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Conference Paper

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50th Congress of the European Regional Science Association: "Sustainable Regional Growth and Development in the Creative Knowledge Economy", 19-23 August 2010, Jönköping, Sweden

Provided in Cooperation with:

European Regional Science Association (ERSA)

Suggested Citation: Osland, Liv; Gibb, Kenneth; Pryce, Gwilym (2010) : Inequalities in Access to Employment and the Impact on Wellbeing: A Criterion for Spatial Planning?, 50th Congress of the European Regional Science Association: "Sustainable Regional Growth and Development in the Creative Knowledge Economy", 19-23 August 2010, Jönköping, Sweden, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

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

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Preliminary Draft : Please do not quote

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 in 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 living 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 and compare the spatial distribution of the access welfare variable with the spatial pattern of deprivation.

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 skills. 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 those who live in the immediate vicinity of 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 estimating its monetary value. 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 the geographical pattern of social deprivation. Our results show a 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) could be of value in routine 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

Urban space, inequality and employment

This short, selective literature review attempts to cover and then synthesise findings from three broad urban literatures: spatial/skills mismatch; the urban land rent gradient and the empirical analysis of inequality across urban space. These three literatures correspond directly to the principal goals of the paper: the inequality of access to employment across urban space, the money value placed on that access and the urban spatial relationship between employment and wider inequality.

Spatial Mismatch

The spatial mismatch literature originated in the pioneering work of Kain (1968) and has generated extensive empirical investigation that was then pooled together for review by Wheeler, 1990; Jencks and Mayer, 1990; Holzer, 1991; Ihlanfeldt, 1992; Kain, 1992; Mayer, 1996; Ihlanfeldt and Sjoquist, 1998; Preston and McLafferty, 1999; Kain, 2004; Houston, 2005; Ihlanfeldt, 2006; and Gobillon et al, 2007.

Spatial mismatch as an idea was originally developed by Kain in order to ‘describe a broad set of geographical barriers to employment for African-American inner city residents’ (Preston and McLafferty, 1999, p.388). Suburbanisation of jobs and residential segregation or sorting into predominantly inner city housing created difficult trade-offs between housing costs, transport and acceptable wages which in turn led to higher degrees of inner city i.e. black worklessness and further reinforcing of ethnic spatial segregation and inequality over space. Subsequent research has sought confirmatory evidence of these forces in terms of employment outcomes, as well as examining other racial groups such as American Hispanics, minority women and wider gender issues, class distinctions and evidence of spatial mismatch in other parts of the world and not just metropolitan America. The empirical evidence broadly supports the thesis but varies considerably in magnitude across time and space and sub-population (Kain, 1992; Ihlanfeldt and Sjoquist, 1998; Preston and McLafferty, 1999; Gobillon et al, 2007).

There has also been a broadening to examine labour market skills levels (i.e. a skills mismatch) as the key source of endemic unemployment in for instance UK cities experiencing economic restructuring in the 1980s and after (Turok and Webster, 1998, Turok and Edge, 1999; Houston, 2005). Papers have also contributed to policy analysis in response to the mismatch focusing on housing market discrimination, labour market information and search policies and a series of initiatives to weaken the commuting cost constraint. Of course, these analyses are founded on different conceptualisations of urban labour markets, for instance the extent to which the labour market is segmented or in fact can draw in mobile labour from across the metropolitan system (Morrison, 2005). In this regard the Gobillon et al (2007) paper is particularly useful in that it expressly tries to move beyond empirical confirmation of one form or another of the hypothesis and instead attempts to understand the underlying process of mismatch, identifying seven mechanisms of mismatch (p.2408-09):

1. workers may refuse a job that involves excessive commutes and are costly relative to the expected wage
2. worker job search efficiency may decrease with distance to the job
3. workers who live far away from jobs may not search sufficiently intensively
4. workers may incur high search costs that lead them to restrict their search space to their own neighbourhood

5. employers may discriminate against residentially segregated potential workers
6. employers may refuse to hire or offer lower wages to long commuters because of concerns about lower productivity
7. suburban employers may think their customers will discriminate against minority workers from the city.

Gobillon, et al, find, in their empirical review of these mechanisms, that ‘there is some clear evidence supporting the effect of commuting costs and customer discrimination on unemployment. There is also suggestive evidence that the increase in search costs and the decrease in search efficiency with distance can cause unemployment. However, it appears that the search incentive, productivity and redlining assumptions have not [yet] been empirically investigated’ (p.2419).

Land Rent Gradients

The land rent gradient i.e. the spatial shape or pattern of a standardised unit of land over urban space has been widely discussed in the literature both as a textbook stalwart of monocentric access-space trade-off (and polycentric applications of) explanations of the urban economy and how it allocates land to different uses across space, but also in terms of empirical outcomes (Alonso, 1964; Muth, 1969; Mills, 1972; Evans, 1985; McDonald, 1997; Anas et al, 1998; O’Flaherty, 2005; Arnott and McMillan, 2006; McDonald and McMillen, 2007).

The essence of the basic model is that derived from a monocentric model wherein different land use have different bid-rent functions over urban space, rents, land values (and standardised house prices) will fall at a diminishing rate from the city centre (e.g. Evans, 1986, p.24). Better access to services in the city centre requires accepting higher per unit land costs (O’Flaherty, 2005, argues that rents are the costs that you impose on other people by your impact on the rationing of space – p.121). Rather pragmatically Evans argues that while the Alonso/Muth/Mills trade-off model does a good job explaining the spatial rent gradient in most large cities it is less effective elsewhere in part because of the well known restrictiveness of the model’s assumptions.

The empirical evidence on the shape and existence of well-behaved land rent gradients (with monocentric assumptions) is not straightforward because of the lack of good data (McDonald and McMillen, 2007, p.149). McMillen (2006, p.136) argues that the monocentric model also suffers because of its static nature and that the age or vintage of cities matters fundamentally - 'densities reflect the past, whereas land values reflect expectations about the future'. Moreover, polycentricism and the changing pattern of urban employment and the decentralisation of specific sectors such as manufacturing and even a range of economic services – captured in Garreau's Edge City concept, brings the two dimensional rent gradient concept into some disrepute and indicates that the empirical researcher may need to uncover and investigate a larger number of rent gradients associated with employment subcentres, residential neighbourhoods and transport nodes across cities and metropolitan regions (Anas et al, 1998). A key issue is whether individual sub-centres are substitutes for each other (and hence have their own rent gradient) or complement each other and hence occupy the same rent gradient (Anas et al, p.1441-42). Theoretical studies suggest that employment subcentres arise where built up areas become sufficiently large and have tipped into high congestion costs, incentivising firms to leave the CBD (McDonald and McMillen, 2007, p.171).

The loss of the tractability of the monocentric model implies a much more fuzzy and context contingent set of relationships between land rents and urban space. McDonald and McMillen report a series of studies that go beyond CBS employment centres, again partly hamstrung by lack of good data and that decentralisation is dynamic and frustrates employment sub centre definition (p.165), but evidence does exist that tracks for instance office rents across space in Los Angeles (Sivitanidou, 1995) which suggest higher local office rents where there is good access to transport, closeness to high visual amenities, lower crime, more retail space and land use regulation (quoted in McDonald and McMillen, 2007, p.166). However, it should be noted that in terms of measuring empirical rent gradients, McMillen (2007, p.136) argues that traditional monocentric models can accommodate employment sub-centres, as their effects are 'more marginal and can be handled by introducing additional explanatory variables'.

The Spatial Distribution of Urban Economic Inequality

A core idea of the trade-off model is that higher income groups have an elastic income demand for space and consequently households are sorted by space with higher income groups suburbanising (although there are many contemporary cities and nations where higher income groups are found in city centres – Meen and Meen, 2003). We have already seen one interpretation of the spatial mismatch hypothesis as a dynamic residential sorter by minority status or skill level. Anas (2006, p.542) also points out that agglomeration processes can create ‘voluntary ghettos’ segregating because proximity of like economic agents may reduce costs e.g. a Chinatown. Schelling has also identified self-organising processes where economic agents tip into segregated use of space (Meen and Meen, 2003; Meen et al, 2005). Of course, what begins as a voluntary process may cease to be and become involuntary over time as a city’s economy changes. Spatial patterns of segregation may therefore also reflect market imperfections, market failures and the consequences of policy.

In the UK researchers have grown familiar with indices of multiple deprivation drawing on increasingly sophisticated data and modes of analysis (but normally including employment, occupational status and material income as key domains of deprivation at the relevant sub-local authority geography). At the same time, urban geographers have spent more than 50 years fine-tuning spatial distributional analysis with tools such as indices of dissimilarity or isolation, again made easier to use and more tractable with developments in data and computing packages.

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:

If we ask how the distribution of Access Welfare varies 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.

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 (refs?).

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. As noted above, there is research that suggests that linear distance may be a surprisingly good approximation of journey times in large samples.

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 Hills 2007). 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.

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

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.

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 (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.

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

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 access to employment is perfectly equally distributed, the Gini coefficient will equal zero. In a perfectly unequal society, where all access to employment 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 & Size	Traditional	0.1050	0.3065
	Bay	0.1916	0.3936
	Bedrooms	2.2450	0.8900
	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
	eed_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.

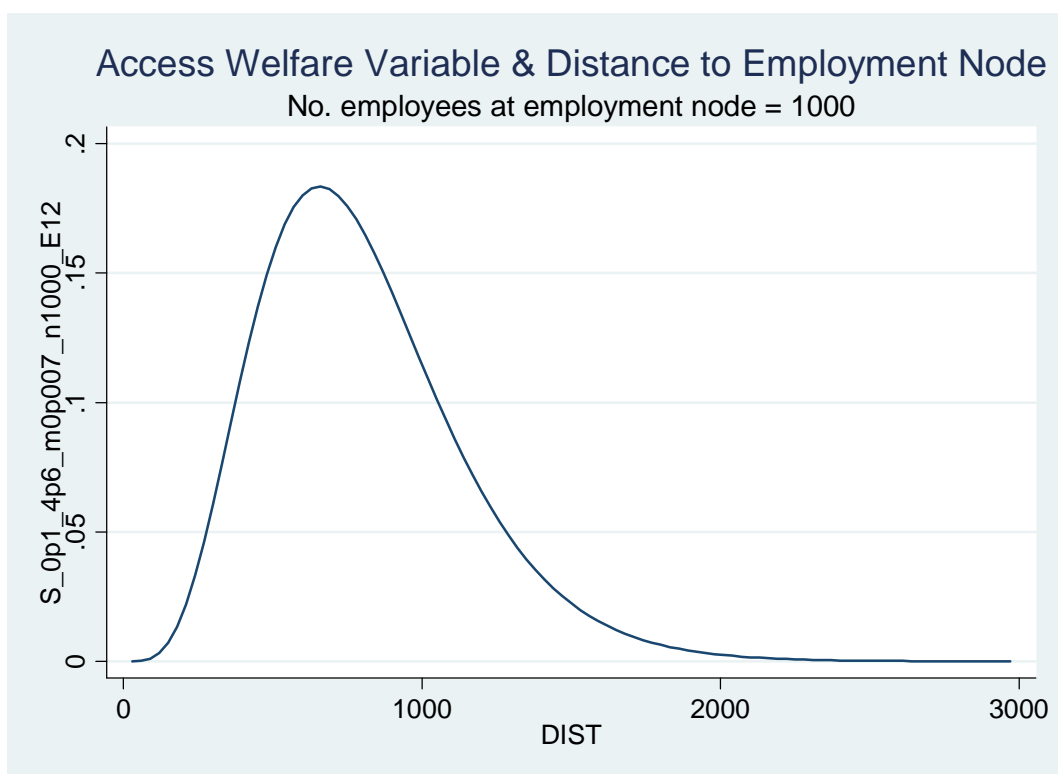
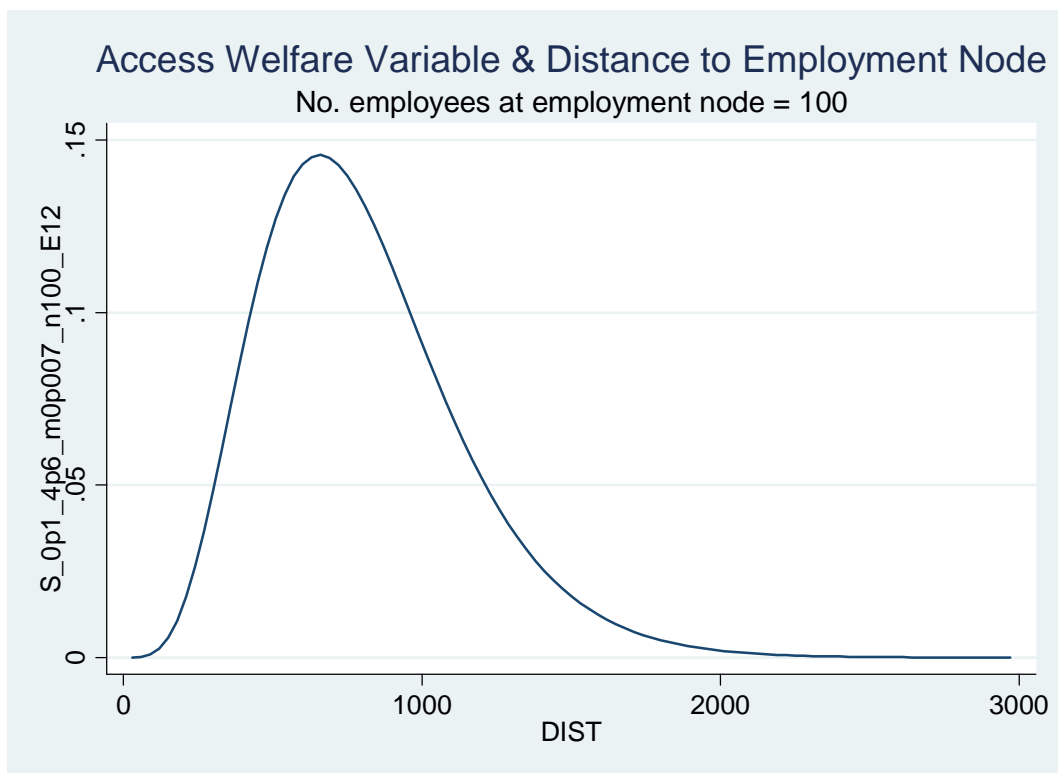
The estimation results found in Osland and Pryce (2009) clearly showed that the Access Welfare variable contributes significantly to explain variation in housing prices in the Glasgow area. The variable is most significant when monotonicity is not imposed. To provide evidence for this result, Osland 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
convsd_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.



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

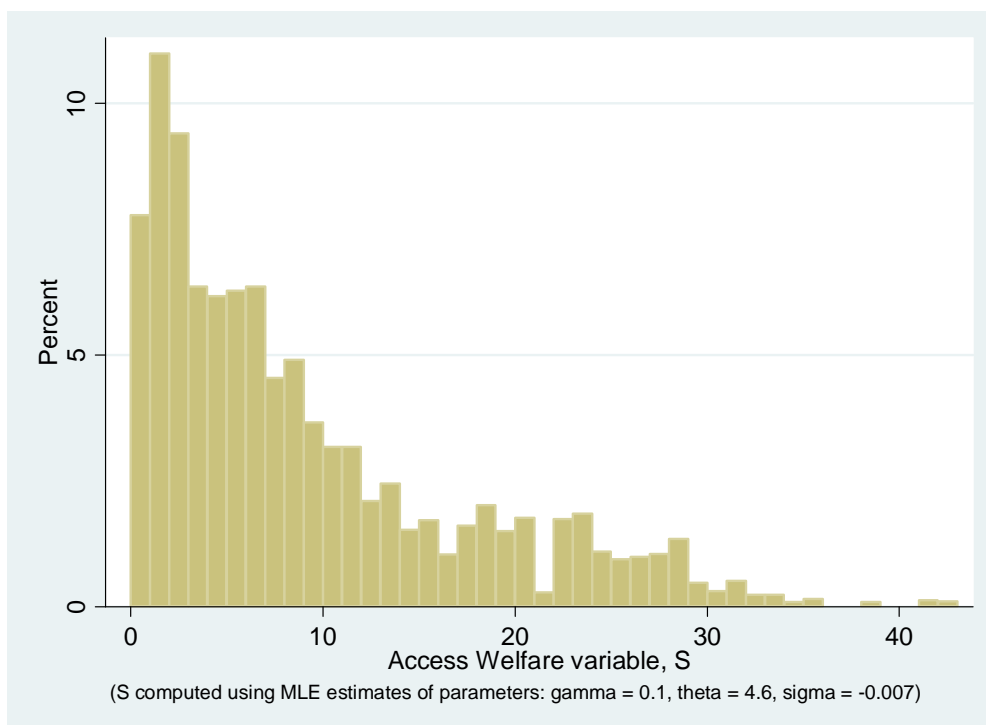
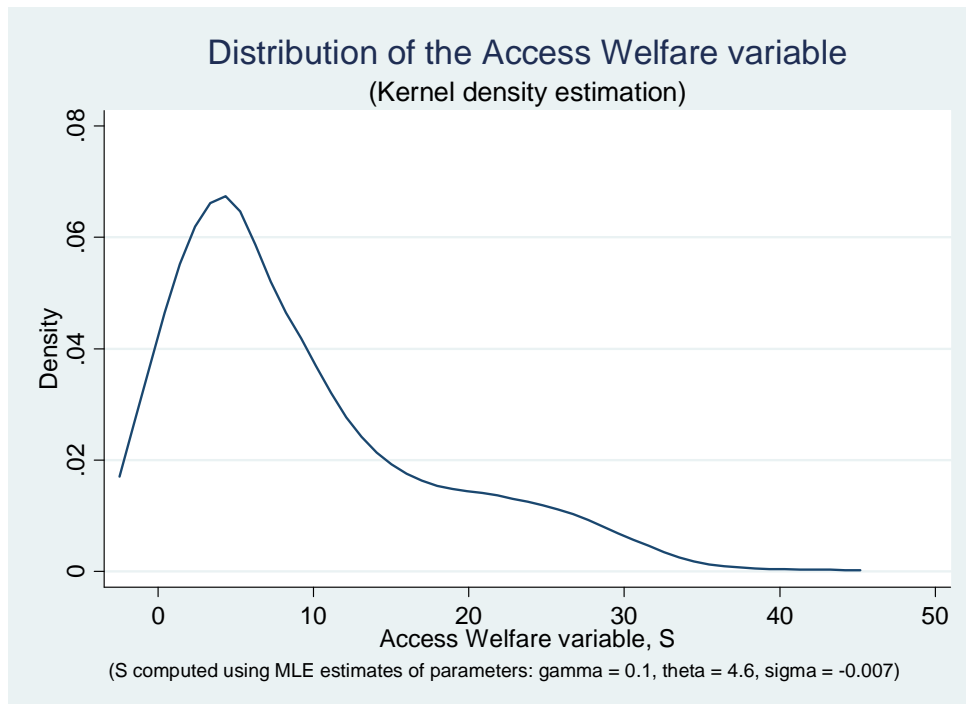


Table 3: Summary Statistics for the Access Welfare variable S

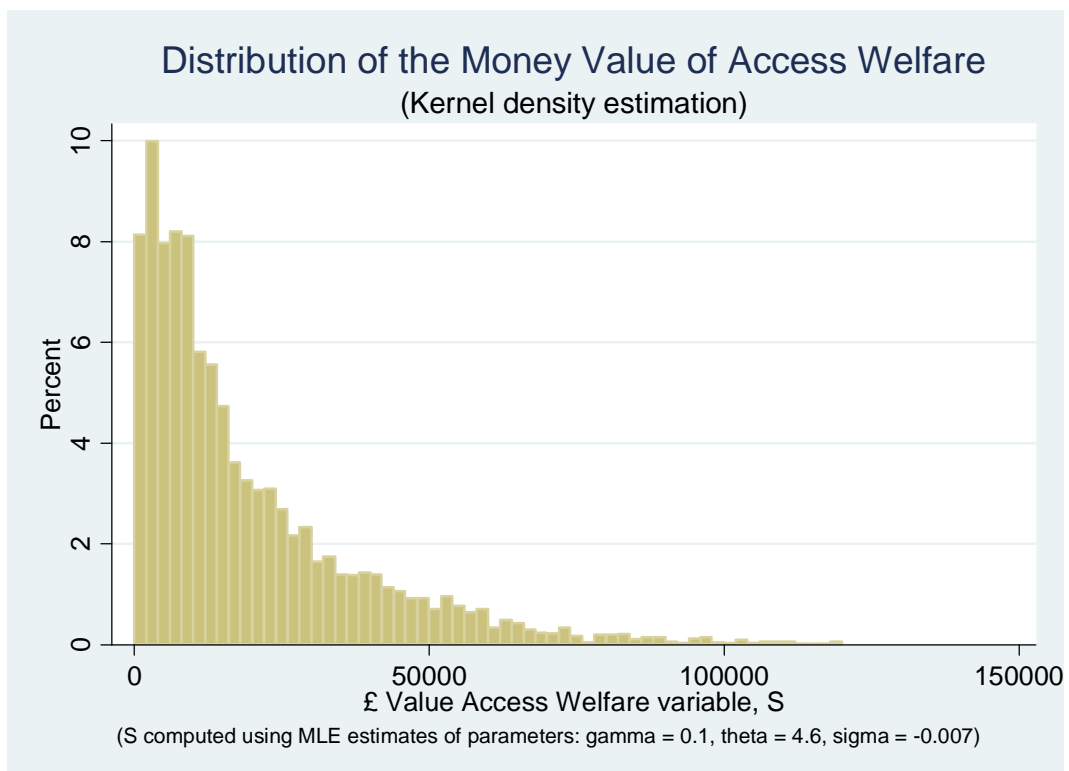
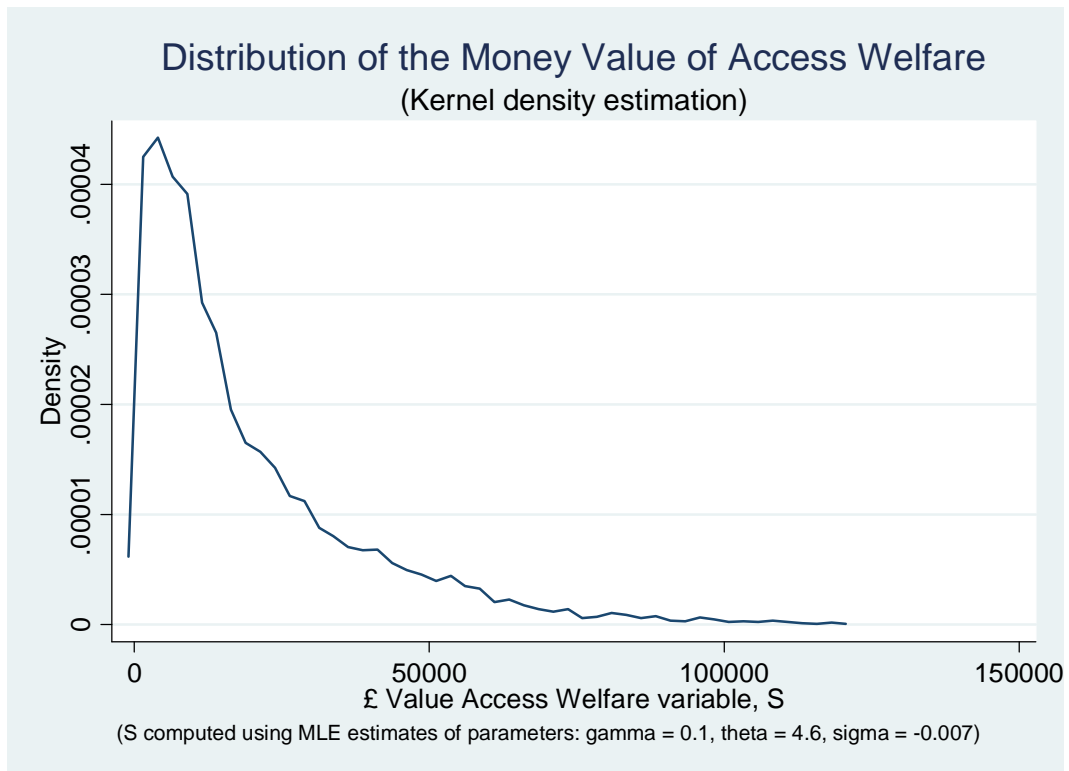
Measure	Value
Number of postcodes	4671
Mean	9.14
Std. Dev.	8.25
Min	.004
Max	42.70
Coefficient of variation	0.90
Gini coefficient	0.48
Atkinson epsilon = .5	0.20
Atkinson epsilon = 1.0	0.40
Atkinson epsilon = 1.5	0.61
Atkinson epsilon = 2	0.81

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.

These results show that the average value of access to employment in houses in Glasgow is £18,551.69. This compares with the value of average house = £140,000. In other words, 13% of value of average house can be ascribed to access to employment. So access to employment is important to homeowners and therefore valuable. And if valuable, it is likely to be unequally allocated in a market system because income, wealth and human capital are unequal.

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

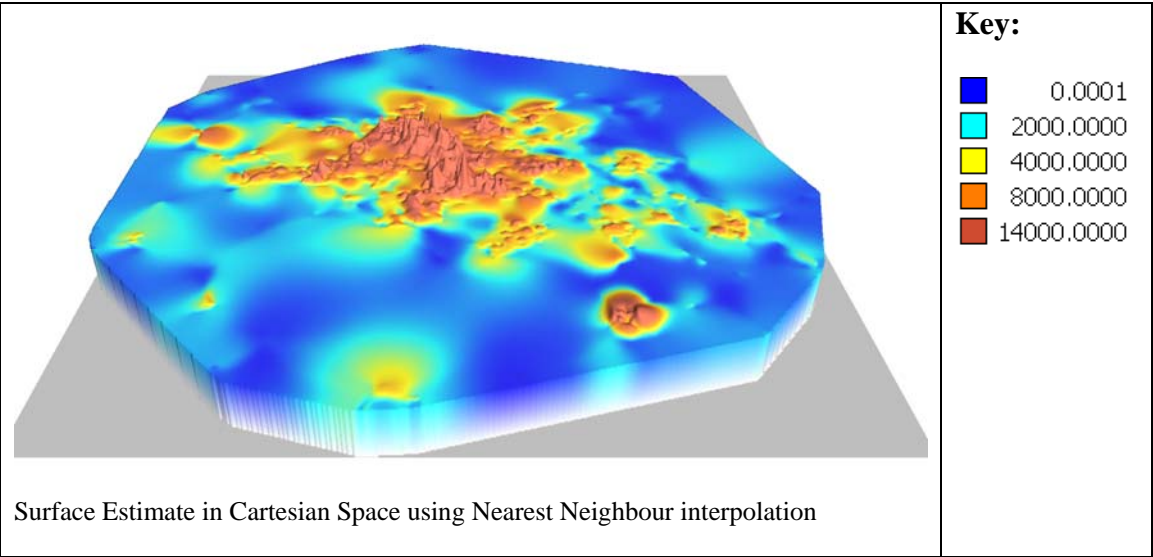


Figure 5: Geographical Distribution of the Unemployment Rate

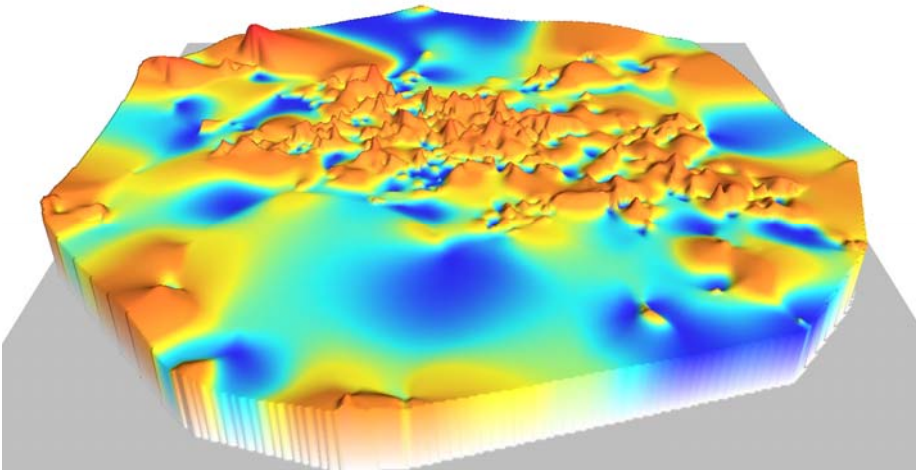
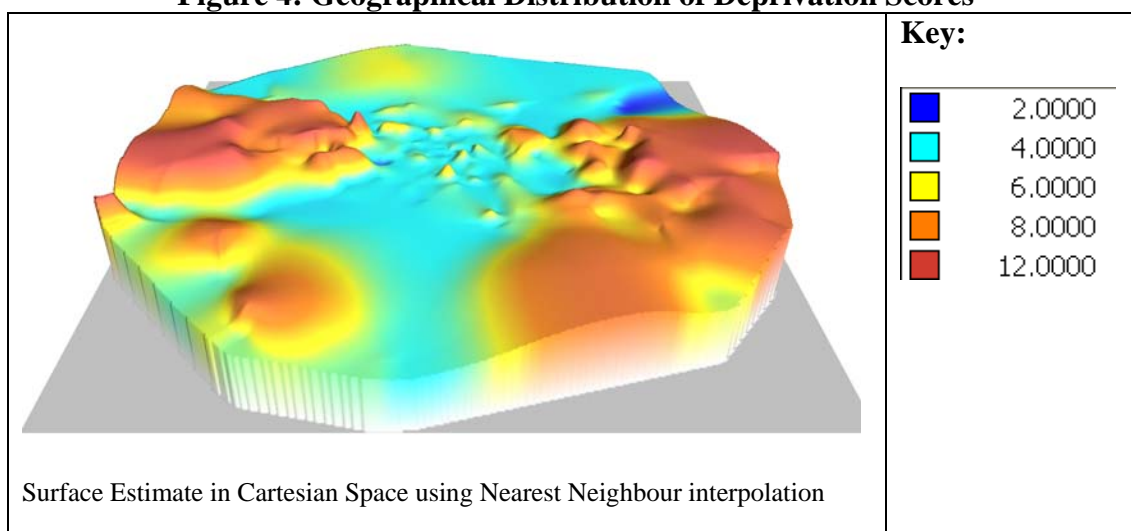


Figure 4: Geographical Distribution of Deprivation Scores



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*).

Our results emphasise the need for 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.

Finally, our model could be used to simulate the impact on inequality and spatial mismatch of new developments, such as the construction of a new factory. It is a fairly easy application of the model to enter hypothetical increases in employment in particular postcodes and estimate the effect on Access Welfare and the corresponding Gini and Atkinson coefficients.

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Tables: SES April 2010

	A e=0.5	A e=1.0	A e=1.5	Gini
Glasgow Money Value of Access	0.23	0.4	0.61	0.52
Glasgow House Prices (CML)	0.08	0.14	0.20	0.30
Scottish House Prices (CML)	0.08	0.15	0.22	0.31
UK House Prices (CML)	0.09	0.17	0.23	0.33
Glasgow OO Income (CML)	0.08	0.15	0.35	0.31
Scottish OO Income (CML)	0.08	0.15	0.33	0.31
UK OO Income (CML)	0.12	0.20	0.32	0.36

	R1	R2	R3	R4	R5	R6	R7	R8
Dep Variable	Ucount	Urate	Ucount	Urate	Ucount	Urate	Ucount	Urate
Employees	0.0004 (3.6)	0.00000 (1.1)			0.0004 (4.0)	0.0000 (1.3)		
Money Value Access			0.0182 (0.9)	-0.0063 (-1.7)			0.0894 (4.6)	0.0069 (2.0)
House Price (median)					-0.0001 (-15.0)	0.0000 (-16.8)	-0.0001 (-15.6)	0.0000 (-16.8)
constant	13.93 (37.5)	2.53 (38.5)	13.86 (27.4)	2.65 (29.8)	22.84 (33.5)	4.26 (36.1)	22.26 (31.7)	4.21 (34.7)
N	958	958	958	958	958	958	958	958
Adj R2	0.01	0.00	0.00	0.00	0.20	0.23	0.20	0.23

