generally.

Area effects “are potentially important in themselves as a source of disadvantage” (Atkinson and Kintrea, 2002) however the key word here is “potentially” indicating that the causal link is hard to specify. Much of this literature can identify spatial concentrations of poverty for example, and can link this to variations in service

quality and accessibility (Sinclair 2001). In the UK this connection has often been assumed but in economies where public services are often specifically targeted at areas of concentrated poverty there is also evidence that this may not be a simple correlation.

Hills (2007) points out that:

While there has been a fall in the proportion of social tenant householders formally classed as “unemployed”, there has been a striking rise in the proportion of social tenants classed as “other inactive” (63 per cent of whom are lone parents) and particularly in those reported as “permanently sick or disabled”, to nearly one quarter of all those of working age. As the final panel shows, such “other inactive” households are now overwhelmingly those with children. (p46)

As inequalities and outright disadvantage are often linked to employment status the social rented sector is clearly of some importance. A likely spatial effect will be the concentrations of employment and income related inequality on estates where the right to buy was not felt to be attractive in the 1980s (when over 40% of council tenant households were in employment). Peripheral estates will feature significantly in this (for example east Birmingham) but so will estates of unpopular construction types and all of these will have key spatial characteristics that may not fully equate to accessibility. In some instances services and facilities are technically accessible but aren't used (e.g Moss Side and East Manchester are accessible to central jobs (walking distance) but not often accessed in practice due to other barriers (perceptions, aspirations etc).

Spatial planning in relation to services often target public services to areas of disadvantage and this is where spatial information has already been used to target service provision. In some instances accessibility to some services in disadvantaged

areas is greater than in more privileged neighbourhoods (although accessibility measured in time may be easier due to being able to afford personal transport) Examples of this in the literature include schools, nurseries, urban parks and playgrounds. Generally these are found to be well distributed but not always well used.

Macintyre et al (2008) surveyed the accessibility of 42 services in Glasgow by areas of deprivation and found that “access to services does not always disadvantage poorer neighbourhoods” (this finding is consistent with Atkinson and Kintrea 2002). However many of the services or resources accessible in more deprived areas were publicly provided (police, primary schools, public nurseries, play areas etc) and, strangely, included “vacant and derelict land/buildings” which are often seen as signs of disadvantage rather than as resources. In contrast, many private services were more accessible to comparatively affluent areas.

It seems reasonable that privately run services operating for profit are more likely to locate themselves in areas where there is more disposable income available. While this may disadvantage people in the more deprived area in theory, the question remains whether they are practically disadvantaged by lack of access to private schools, private fitness centres, banks, building societies and so on. The causal relationship here remains unclear: are services sparse because the area is deprived or is the area deprived because services are sparse?

Furthermore, when social housing is identified as the location of poverty concentrations, this can also be said to reflect both the remit of the sector (meeting

needs) and the fact that much recent development has taken place within areas of existing deprivation (low land costs, public ownership etc. all increase the likelihood of new social housing development through RSLs). Attempts to resolve the concentration problem with mixed tenure developments may have diluted poverty concentrations where they have been successful, but this has often been as a result of the relocation of disadvantaged households (for example the Moving to Opportunity programme in the USA is the most monitored project of this sort but there have been similar effects in Manchester and other British cities).

The issue of access to services or employment centres is not always about spatial distance. The most obvious additional factor is time, where a short distance may take a long time because of congestion (Vandenbulcke et al 2008) or where distances are shrunk by access to rapid transport (at high cost) compared to shorter distances being extended by poor services, no private transport, or by service costs. Simple spatial and time measures may not capture all the dynamics here either. In the Wester Hailes area of Edinburgh, a subway under a wide dual carriageway provides a direct link from houses to shops and other services. However elderly residents fear violence in the dark underpasses and often choose to cross the road by catching a bus to a safer crossing place and then catching another bus back on the other side of the road. So crossing the road both ways involves 4 bus journeys!

As mentioned above, much of this discussion relates to social housing locations and may not be easily transferable to price data analysis. Even where RTB houses are transacted in these areas they are increasingly purchased for a low value rental market

by private landlords so the price reflects the local low income household rental yield potential rather than amenities directly.

2. Research Questions

We seek to investigate the following research questions:

1. *How unequal is the wellbeing derived from access to employment across the city?*

That is, we seek to estimate the distribution of “Access Welfare” across locations in Glasgow, and to use standard measures, such as Gini and Atkinson coefficients, to gauge how unequal that distribution is across space.

2. *What is the money value placed on access to employment*

We seek to estimate the financial value that society places on being located in close proximity to employment, mindful of the fact that there may be offsetting factors at work (i.e. negative as well as positive effects on wellbeing associated with living near a centre of employment – see methods section below).

3. *How does the inequality of access to employment correspond to the geographical pattern of variation in social deprivation?*

In other words, who receives the most welfare gains from access to employment, the poor or the rich? This is an important question because it potentially relates planning decisions to social and economic inequality. It also connects our results to the predictions of urban economic theory which traditionally places higher income households further from employment nodes.

3. Methods

Methodological Issues:

(a) Multiple Employment Nodes

Access to employment cannot adequately be measured by distance to CBD or the nearest employment node. This is because (i) there are likely to be multiple centres of employment across the city; and (ii) different employment nodes will have different levels of employment. Furthermore, many households have more than one worker and many workers are required to work between two or more sites (Yiu and Tam, 2007). Access to future job opportunities is also important (Crane, 1996, p.342). Ideally, therefore, we seek a way of deriving a gravity based access measure, along the lines of Osland and Thorsen (2008), which takes into account the distance to multiple employment nodes, and weights these distances by the size of each node.

(b) Negative Externalities

A second problem arises from the fact that locating too close to an employment node is likely to have a negative effect on welfare. Richardson (1988) suggested introducing “some other element in rent determination, which tends to become larger with increasing distance” (p.62). Namely, the “concept of an externality rent which is negatively associated with density” (p.62). While Richardson’s proposed solution has theoretical flaws (see Grieson and Murray (1981) and Tauchen 1981) the basic idea is sound. That employment centres might be associated with lower welfare is not controversial assumption – zoning rests on the philosophy that residence and production should be kept apart due to the noise, pollution and congestion associated

with the latter. This leads to distance to employment being viewed as a trade-off between rising transport costs and falling disamenity of proximity to commercial/industrial buildings (Osland and Pryce 2009). Li and Brown (1980) follow a similar line of reasoning based on “micro-neighbourhood externalities”, estimated from the effect of distance to physical and commercial features, though they overlook the effect of access to multiple centres, which could be crucial as noted above.

(c) Direction of Causation.

If we ask how does the distribution of Access Welfare vary by income group, we must be aware that employment access may itself affect earning potential. So the direction of causation may run two ways. In the long run, the earning potential associated with locating in a particular area will be reflected in the price of housing in that area, so the geographical pattern of house prices observed in a given moment should indeed reveal wellbeing if house prices are approximately in equilibrium. Nevertheless we should describe our results with caution because of the dynamic and circular relationship with income.

A second cause for concern arises from the fact that planners have limited control of the location of firms. They can zone land use and direct planning permissions but cannot force firms to locate in a particular area – they may simply relocate in a different city. One factor affecting the location decision of firms is the pool of skilled labour. A second is the proximity to market – other things being equal, firms seek where the demand for their goods can be realised. This in turn is affected by the

location of high earners so it may be that employment location follows income rather than the other way round.

Consequently, we do not present our analysis of the correspondence between Access Welfare and income as a strictly causal one, rather we simply describe the pattern observed.

(d) Transport vs Distance

Another theme in the literature, which we shall overlook here, is the role of transport. The assumption seems to be that space does distribute attributes and services unequally and that transport is the solution in some instances. Germany has a regional planning strategy that is based around no one being more than a limited commuting time from an urban centre for example. This policy is said to have evened out economic development and house prices.

In terms of our present study, the issue is whether simple distance to employment is an adequate proxy for accessibility. Glasgow has a complex mesh of roads, railways, bus routes and cycle lanes and so there will inevitably be errors and biases associated with using simple Euclidian distance as a measure of access. There is, however, a strong counter argument to attempting to use a measure based on commuting time or travel costs rather than distance. The very complexity of the transport network is likely to frustrate meaningful measurement. Idiosyncrasies in transport access may be so localised that they will escape any attempt to capture them in a single measure. As a result, modelling transport access may lead to greater bias, or at least offer little gain, compared to simple distance measures. Adair et al (2000), for example, find accessibility in most submarkets to have low significance levels (sig. > 0.05) despite

going to considerable lengths to define a precise measure of accessibility. Moreover, there is research that suggests that linear distance may be a surprisingly good approximation of journey times in large samples. Combes and Lafourcade (2005), for example, find that the two have a correlation coefficient of over ninety percent. Duranton and Overman (2005) argue that And there are theoretical grounds for believing that there are countervailing biases implied by using Euclidean distance as a measure of accessibility which are likely to cancel each other out. While one might expect journey distances to exceed Euclidean distances in low density areas because of fewer roads, the effect will be compensated for by less congestion in those areas (Duranton and Overman, 2005, p.1083).

(e) Social Renting

One obvious concern, regarding the use of a hedonic model to simulate the house price effects of access to employment, is whether analysis of house price data can capture significant information about spatial inequality in employment in areas dominated by social renting. This is especially important as spatial concentration of social housing is associated with a variety of disadvantages (income, employment, obstacles to employment such as disability etc. – see points from Hills 2007 above). One important development that goes some way to ameliorate this concern is the advent of Right to Buy. Because social housing can now be purchased and resold into owner occupancy, areas that were exclusively social renting (and remain primarily so) will now be represented in a dataset of private house transactions, and the price differentials in those sales will allow us to pick up variations in quality of life, holding constant the type and size of property. Inevitably, however, such sales are sparse

relative to areas that are dominated by owner occupancy or private renting¹ and there may be sample selection problems. However, it is anticipated that the geographical variation in access to employment and other drivers of wellbeing will be so pronounced that it will dominate the loss of precision that arises from sparse observations.

Econometric Strategy

To address the problem of multiple employment nodes and the complication that the effects of distance may not be linear or even monotonic, we need to find a way of modelling the relationship between access to employment and house prices that does not impose linearity or monotonicity, and that captures the effect of proximity to many employment centres, each of varying size in terms of numbers employed.

Our approach is to use the regression model of Osland and Pryce (2009) which relates the price of homogenous housing at a given location to the gravity based access variable, S_j , where $S_j = \sum_j L_j^\gamma v_j^\theta \exp[\sigma v_j]$. In the current paper, we interpret this variable as an indicator of the wellbeing or welfare that arises from access to employment. We there describe S_j as our Access Welfare variable. Note that by estimating the values of parameters g , q and s , we are able to take into account the non-monotonic effect of distance on welfare – that is, S can rise with proximity to employment nodes but then decline as one approaches close proximity.

¹ Dwellings used for private renting also enter databases on house transactions because private landlords buy and sell properties.

Of course, to isolate the effect of distance to employment, we need to control for dwelling heterogeneity (house prices in one area may be more expensive not because of access to employment but because of larger or better quality housing). We attempt to control for such effects by including a range of house characteristics in the model plus distance to the central business district (CBD) which is assumed to be the locus of a variety of important amenities including shopping facilities and leisure attractions, which have an impact on wellbeing (and hence the value of housing in close proximity) above and beyond the effect of access to employment.

We use the log of house prices (because house prices tend to be approximately log-normal, that is, while selling prices are certainly not normally distributed, the distribution of the log of house prices is close to normal). This leaves us with the following model:

$$\ln(P) = a_0 + \mathbf{b} \cdot \mathbf{A} + a_1 \sum_j L_j^\gamma v_j^\theta \exp[\sigma v_j] + a_2 CBD + a_3 Seas_d + a_4 D+i Subm_d + a_5 SPerf + \varepsilon \quad (1)$$

where P = observed selling price at location i , \mathbf{A} is a vector of attributes of dwelling at location i , and CBD is the distance to the central business district. CBD is included to test whether there are any effects of proximity to CBD other than distance to employment centre effect (Osland and Thorsen, 2008). The model is adjusted for time of sale, and hence, seasonal dummies $Seas_d$ are included. $Subm_d$ denotes the inclusion of submarket dummies. The area is divided into four submarkets: the West End, East End, South Side and North Side. In our regression models we include a dummy variable for each of these submarkets except the West End ($Subm_d$). The

variable $SPerf$ denotes school performance, and has been shown to be of importance in the housing submarket literature (see for instance Goodman and Thibodeau 1998). The main challenge here is to estimate the access parameters γ , θ , and σ , which we achieve using Maximum Likelihood methods. If one assumes monotonic distance effects on the house price gradient, then this is equivalent to imposing the restriction $\theta = 0$, and the model reduces to $S_j = \sum_j L_j^\gamma \exp[\sigma v_j]$, which is similar to the O&T (Osland and Thorsen 2008) regression model. More details are given in Osland and Pryce (2009) on the estimation process where a variety of regression models are estimated. In the current paper we use the OLS results for sake of simplicity.

Measuring Inequality:

We employ three methods to measure inequality of access: kernel density estimation, Gini coefficients and Atkinson coefficients.

Kernel density estimation is a non-parametric approach to estimating the probability density function of a variable. The probability density function is a mathematical representation of the distribution of a variable. It is similar to a histogram except that the vertical axis is standardised to ensure that the area under the distribution equals one. Also, the density curve is more precise than a histogram in the sense that it shows the shape of the distribution as a continuous line rather than as a series of discrete columns.² We estimate the shape of the distribution using kernel density methods which are non-parametric and so do not assume a particular shape to the distribution

² For more details, see an introductory statistics text, such as Moore and McCabe (2003 pp. 66-68, 82-83, 310-312).

(i.e. it means that we do not have to assume that employment access is normally distributed, for example). In terms of our current requirements, kernel density estimation allows us to simulate the shape of the distribution and hence helps us visualise how unequal access to employment actually is. If there is complete equality in access, then the density function will appear as a single spike – every observation will have the same value. The greater the inequality in access, the more spread out the distribution will be.

The Gini coefficient takes on a value between zero and one, and can be represented as a percentage (Johnson, 1973; Lambert 1993; De Maio 2007). If wealth is perfectly equally distributed, the Gini coefficient will equal zero. In a perfectly unequal society, where all wealth is owned by one person, the coefficient will equal one. The standard Gini measure of inequality is applied to the Access Welfare variable.

Atkinson coefficients allow one to specify a sensitivity value, e , to capture how concerned the researcher is about those in the sample with lowest value of the variable in question (in this case, the Access Welfare variable). e can be specified to lie at any point range zero to infinity, the higher the value, the greater the sensitivity of the index to inequalities at the bottom of the Access Welfare distribution. Atkinson coefficients are conventionally computed for a variety of values of e , typically $e = 0.5$, 1, 1.5 and 2 (De Maio, 2007, p. 850). We apply the standard Atkinson measures of inequality to the Access Welfare variable.

5. Data

The variables of our model are summarised below in Table 1. As outlined before, in line with many hedonic studies we include four types of variables: Type of dwelling, internal characteristics of the houses, external characteristics, size of houses and lots, seasonal dummies, a number of neighbourhood and submarket variables. The house price data were supplied by Glasgow Solicitors Property centre, a consortium of over 200 real estate agents across the Strathclyde city region, and are comprised of 6,269 dwelling transactions in Glasgow in 2007. This comprises a fairly large dataset, given that we are going to perform a spatial econometric analysis. The dataset has a relatively dense spatial distribution. A large proportion of the data lies within about 10 km of the center of Glasgow, the maximum distance for any observation from the center is about 30 km. In order to identify the relationship between house prices and labour market accessibility, some variation in accessibility is necessary. This calls for using a relatively large geographical area as our basis. A thorough presentation of the average selling prices, types of houses, differences in landscape, neighbourhood characteristics and access to a range of amenities that appear in these submarkets is found in Pryce and Gibb (2006).

Table 1 Descriptive statistics

	Variable Name	Mean	Standard Deviation
	Selling price (GBP)	139,850.00	75,714.17
Type of Dwelling	House	0.2792	0.4486
	Conversion	0.0182	0.1336
	Detached Bungalow	0.0227	0.1488
	Semi detached bungalow	0.0188	0.1359
	Detached Villa	0.0638	0.2444
Internal Characteristics &	Traditional	0.1050	0.3065
	Bay	0.1916	0.3936
	Bedrooms	2.2450	0.8900

Size	Public rooms	1.2770	0.5735
	Ensuite	0.0518	0.2217
	Gas Central Heating	0.6168	0.4862
	Needs upgrading	0.0193	0.1376
	Luxury	0.0284	0.1661
External Characteristics & Size	Plot measured in Acres	0.0016	0.0399
	Garden	0.7212	0.4485
	Garage	0.2346	0.4238
	Parking	0.1099	0.3128
	Views	0.0526	0.2233
Season	Spring	0.2823	0.4502
	Summer	0.2747	0.4460
	Autumn	0.2337	0.4232
Neighbourhood/ Submarket Variables	Deprivation	5.6220	2.3930
	School Performance	35.7866	22.8057
	eend_d	0.0861	0.2806
	sside_d	0.1905	0.3927
	ngla_d	0.0322	0.1766
Distance to CBD	Distance to CBD (km)	8.4988	6.3382

6. Results

Regression Results

The specification of the Access Welfare variable makes the hedonic house price model (1) non-linear in its parameters. For this reason maximum likelihood estimations have first been performed to obtain optimal values of the parameters. In this way, all the parameters have been estimated simultaneously as against a more stepwise procedure found in for instance Adair et al. (2000). Thereafter we have performed least squares estimation of (1) which is based on imputed values of the estimated parameters found in the Access Welfare variable. This explains the ordinary least squares results documented in Table 2.

The estimation results found in Osland and Pryce (2009) clearly showed that the Access Welfare variable contributes significantly to explain variation in housing prices in the Glasgow area. The variable is most significant when monotonicity is not imposed. To provide evidence for this result, Osland and Pryce (2009) followed a spatial econometric approach as recommended by Florax et al. (2003). This means that the paper started with some relatively simple model specifications. These model alternatives were then thoroughly tested for various spatially related misspecifications. Regardless of which spatial model we used (i.e. spatial error model, spatial lag model or a more comprehensive spatial Durbin model), regardless of estimation method and number of neighbours included in the weights matrices, the variable labour market accessibility with a non-monotonic distance effect was important for explaining variation in housing prices. Tests for spatial effects showed that a spatial error model probably is the most correct specification of (1). This may imply that the ordinary least squares estimator is unbiased. It should, however, be

noted that there are relatively large variations in the values of the estimated elasticities of employment accessibility in the OLS-model and the spatial error model. This warrants a careful interpretation of the results found in this paper.

Table 2 Regression Results

Linear regression			Number of obs = 6269		
			F(28, 6240) = 400.69		
			Prob > F = 0.0000		
			R-squared = 0.6103		
			Root MSE = .30549		

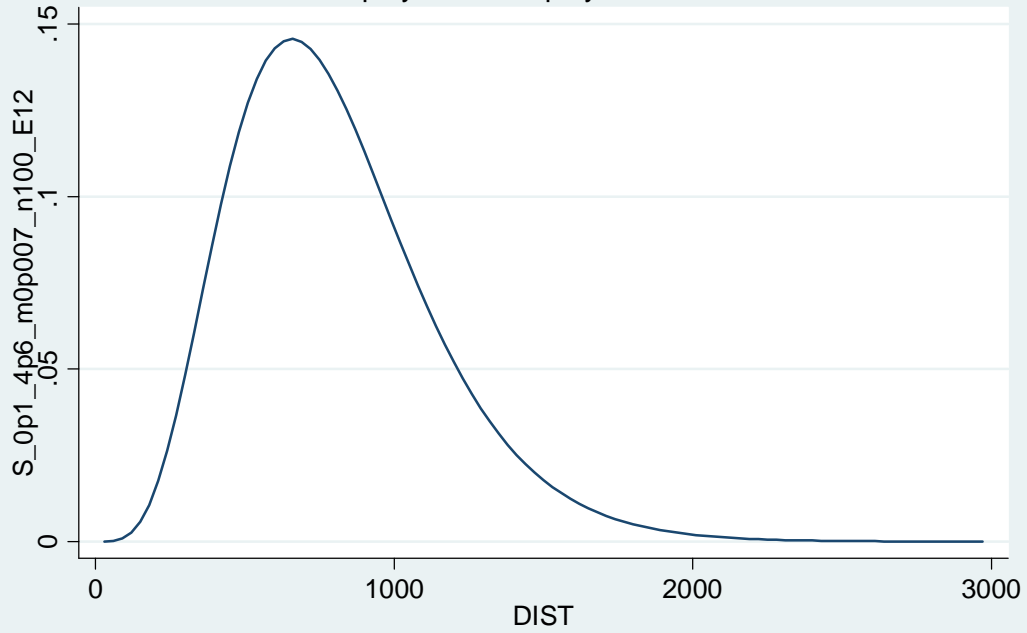
sellingpln	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]

hous_all	.2196775	.0131007	16.77	0.000	.1939956 .2453595
convsn_d	.3695046	.0261976	14.10	0.000	.3181483 .4208608
bundet_d	.3158067	.0284138	11.11	0.000	.260106 .3715075
bunsd_d	.1641338	.0214784	7.64	0.000	.1220287 .2062389
vildet_d	.1380729	.0181949	7.59	0.000	.1024046 .1737412
trad	.0718791	.0184767	3.89	0.000	.0356584 .1080997
bay	.1095154	.0095229	11.50	0.000	.0908471 .1281836
bedrooms	.1849854	.0072579	25.49	0.000	.1707574 .1992134
publicro	.1635422	.0104666	15.63	0.000	.1430241 .1840603
ensuite	.1097422	.0153395	7.15	0.000	.0796715 .139813
gch_d	.0415696	.0084399	4.93	0.000	.0250244 .0581147
needsupg	-.1107956	.0253196	-4.38	0.000	-.1604307 -.0611605
luxury	.1359236	.0227219	5.98	0.000	.0913809 .1804663
acre	.336311	.0927142	3.63	0.000	.1545592 .5180628
garden_d	.0458404	.0104032	4.41	0.000	.0254466 .0662341
garage_d	.0990781	.0112651	8.80	0.000	.0769946 .1211616
parking	.0369223	.0163794	2.25	0.024	.0048129 .0690316
views	.068451	.0230265	2.97	0.003	.0233112 .1135909
spring	.0361596	.0102335	3.53	0.000	.0160985 .0562208
summer	.0539391	.0100373	5.37	0.000	.0342625 .0736156
autumn	.0436298	.0114168	3.82	0.000	.021249 .0660107
deprivtn	-.0170906	.0027176	-6.29	0.000	-.0224179 -.0117632
schoolpe~100	.2208635	.0231542	9.54	0.000	.1754733 .2662537
eend_d	-.1587008	.0134379	-11.81	0.000	-.1850437 -.1323578
sside_d	-.1387943	.0097877	-14.18	0.000	-.1579815 -.1196071
ngla_d	-.2118817	.0210185	-10.08	0.000	-.2530852 -.1706781
cbdkm	-.0057795	.0012065	-4.79	0.000	-.0081447 -.0034143
VS_431_E12	.0161653	.0006758	23.92	0.000	.0148405 .0174901
_cons	10.81296	.0321817	336.00	0.000	10.74987 10.87604

The estimated accessibility measure is plotted against distance to nearest employment centre below (where employment = 100 and then when employment = 1,000). The plots reveal clear evidence of non-monotonicity in the impact of access to employment on house prices.

Access Welfare Variable & Distance to Employment Node

No. employees at employment node = 100



Access Welfare Variable & Distance to Employment Node

No. employees at employment node = 1000



1. How unequal is access to employment across the city?

Our first task is to estimate the distribution of “Access Welfare” across locations in Glasgow, and to use standard measures, such as Gini and Atkinson coefficients, to gauge how unequal that distribution is. We have created a variable that captures the benefits of access to employment while taking into account the undesirable effects of being located too close to an employment node. We call it the Access Welfare Variable and have estimated its kernel density function in Figure 1 below for Glasgow (dropping out repeat postcodes). While no household has zero welfare, over 7 per cent of people have access welfare values less than 1, and a further 11 per cent have values less than 10, either because they are located very near employment centres (and therefore suffer from noise, pollution and congestion) or very far from employment nodes. Access to employment is highly unequal with the average variation in Access Welfare coming in at around 90% of the mean (as shown by the coefficient of variation). The Gini coefficient of .48 (relative to a value of zero in a world of equal access and a value of 1 in a world of perfect unequal access) paints a similar picture, as do the Atkinson coefficients.

Figure 1: Density Function Estimate for Access Welfare Variable, S

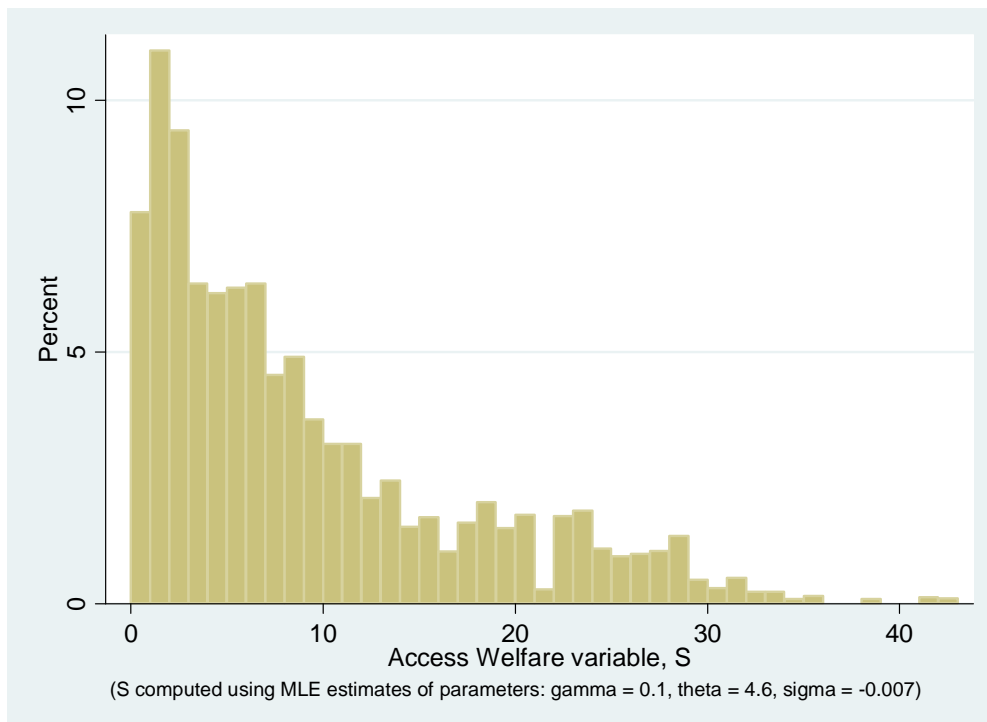
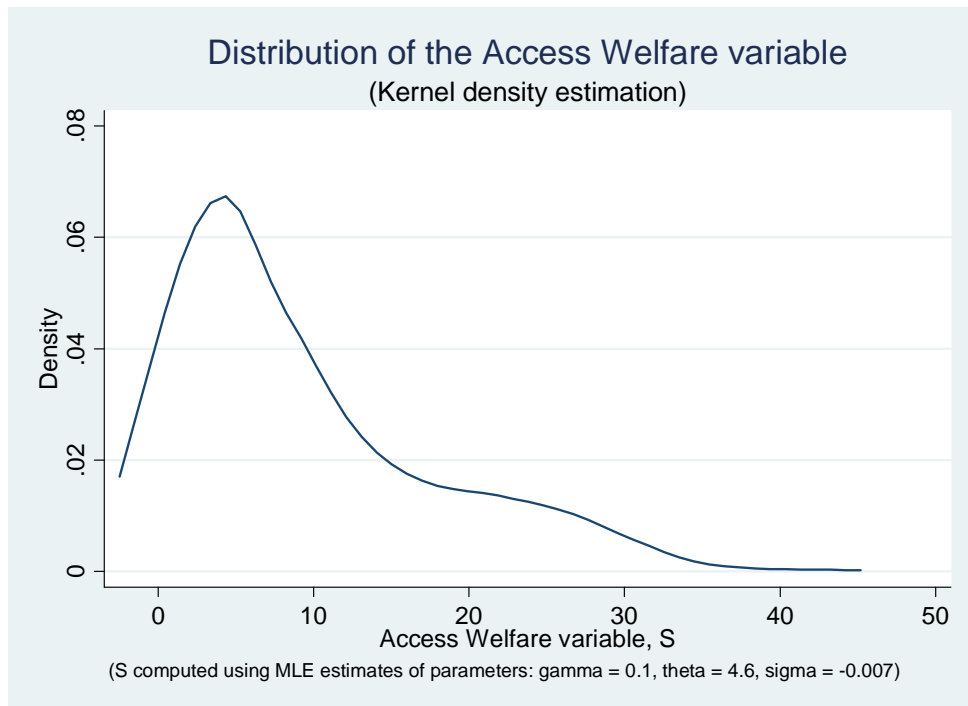


Table 3: Summary Statistics for the Access Welfare variable S

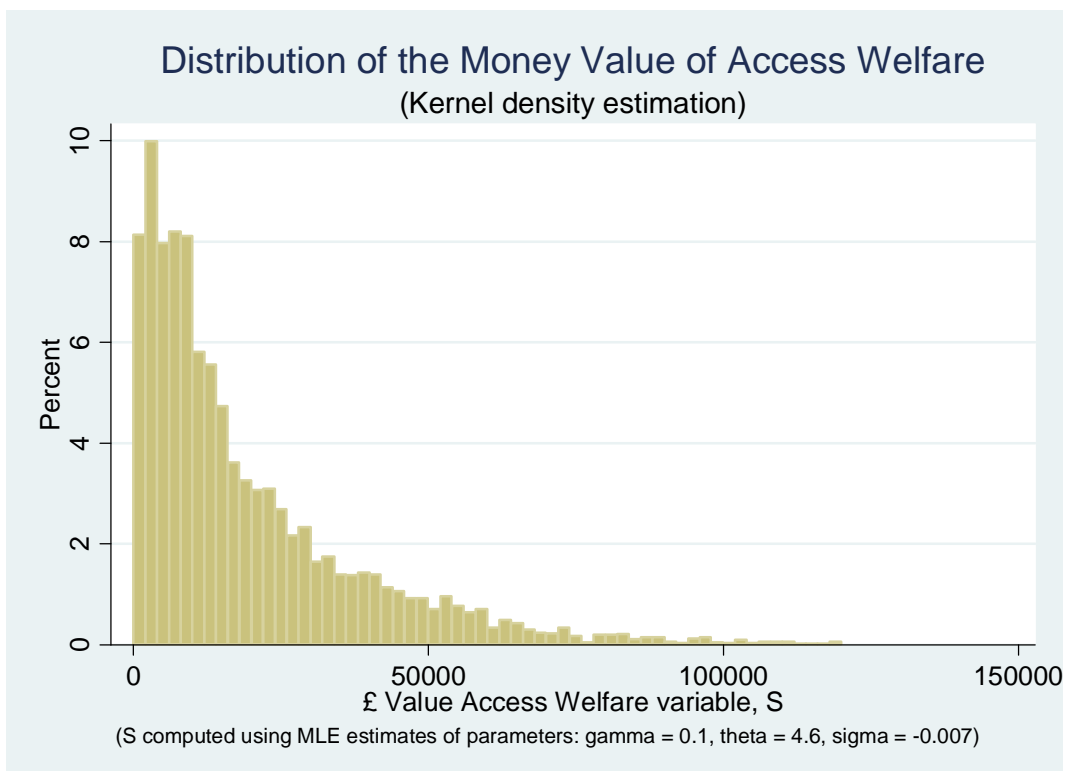
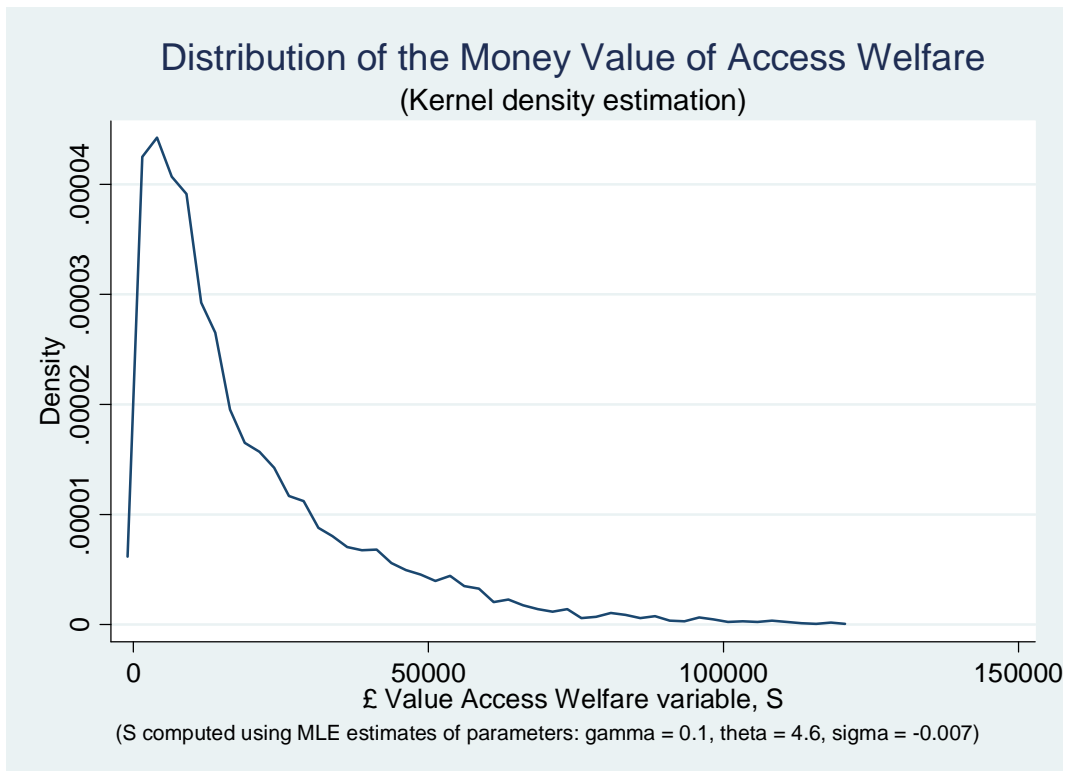
Measure	Value
Number of postcodes	4671
Mean	9.14
Std. Dev.	8.25
Min	.004
Max	42.70
Coefficient of variation	0.90
Gini coefficient	0.48
Atkinson epsilon = .5	0.20
Atkinson epsilon = 1.0	0.40
Atkinson epsilon = 1.5	0.61
Atkinson epsilon = 2	0.81

2. *What is the money value placed on access to employment*

One limitation of the S variable is that it does not have an obvious scale. This makes it difficult to interpret. We know, in principle, that S has a one to one mapping with the wellbeing associated with access to employment (the higher the value of S the greater the wellbeing) but the numbers themselves do not relate to recognisable units of measurement. So, we seek an appropriate way of rescaling the values to make the numbers more meaningful. Hence we attempt to estimate the financial value that society places on being located in close proximity to employment, knowing that the S variable incorporates the offsetting factors due to negative externalities. To convert our S variable to a monetary scale, we use our regression model to compare the predicted value of each house in our sample with that of a dwelling with zero access.

The results are presented below in terms of a kernel density estimate of the distribution of MVAW (the Money Value of Access Welfare) across space, and summary statistics describing the mean and dispersion of the distribution. Again, all results indicate considerable inequality, with a coefficient of variation of 110% and a Gini coefficient of 52%.

Figure 3



**Table 3: Summary Statistics for MVAW
(Money Value of Access Welfare variable S)**

Measure	Value	
Number of postcodes		4,671
Mean	£	18,551.69
Std. Dev.	£	20,260.73
Min	£	12.36
Max	£	231,229.70
Coefficient of variation		1.09
Gini coefficient		0.52
Atkinson epsilon = .5		0.23
Atkinson epsilon = 1.0		0.40
Atkinson epsilon = 1.5		0.61
Atkinson epsilon = 2		0.81

Note: These statistics refer to the average MVAW ((Money Value of Access Welfare variable S) for each post code, of which there are 4,671 in our data. MVAW is the contribution to the value of the house made by wellbeing generated from access to employment. Calculated by comparing the predicted value of houses in each postcode assuming observed Access Welfare values with the predicted value assuming zero Access Welfare.

3. *How does the inequality of access to employment correspond to the geographical pattern of variation in social deprivation?*

Who receives the most welfare gains from access to employment, the poor or the rich? This is an important question because it potentially relates planning decisions to social and economic inequality. It also connects our results to the predictions of urban economic theory which traditionally places higher income households further from employment nodes.

We interpolate our results across space using nearest neighbour methods to give a complete unbroken 3D surface of the Money Value of Access Welfare covering areas of both high and low deprivation. We apply the same GIS techniques to derive a surface of deprivation (the peaks represent highly deprived areas).

Figure 4: Geographical Distribution of the Money Value of the Access Welfare Variable

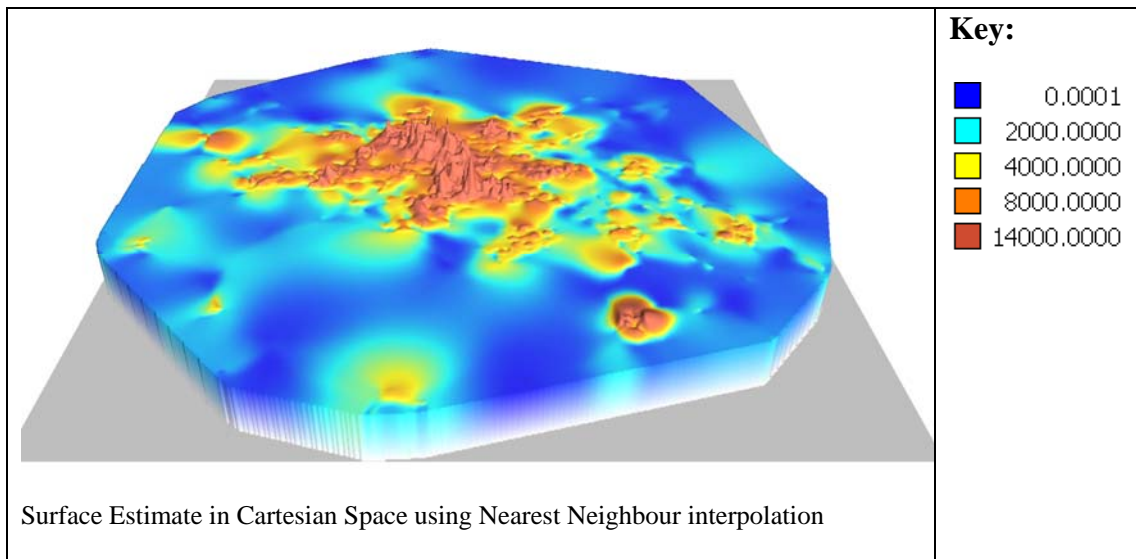
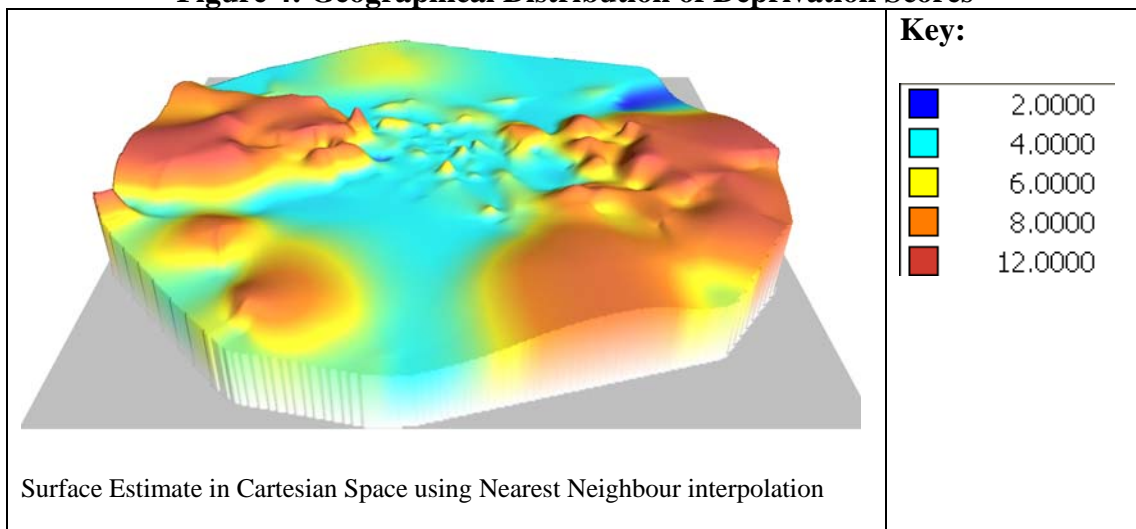


Figure 4: Geographical Distribution of Deprivation Scores



Comparison of the surface plots of the Money Value of Access Welfare and Deprivation scores, reveals an apparent negative correlation: highest wellbeing from access to employment is concentrated in low deprivation areas. As noted earlier, we have to be careful not to infer causation, but there is clear evidence of negative correlation, and this in itself is cause for concern.

The negative correlation is confirmed when we apply simple regression (as a descriptive tool) of MVAW on deprivation. As Table 4 shows, the slope coefficient is found to be -£2,614 with a relatively narrow confidence interval (95% CI: -£2760, -£2,467) lying well below zero (estimates are based on Whites Standard Errors to correct for heteroskedasticity). This means that, for every unit increase in the deprivation score, the money value of access to employment tends to fall by around two and a half thousand pounds, or 18% (see the coefficient on the log-linear regression which can be interpreted as measuring the proportionate change in the dependent variable of a unit change in the independent variable).

Table 4: Regression of MVAW on Deprivation (for descriptive purposes)

Linear regression					Number of obs = 6269	
					F(1, 6267) = 1219.59	
					Prob > F = 0.0000	
					R-squared = 0.0925	
					Root MSE = 19591	

Money_Valu~S		Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]

deprivtn		-2613.527	74.83769	-34.92	0.000	-2760.235 -2466.82
_cons		34400.53	609.201	56.47	0.000	33206.29 35594.78

Log-Linear regression					Number of obs = 6269	
					F(1, 6267) = 882.77	
					Prob > F = 0.0000	
					R-squared = 0.1327	
					Root MSE = 1.1097	

Money_Valu~n		Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]

deprivtn		-.1813906	.0061051	-29.71	0.000	-.1933587 -.1694226
_cons		10.35346	.0369247	280.39	0.000	10.28107 10.42584

7. Conclusion

This paper has sought to address three research questions: (1) How unequal is the wellbeing derived from access to employment? (2) What is the money value placed on access to employment? and (3) How does the inequality of access to employment correspond to the geographical pattern of variation in social deprivation? We have proceeded to answer these questions on the basis that house prices, once adjusted for property type and size, will reflect variation quality of life across space. We derive econometric estimates on this basis of the impact of employment access on house prices.

Our approach has been novel in that we have sought to address both the highly non-linear relationship between wellbeing and distance to employment, and the existence of multiple centres of employment nodes, each of a different size. We are aware that this study is nevertheless a static one and therefore cannot tackle the difficult problems of causality and simultaneous determination. We are also aware of multiple sources of imprecision and bias in our model (not least the relatively sparse observations on house prices in the most deprived areas) but we believe that our key results (the inequality of access and the negative correlation with deprivation) are so pronounced that they are unlikely to be overturned by using more precise and complete data.

It is beyond the scope of this paper to estimate what proportion of the mismatch between those who need work (unemployment tends to be highest in highly deprived areas) and where work is located is due to the sorting process of the market and what proportion is due to the cumulative history of planning decisions

(particularly the construction of peripheral social housing estates in the 1960s). The two are inevitably interlaced. Nevertheless, our results highlight the potency of this mismatch, and the extent to which it has persisted in the face of Glasgow's long recovery from deindustrialisation (Turok *et al*).

Social mix is often advocated on the grounds of improving social cohesion. However, our results emphasise that there may be a much more tangible benefit in a city like Glasgow arising from improved access to employment for the poorest households. Note, however, that new private housing estates are themselves likely to lie on the periphery, and so the real implication of our results is not so much the infusion of social mix into new development but how to increase social mix in established areas of the city that have good access to employment.

Our findings also raise the question of whether a model of this kind might provide a useful input into strategic planning generally. While the model has its limitations, it does make explicit the implications for equality of access of the juxtaposition of residential and employment location. Our findings highlight important questions about the priorities of planning policy and whether equality of access (based on models of the kind proposed here) should be an active ingredient of strategic planning decisions.

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