Does where you live influence your socio-economic status?

Key words:

Residential property, spatial analysis, socio-economic status, societal wellbeing, GIS

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Abstract:

The relationship between the wellbeing of society and understanding of land market structure and behaviour is an important research theme for understanding socioeconomic status (SES). Traditional SES area based measures of income, occupation and education are generally applied in the examination of a broad spectrum of societal issues. This paper examines the contribution of understanding the spatial variation of SES based upon residential property sales data unrestricted by the traditional artificial geographic boundaries in which SES is assumed uniform. Originality lies in identifying the locational component of residential property wealth as a proxy for SES. It includes market behavioural characteristics that reflect both the context and composition at particular locations. This provides a broader understanding of SES than income, occupation and education. The analysis uses a hedonic regression model based on transactions of detached housing. The model is specified using only available property attributes as independent variables and is therefore blind to location. The residuals from this hedonic model are used to calculate the relative location factor (RLF) for each transaction property. These were interpolated as a continuous surface capable of predicting values at the individual property level or aggregated to a spatial unit relevant to the particular application. There was a significant correlation with the traditional SES indicators and health outcomes that have traditionally been shown to have a correlation with SES.

Introduction

The link between socioeconomic status (SES) and societal wellbeing is well established. The link between SES and location is developing. The relationship between the wellbeing of society and understanding the land market structure is an important theme in the literature (Rothenberg et al., 1991; Meen, 2001) particularly as purchase decisions for residential property are often based upon perceptions of the influence of surrounding structural and environmental attributes (context) and the characteristics of the surrounding population (composition). Residential property purchasing behaviour can be observed through the prism of the real estate market reflecting the relative desirability of one location over another as the real estate market varies geographically. How SES is measured for location is critical to understanding how it influences social outcomes.

This paper, drawing upon the desire of people to live in neighbourhoods that offer amenities supportive of quality of life objectives, demonstrates that the locational component of residential property value can provide insights into the wealth aspect of SES and help inform policy on issues critical to the wellbeing of society. In breaking new ground, the paper demonstrates that property wealth may capture an important dimension of SES often missed in the more traditional measures of income, education and occupation. SES associated with property wealth is broader than traditional measures and includes the environmental quality (including, density, accessibility, vegetation cover and aesthetics) of the individual property being purchased.

While isolating residential property relative location values from real estate transactions is not new (Gallimore et al., 1996), the innovation lies in applying them as a tool for understanding spatial SES (SSES) to inform social science policy.

This paper reviews appropriate literature and develops the underlying theory and concepts of an informed model to isolate location. A hedonic regression approach deliberately specified to isolate 'location', thereby containing the market effect of 'location' in the residual, is proposed. The hedonic model, applied to the Adelaide Metropolitan Area (South Australia) demonstrated how the residual varied across geographic space at the individual property level providing a relative measure of the desirability of 'location'. To validate its utility as an SES measure, the results were compared with the widely applied SES measure in Australia, the Australian Bureau of Statistics, Socioeconomic Indices for Areas (SEIFA). Its utility for wellbeing was tested using health data as this is the most developed application of SES and outcomes research. In a cross sectional analysis property wealth was strongly statistically associated with relative risks for several cardio metabolic risks. The paper concludes by highlighting the application to policy issues, its significance for social science and its potential transferability.

Literature

The literature on SES is extensive embracing a wide spectrum of societal issues (Australian Bureau of Statistics, 2012; Baum et al., 2005), domestic violence (Abramsky et al., 2011; Aizer, 2010), social cohesion (Berry and Welsh, 2010; Rios et al., 2012), poor health (Chaix et al., 2007; Coffee et al., 2013; Matthews et al., 2011), education (Clarke et al., 1999; Frempong et al., 2012), school funding (Henry et al., 2010; Neymotin, 2010), unemployment (Klein-Hesselink and Spruit, 1992; Lynn et al., 1984), affordable housing (Anderson et al., 2003; Kautz, 2001), gentrification initiatives (Clerval, 2006) and housing policy (Dietz and Haurin, 2003; Dunn et al., 2006). In contrast, the SES literature is relatively silent on locational aspects of property wealth to the individual residential property value.

SES has traditionally been represented using income, education or occupation (Braveman et al., 2011; Laaksonen et al., 2005; Pickett and Pearl, 2001; Williams et al., 2010; Baum et al., 2005; Henry et al., 2010). The extent that these indicators of SES sufficiently capture wealth is a matter of debate (Duncan, 2002; Bond Huie et al., 2003; Pollack et al., 2007; Vernez Moudon et al., 2011). The family home (real property) has been estimated to account for between 25% to 50% of a family's net worth (Zhu Xiao Di et al., 2003) and hence offers a potentially superior measure of the personal wealth component of SES. The importance of housing to wealth accumulation is supported by (Berry and Wise, 2007; Somerville et al., 2007). Real property is a prime component of the urban economy and has been suggested that it accounts for as much as 15 to 20% of GDP (Gibb & Hoesli 2003, p.888) and is linked to the broader concept of class and location. The question of the theoretical and practical existence of social class has been discussed for many years (Bourdieu, 1987; Irwin, 2015). Recent contributions discuss SES and social class interchangeably although differentiating class as being along process lines (e.g. upper, middle, lower class) and SES through indicators of income, education and occupation advocating the use of both to describe social equity (Wyatt-Nichol and Brown, 2011). Using a property based wealth indicator may assist in identifying location or "where to live" and assist in objectively establishing a categorisation of 'class'. A report undertaken by the Australian National University (ANU) (Sheppard and Biddle, 2015) included a wealth measure using property as part of their concept of Social Class in Australia. Although class is not readily perceived as quantifiable in social research, the recognition of property wealth in the broader concept of class demonstrates an awareness of the role property wealth plays in the identification of social class in Australian society.

The use of property value as an SES proxy in social science research is largely associated with health studies; its wider application to social science is yet to be realised. In Great

Britain[1] a number of studies have used the council value tax bands, which were introduced in 1992 to enable local government to raise tax revenue, for health research linking property value to general practice workloads, deprivation, obesity and diet (Beale et al., 2000; Beale et al., 2001; Fone et al., 2006). Similarly, US studies have used individual property value to investigate deprivation and obesity (Vernez Moudon et al., 2011; Drewnowski et al., 2015; Drewnowski et al., 2014; Rehm et al., 2012). In the Rehm et al (2012) study, the property value measure was based on the combined value of both land and improvements and calculated as the mean assessed property value per residential unit. Vernez Moudon et al.(2011) and Drewnowski et al (2014 and 2015) calculated two individual metrics based upon the assessor's value as determined for property tax purposes, to represent real estate wealth capturing both structural as well as locational attributes. The first metric, the mean assessed property value per residential unit, was considered to be an individual wealth measure while the second, the focal mean of an 833 metre buffer around each respondent's property, was used as a neighbourhood measure. Vernez Moudon et al., (2011) discussed the neighbourhood effect and the individual effect of residential property wealth as important to represent both compositional and contextual measures of SES. The authors argued that it is individual (personal wealth), and not area-level measures (neighbourhood wealth), that are important, although property values can be used to measure both by aggregation using arbitrarily defined spatial units.

Any dwelling traded in the residential property market is essentially a piece of real estate geography comprising a complex bundle of locational and structural components that include the value of attributes such as the proximity to various places of interest as well as the physical attributes of the structure of the dwelling. This may be seen through a number of

[1] All properties are allocated to one of eight valuation bands.

factorial ecology studies spanning different decades (Burnley, 1980; Lockwood and Coffee, 2006) observed that SES was an essential component of real estate geography while authors such as (Jackson et al., 2007; Kestens et al., 2006; Reed, 2001) argued that a significant component of the price paid for real estate geography reflected SES. According to (Evans, 1995), it is this piece of real estate geography, including the influence of surrounding structural and environmental attributes of properties (context) and the characteristics of the people living in the neighbourhood (composition), that consumers purchase when satisfying their need for housing. Adding to this complexity, perhaps the most important difference between the housing market, particularly at the urban level, and other commodity markets lies in the nature of their equilibrium. The market equilibrium for the housing market is more than just the classical equilibrium between price and quantity. The housing market has an extra equilibrium of price and geographic position. Housing is unique and fixed in space and because geography is important this is indicative of a geographic equilibrium between the price of the property and its accessibility to various points of interest (Thrall, 2002).Property value modelling takes location into account in two broad forms. The first method uses smaller *a priori* spatial units (such as suburbs or postal codes) or spatial market boundaries in which homogeneous market behaviour is assumed to exist (Adair et al., 1996). The second method represents location as a continuous value surface based on geocoded property values reflecting proximity to services and facilities. . Other models such as spatially weighted analysis (Anselin, 1998; Anselin, 1995) or Geographically Weighted Regression (GWR) (Fotheringham et al., 2002) used the market value basket concept to isolate the locational component (Borst, 2014) arguing that the regression coefficients of the dwelling attributes vary over space. GWR displays different added values for a constant dwelling construct at different locations, attributing the difference in added value to location. In the context of property valuation, GWR provides a methodology that accounts for location in mass appraisal valuations (McCluskey et al., 2013; McCord et al 2012).

Locational factors are frequently used as proxies for the many unobserved property variables in modelling residential housing price (Pavlov, 2000). However, the problem faced by researchers is the number of locational attributes is potentially infinite. While some of the attributes may be observed others cannot be collected or measured (Orford, 1999). The resultant interpretation of the regression coefficients may be subject to omitted variable bias (Koop, 2005), and as noted by (Clarke, 2005) the addition of variables may increase or decrease bias in the coefficient of interest. In addressing this issue from a locational perspective, (Gallimore et al., 1996) advocated a solution via omission, rather than the inclusion of potentially infinite variables, by building models that included variables that only represent the structure of the dwelling. The residual, it was argued, contained the cumulative effect of omitted variables including location.

While the literature describes a broad number of important societal issues influenced by SES, as highlighted earlier in this paper the reliance on traditional measures is changing to include the contribution of property wealth. This is evident in the health literature in particular, as the application to the broader social science research agenda is not yet well established. This paper seeks to address this gap through the application of the locational aspects of property wealth as a SES dimension. Context (surrounding features and services) and composition (surrounding characteristics of people) describing the environment where individuals live is important in understanding SES. The strong association between SES and location provides the basis for adopting the application of Gallimore's (1996) pragmatic modelling approach to develop a property wealth SES measure (the relative location factor). Other modelling approaches including GWR are part of further research into alternative methodologies.

Theory and Model Development

In developing a property wealth based SES measure, the traditional income, education and occupation SES definition is preserved in the sense that both measure components of wealth and therefore cannot be considered as one causing the other. Personal wealth defines components of traditional income, education and occupation SES and property. Property wealth provides a locational component to the personal wealth element and can therefore provide a complementary spatial dimension to SES.

The development of a relative location factor (RLF) was designed to isolate the 'locational' component of property value capturing the compositional and contextual elements that link residential property value and SES. In the RLF model, the component of the property value deemed to represent the relative locational component, a proxy for SES, is derived using the residual of a single hedonic regression model. In essence, location is measured by omission (unobserved effects contained in the error term) rather than specific inclusion of individual locational attributes (predicted effects). To obtain a locational value component, it is important to exclude ***the influence of the sale property structural attributes*** for each location for which the RLF is calculated but include ***the locational significance of structural attributes of surrounding sale properties***. Sales of improved single residential properties (sale price) are used to calibrate the average marginal utility of the specified structural attributes and predict the value of each property sale in turn leaving the residual as the difference due to location.

The model takes the following general form $SALE\ PRICE = f(structural\ attributes) + error(spatial\ and\ random)$ with the error containing those attributes that capture locational effects of the predictive model. It is assumed that errors are randomly distributed across geographic space and therefore do not affect the relativity of the resulting locational measure. This approach purposely adopts a relative and not an absolute measure of location[2].

The relative location factor (RLF) = (SALE PRICE/PREDICTED PRICE) * 1000 is calculated for each of the sale property location points and an interpolated predictive surface created across the study area. The predicted price is the estimated price using the attributes contained in the hedonic model described in the methodology at each geocoded point of sale. The RLF is interpolated as a continuous surface using Empirical Bayesian kriging in a geographic information system (GIS). RLF values greater (or less) than one thousand indicate instances where paid prices are greater (less) than real values of the dwellings as characterized by their measured attributes. This reflects the relative value of the location, not the dwelling per se.

The originality of this method is the use of property locational value as an objective wealth measure and expressing the RLF established at each sale point as a continuous predictive interpolated surface across the study area (RLF). The strength of this approach over other SES indicators is the ability to predict the RLF surface at the individual property level providing a detailed spatial socioeconomic status (SSES) measure, rather than an average computed for an arbitrary aggregated administrative spatial unit. Berrigan et al., (2015) reported on the issue of averages over larger *a priori* administrative spatial units and how these aggregations increased the difficultly of exploring data whereas individual property location metrics provided an important point of difference in the spatial analysis of SES. What RLF contributes to the research and understanding of SES is a spatially detailed robust and objective property derived wealth SES measure built from the market transaction price. The efficacy of RLF is assessed in the Adelaide study area, initially validated against

[2] If some element of the absolute location is lost whilst controlling for structural attributes at the specific sale points this does not inhibit the relative nature of the measure.

traditional SES measures and then applied to the health sector, the major social science research concentration using SES and location.

Method

Study Area

The study area is metropolitan Adelaide, the capital city of South Australia with a population in 2011 of 1.2 million (Figure 1) and is characterised by single residential dwellings on large parcels of land (Australian Bureau of Statistics, 2013).

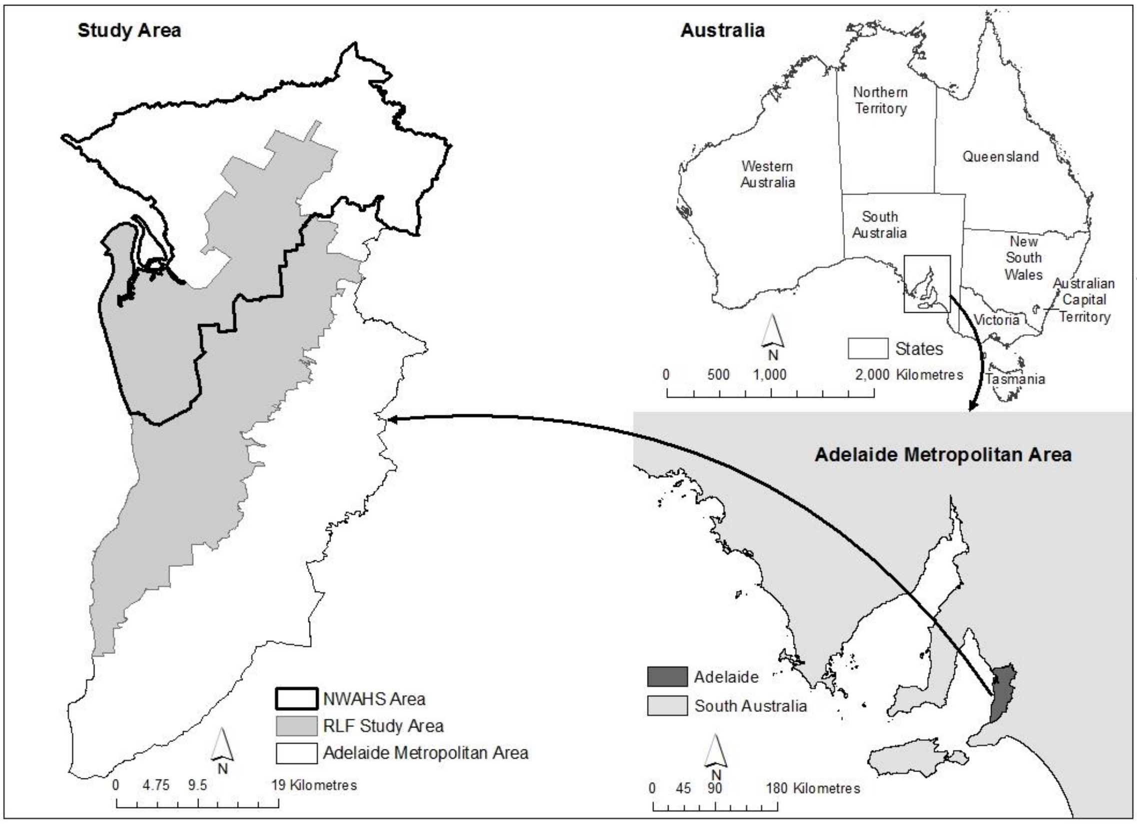

Figure 1: Study Area, Adelaide Metropolitan Area.

Adelaide has an active property market with the majority of sale transactions through private treaty with owner occupancy the main tenure, similar to many international jurisdictions.

This study area is considered an appropriate geographic scale for the application of RLF as it reflects a “contained” housing market but characterised by sub-markets (McGreal et al., 2016)

Data

Completed sales transaction data[3] from the 2011 Sales History from the South Australian Valuer General for the Adelaide Metropolitan Area were used in a global hedonic ordinary least squares (GOLS) model[4]. RLF was derived by modelling single residential sales, which accounted for approximately 76% of the dwelling stock in the study area, comprising single residential tenure either rental or privately owned (Australian Bureau of Statistics, 2013). Sales transactions between May and September 2011 were used as an indicator of market value as at 30 June 2011. No adjustment was made for time as the market was deemed stable over this period. The date was chosen to enable comparison of RLF results with the Census SES indices from the 2011 quinquennial Census of Population and Housing. Only valid sales that indicated market value of single residential detached dwellings were used. The data were cleaned to ensure no erroneous observations were included with exclusion of outliers and cases with missing data. This resulted in a sales data set of 3275 sales. The dwelling characteristics used in the global hedonic ordinary least squares model based RLF are summarised in Table 1[5].

Model Specification

The hedonic model specification included the non-linear behaviour of the building area (as

[3] All sales records are geocoded to the street address facilitating analysis at an individual property level.
[4] Any non-urban component of the sales data were removed when calculating RLF as these sales included unrelated housing markets and variables.
[5] The age of the dwelling has been categorised by the decade in which the dwelling was constructed and referred to as the ERA of construction.

area squared) and dichotomous variables for the ‘age’ of a property (by construction decades) and variables for dwelling styles (Table 1) extending the work of Rossini and Kershaw (2005, 2006) on model variable selection relevant to the Adelaide market. Variables such as building style, dwelling quality, and wall and roof construction were designed to adjust for variations of properties at the extremes based on expert knowledge of factors that reflect market behaviour. Such factors may vary between jurisdictions with those shown in Table 1 being those considered relevant and available in the Adelaide market.

VARIABLE	TYPE	DESCRIPTION	SOURCE
Sale Price (SP)	continuous	Sale Price in dollars	1
Dwelling size (DS)	continuous	Equivalent main area in square metres	2
Year of Construction		Year Built obtained was divided into decades as this was professionally considered to be the manner in which the market perceived the AGE of a property. ‘Dichotomous variables’ were constructed to reflect this:	2
ERA_PRE1900	Dichotomous	1 if Year Built < 1900 else 0	
ERA_1900to1920	Dichotomous	1 if Year Built>=1900 and < 1920 else 0.	
ERA_Twenties	Dichotomous	1 if Year Built >=1920 and < 1930 else 0.	
ERA_Thirties	Dichotomous	1 if Year Built >=1930 and < 1940 else 0.	
ERA_Fourties	Dichotomous	1 if Year Built >=1940 and < 1950 else 0.	
ERA_Fifties	Dichotomous	1 if Year Built >=1950 and < 1960 else 0.	
ERA_Sixties	Dichotomous	1 if Year Built >=1960 and < 1970 else 0.	
ERA_Seventies	Dichotomous	1 if Year Built >=1970 and < 1980 else 0.	
ERA_Eighties	Dichotomous	1 if Year Built >=1980 and < 1990 else 0.	
ERA_Ninties	Dichotomous	1 if Year Built >=1990 and < 2000 else 0.	
Dwelling land area (LA)	Continuous	Area in square metres taken from the digital cadastre polygon	2
Dwelling quality			
POORQUALITY	Dichotomous	Based on a dwelling condition code (0-9) with 0 being very poor and 9 being excellent. Less than 4 then 1 else 0.	2
GOODQUALITY	Dichotomous	If greater than 8 then 1 else 0	2
Roof Construction			2
ImitTileRo	Dichotomous	Various roof materials are coded on the database An ‘imitation tile roof’ is considered relevant to value.	
Dwelling Style			
CONTEMP	Dichotomous	Variations of the most common Contemporary and	2
CONVENL	Dichotomous	Conventional styles are grouped under the relevant CONVENL or CONTEMP variable	
GOVTHOUSIN	Dichotomous	Variations of government housing are grouped under this variable. These are typically of a cheaper construction type and less desirable in the market place.	2
Wall Construction			
STONEWALL	Dichotomous	Variations of the STONE WALL construction are grouped under this variable.	
FRAMEWALL	Dichotomous	Variations of frame construction (timber & steel) are grouped under this variable.	

Table 1: Dwelling characteristics.

The natural logarithm of the property price is the dependent variable. The use of the natural logarithmic is common in hedonic modelling to account for the assumption of a normal (at least symmetric or bell-shaped) distribution of the dependent variable and linearity (Keskin, 2008). The inclusion of second order or higher polynomial terms in the hedonic modelling are intended to capture quadratic and cubic trends in addition to linear trends. This is a significant development from the earlier RLF specification (Coffee and Lockwood, 2012) to include characteristics as defined by the property profession when estimating value using hedonic models as this provides a better reflection of the residential market for the study area at a particular point in time.

The hedonic model is expressed as:

$$\text{Price} = \beta_0\ \beta_1^{LA}\ \beta_2^{DS}\ \beta_3^{DSsqrd}\ \beta_4^{Framewall}\ \beta_5^{STONEWALL}\ \beta_6^{CONTEMP}\ \beta_7^{CONVENT}\ \beta_8^{GOVTHOUSIN}\ \beta_9^{ERA\_PRE1900}\ \beta_{10}^{ERA\_1900\ to\ 1920}\ \beta_{11}^{ERA\_Twenties}\ \beta_{12}^{ERA\_Thirties}\ \beta_{13}^{ERA\_Fourties}\ \beta_{14}^{ERA\_Fifties}\ \beta_{15}^{ERA\_Sixties}\ \beta_{16}^{ERA\_Seventies}\ \beta_{17}^{ERA\_Eighties}\ \beta_{18}^{ERA\_Ninties}\ \beta_{19}^{POORQUALITY}\ \beta_{20}^{GOODQUALITY}\ \beta_{21}^{ImitTileRo}\ \text{Error}$$

where β_0 to β_{21} are regression coefficients to be estimated, and the error term contains spatially structured and unstructured variations (accounting for intangible factors).

The ratio of sale price to predicted price for each geocoded sale point is in fact the exponent of the residual of the hedonic model [that is, in the natural logarithm scale: residual=Ln(price)-Ln(predicted price)] and the RLF at each point is the ratio of sale price to predicted price. A continuous raster surface is interpolated from each of these sale points across the whole study area.

A number of interpolation techniques are available within GIS focussing on predicting values between known data points to give a continuous surface. Techniques include a variety of interpolation methodologies but in essence each of these are based on Tobler's premise that near points are more likely to be similar than more distant points (Tobler, 1970). Broad forms of interpolation include 'global' and 'local' models where various trend surfaces or inverse distance models can be used. Inverse distance models (IDW) use distance decay to represent the influence of near neighbours and can specify distance and the number of neighbours used for interpolating the surface. Unlike IDW, geostatistical interpolation uses the semi-variogram to identify specific data variations. In this study, Empirical Bayesian kriging was used to interpolate the continuous RLF raster surface from the individual sales point ratios (3275 sale transactions). This interpolation technique was chosen as it incorporates local semi-variograms to more realistically capture the local (small-scale) variation in the data and better adhere to the assumption of stationarity for optimal kriging. Employing an overlap factor of 2 allows each point to be located in two of the adopted 100 subsets in which local semi-variograms are derived and which provide a smoother surface (Krivoruchko and Krause, 2012). It is from this continuous surface that the proxy SES can be predicted at the individual property level.

Results and Discussion

The RLF Global Ordinary Least Square model resulted in an adjusted R squared statistic of 0.64 (that is, 64% of the total variability observed in the sales price was explained by the dwelling attributes). A global Moran's Index of 0.39 (Z-score of 46.9 and p-value < 0.0001) was calculated on the residuals for all sale points ($n = 3275$) resulting in a less than 0.01% likelihood that the clustered pattern of the RLF ratio was due to chance alone. The Anselin Local Moran's I was used to geographically represent statistically significant clusters of either high or low values of the RLF as shown in Figure 2.

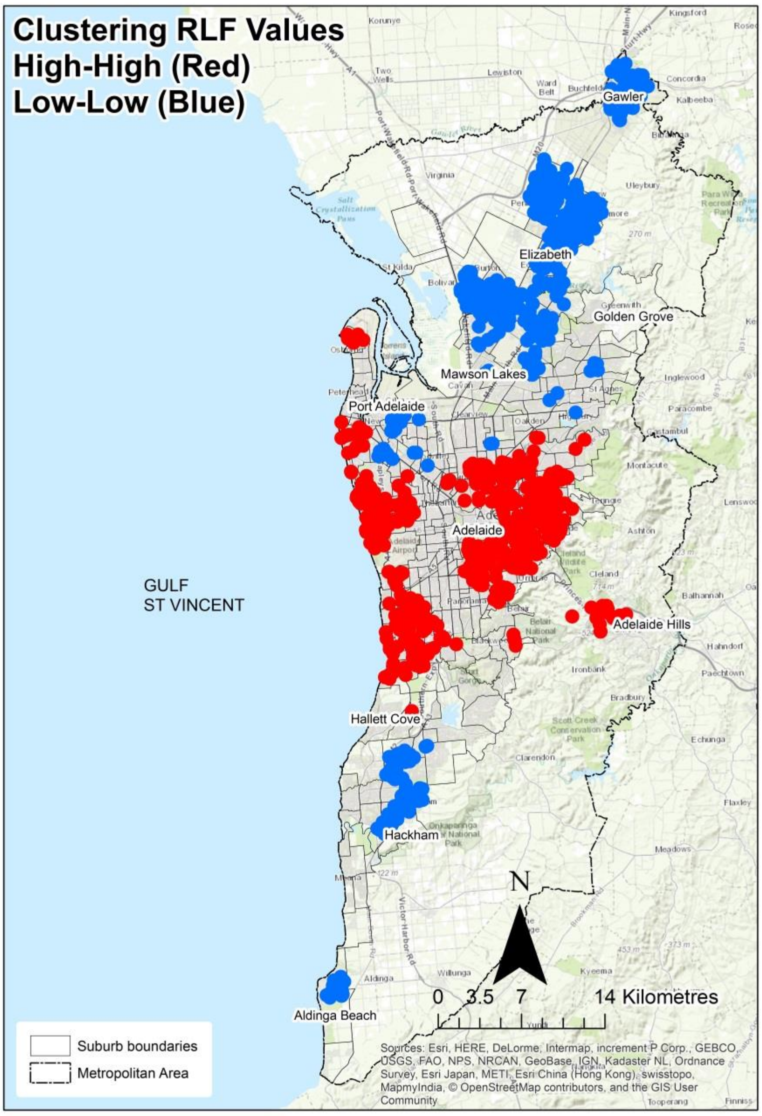

Figure 2: Clustering and high and low RLF scores.

The 3275 ratios were interpolated across the study area to produce a continuous RLF surface. RLF is expressed as the ratio of the sale price divided by the predicted price x 1000 to provide an interpretation of the error term as the relative desirability, expressed by the market, for each of the sale properties. An RLF value greater than 1000 indicated that, when compared with the average, there was a premium paid for the property location, over and above the structural dwelling attributes; conversely an RLF of less than 1000 indicated less was paid for the property due to its location.

The resulting RLF surface conformed to local understanding of the most and least desirable areas to live in Adelaide and with the spatial distribution of the Australian Bureau of Statistics (ABS) SES indices. In general the coast and eastern areas are generally perceived as more desirable place to live than those in the northern and southern parts of the Adelaide Metropolitan Area (Figure 3).

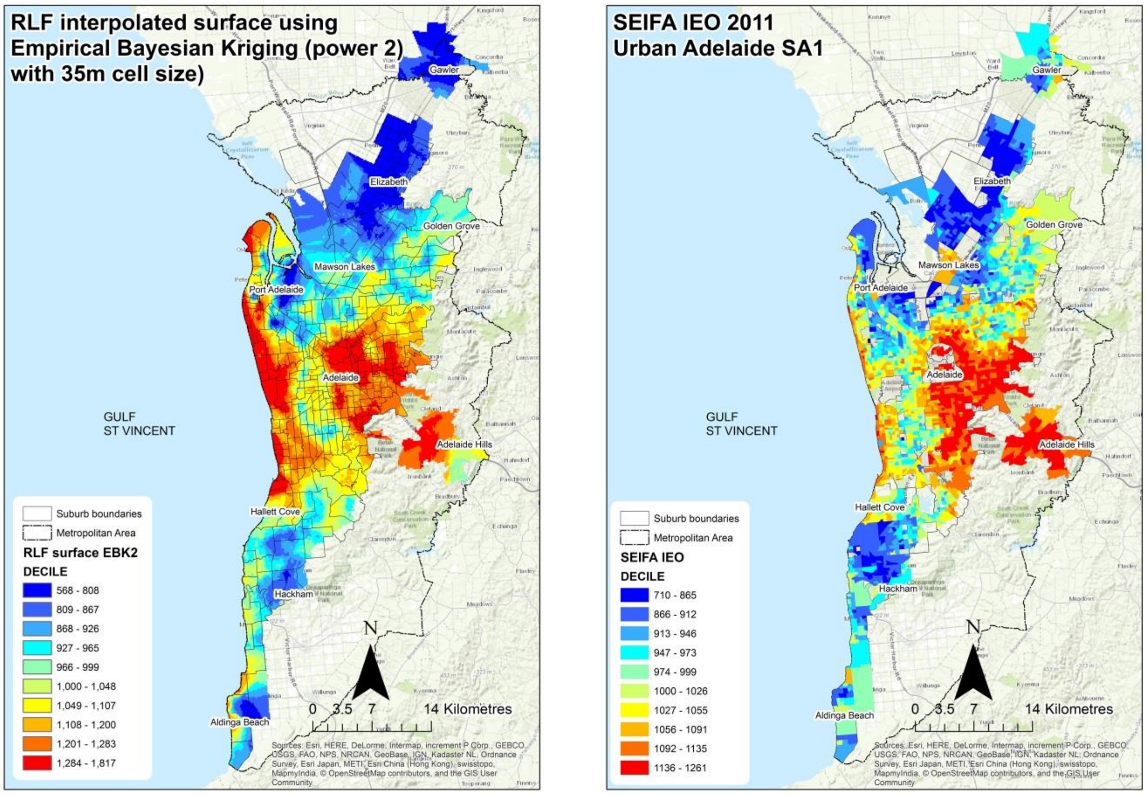

Figure 3: RLF interpolated surface and SEIFA IEO 2011.

Predictive validity of RLF as SES Measure

Critical in the development of RLF was its validity as an SES measure when compared with commonly applied Australian measures. To assess its predictive validity RLF was correlated with other measures of SES as well as with health outcomes which are well known to be associated with socioeconomic disadvantage (Bosma et al., 1997; Marmot and Wilkinson, 2006; Marmot et al., 1978; Adams et al., 2009; Adler and Ostrove, 1999; AIHW, 2011; Blanc et al., 2006; Bradley and Corwyn, 2002; Brownell et al., 2010; Hanson and Chen, 2007; Lewis et al., 1998; McDonough et al., 2010; Oakes and Rossi, 2003; Turrell et al., 1999). In

Australia the standard SES measure for the majority of analyses, especially those including a spatial aspect, is one of the ABS, Socio-Economic Indexes for Areas (SEIFA) (McCracken, 2001). These have been calculated for all censuses since and including 1991. SEIFA indexes are created for a range of spatial units, include the traditional income, education and occupation variables and are comparable across Australia, hence their widespread application. Coffee and Lockwood (2012) compared the 2001 ABS SEIFA relative social disadvantage index (IRSD) decile with the 2001 RLF zonal average decile for each urban census collection district (CD) in the study area with a resulting correlation coefficient of 0.55. This was supportive of a strong association but not to the extent that RLF would be of limited value over and above using SEIFA (Coffee and Lockwood, 2012). This association was re-tested for two 2011 SEIFA indices, the index of advantage-disadvantage (IAD) and the education and occupation index (IEO) leading to correlation coefficients of 0.55 and 0.62 respectively. The rationale for comparing the RLF with the SEIFA indices is to highlight the validity of RLF relative to a standard and widely applied SES measure in Australia. The results demonstrated that RLF was a valid SES measure that provided an additional or alternative indicator for social research. It is important to stress that for the comparison of the 2001 and 2011 ABS SEIFA indices, the results were for an aggregate administrative spatial unit. RLF was aggregated from the property level interpolation to match one of the ABS spatial units (CD and SA1) as this is a restriction on the use of SEIFA (only supplied for aggregated administrative units). However, the RLF scores can be applied at the individual dwelling level and therefore provide SSES values at a scale not available with any other measures.

Application of RLF to Health Analysis

As stated earlier, RLF can be applied broadly across social science research, but as health research has been the major research focus for the application of property value as a proxy for

SES (Drewnowski et al., 2014; Drewnowski et al., 2015; Fone et al., 2006; Vernez Moudon et al., 2011), RLF was tested for associations with health outcomes. Area-level SES variables and RLF associations were tested using data from the Place and Metabolic Syndrome (PAMS) Project[6] which aimed to research the relationships between local-area social and built environmental factors and cardiometabolic health in Adelaide, South Australia. The PAMS project drew on data from the North West Adelaide Health Study (NWAHS), a population-based biomedical cohort established to provide behavioural and clinical data on chronic health conditions and health-related risk factors (Grant et al., 2006).

The analysis using the PAMS population cohort from NWAHS reported a significant association between RLF and five cardiometabolic risk factors (Author et al., 2013). RLF was the independent variable with six dependent variables representing cardiometabolic risk (CMR) and a cumulative CMR risk score.

RLF was significantly associated with five of the six risk factors and the cumulative risk score even after controlling for individual level age, gender and education. Higher RLF values were associated with:

- a lower CMR score (Tertile 3 vs. Tertile 1: Relative Risk (RR) = 0.81, 95% Confidence Interval (CI) = [0.76 - 0.86], p <.0001 and Tertile 2 vs. Tertile 1: RR = 0.91, 95% CI = [0.86 - 0.95], p <.0001)
- a lower risk of being centrally obese (Tertile 3 vs. Tertile 1: RR = 0.89, 95% CI = [0.83 - 0.95], p = 0.0004 and Tertile 2 vs. Tertile 1: RR = 0.93, 95% CI = [0.89 - 0.98], p = 0.0033),

[6] The Place and Metabolic Syndrome (PAMS) project, funded by the National Health and Medical Research Council (NHMRC; #570150 and #631917), linked health information with local community characteristics hypothesised to be associated with Metabolic syndrome.

- having hypertriglyceridemia (Tertile 3 vs. Tertile 1: RR = 0.79, 95% CI = [0.70 - 0.90], p = 0.0005 and Tertile 2 vs. Tertile 1: RR = 0.90, 95% CI = [0.82 - 0.98], p = 0.0173),
- reduced HDL (Tertile 3 vs. Tertile 1: RR = 0.79, 95% CI = [0.67 - 0.92], p =0.0025 and Tertile 2 vs. Tertile1: RR = 0.87, 95% CI = [0.78 - 0.97], p = 0.0159),
- hypertension (Tertile 3 vs. Tertile 1: RR = 0.94, 95% CI = [0.88 - 1.01], p = 0.0824 and Tertile 2 vs. Tertile 1: RR = 0.90, 95% CI = [0.85 - 0.95], p <.0001
- being at risk of or diagnosed with diabetes (Tertile 3 vs. Tertile 1: RR = 0.52, 95% CI = [0.43 - 0.64], p <.0001 and Tertile 2 vs. Tertile 1: RR = 0.79, 95% CI = [0.70 - 0.89], p <.0001)

There is a long standing association between low SES and mortality, poorer health and chronic disease. The results of these analyses testing for associations between RLF, SEIFA and the six CMR chronic disease risk factors as well as the cumulative count supported the predictive validity of RLF as an SES measure. In addition, RLF and its use in analyses of health outcomes reinforced the nexus between place, health and SES. RLF provided an alternative objective, spatially informed, wealth SES measure. The robust association observed between RLF and health outcomes supports the need for continuing investigation into and development of wealth based SES measures.

An additional benefit of the RLF is it can help to address the Modifiable Areal Unit Problem (MAUP) which can be associated with spatial aggregation of data into predetermined administrative spatial units. The MAUP may introduce bias into any analysis as the aggregated result can vary depending on where the arbitrary boundaries are drawn. RLF contributes to MAUP in two main ways. Firstly, as RLF is calculated at the property level it provides SES at a level which avoids the both the scale and zonation issues associated with

MAUP. Secondly, (Openshaw, 1984) suggested that one way of overcoming MAUP was to aggregate data into customised spatial units constructed to reflect the research question and spatial extent of the study area. As RLF can be derived at the property level and through the application of GIS modelling could provide the basis for creating the customised spatial units proposed by (Openshaw and Alvinides, 1996).

Strengths and Limitations

This methodology requires access to detailed property level sales transaction data and associated structural characteristics together with expert property professional judgement to specify the hedonic model variables that represent the prevailing property market. The strength of this approach is that it provides a detailed spatial representation that can help overcome the MAUP (Openshaw, 1984). This is an important outcome in potentially addressing the longstanding issue of MAUP either through its use at the property level or through aggregation to a spatially meaningful unit. RLF can be calculated for any time point, is not tied to census year 5 or 10 yearly cycles and is not subject to issues often associated with self-report data, is available from all jurisdictions that collect real estate transactions and does not impose an additional cost to collect. This makes RLF a flexible, relatively easy to construct variable for social science research that does not require costly surveys or involves long construction times. In different markets the RLF model will require different specifications based upon local professional judgement as an understanding of property market analysis is as vital in this context.

Conclusion

The contribution of this paper to the existing literature is twofold. First, it provides evidence that RLF is a proxy spatial measure of SES. Second, RLF represents SES at the individual property level and can show variations of SSES within a priori administrative spatial units unlocking another dimension in the understanding of SES. In particular, the recognition that SES includes elements of both context and composition and that this can be captured through the locational component in terms of wealth contained in residential property value through the prism of real estate market transactions.

Importantly, this paper provides the theoretical basis of RLF demonstrating that the locational component of real property value and traditional SES indices are linked through a definition of wealth and therefore has a valid claim as a proxy for spatial SES (SSES). The fundamental element of SSES expressed as RLF is the concept of 'where you live' as more important than 'what you live in'. This distinction is the basic building block of societal wellbeing in an economic sense and also in physiological terms making a residential property wealth metric an important component of SES. Whilst this paper was based on the Adelaide Metropolitan Area, Australia the concept is transferrable to other jurisdictions with differing residential market structures, data administration environments and for a range of health and social science outcomes. Further testing of RLF could unlock a rich source for research that can contribute to spatially informed government policy across the broad social sciences which look to develop policy to break the connection between SES and social problems. Context and composition are two important concepts, especially in the application of place data with health outcomes. RLF provides a measure that reflects the influence of both of these aspects and can therefore provide a valuable spatially detailed SES measure for researchers.

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