Cities 60 (2017) 166–179

Contents lists available at ScienceDirect

Cities

journal homepage: www.elsevier.com/locate/cities

# Defining Street-based Local Area and measuring its effect on house price using a hedonic price approach: The case study of Metropolitan London

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ARTICLE INFO

*Article history:*
Received 30 January 2016
Received in revised form 26 July 2016
Accepted 7 August 2016
Available online 10 September 2016

*Keywords:*
Community detection
Multi-level regression model
Hedonic price approach
Neighbourhood planning
Space syntax
Dual graph

ABSTRACT

An under-explored topic within the field of planning and housing studies is related to the definition of local area unit. An empirical problem that arises is that different types of local area units can infer different results. This could be in constructing segregation indices, in estimating hedonic price models or in identifying housing submarkets. This research proposes the concept of Street-based Local Area (SLA), in asking to what extent SLA associate with house price. In order to examine this question, this article borrows from network science and space syntax research in defining SLA. This research conjectures that SLA has a significant effect on house price and that this effect is captured more strongly than ad-hoc administrative region-based local area. In order to test this conjecture, this research adopted the multi-level hedonic price approach to estimate local area effects on house prices for the case study of Metropolitan London in the United Kingdom. Results showed significant local area effects on house prices and that SLA is preferred to region-based one. The plausible reasons are firstly, people perceived the local area on a street network. Street-based Local Area is able to capture more precisely subtle perceptual differences in an urban environment than an ad-hoc administrative region. Second, the topology of the street network reinforces the socio-economic similarity/differences overtime. Differences between local areas can become more pronounced as like-minded people bump into each other, cluster together and share information with each other. Third, as people identify these local areas they would make decisions based on it. The local area becomes part of the housing bundle leading to it having an effect on house price. The main contribution of the research is the novel application of community detection techniques on the street-network dual graph to defining SLA. This is important as it links the topology of the street network to how we define and perceive local area and it presents an alternative to ad-hoc administrative geographies that are currently applied in many aspects of neighbourhood planning.



## 1. Introduction

### 1.1. Background

Research examining intra-city house price variations often focuses on estimating the implicit price at which buyers and sellers are willing to exchange contracts for structural features, accessibility levels and neighbourhood amenities, using the hedonic price approach (Rosen, 1974; Cheshire & Sheppard, 1998). Applying the hedonic price approach, both geographic and geometric accessibility variables were found to be significant when associating with house prices in London between 1995 and 2011 (Law, Karimi, Penn, & Chiaradia, 2013). The results confirm established relationship between property value with geometric accessibility measures (Chiaradia et al., 2013; Xiao et al., 2015) and geographic accessibility measures (Ahlfeldt, 2011; Shen and Karimi, 2016). However, location differential in house price is argued in this article to not only be captured by accessibility effects but also by local area effect as defined by the street network. This follows from previous spatial configuration research, whereby the topology of a street network relates not only to how we move in space but also how we associate with a place (Dalton, 2006; Yang & Hillier, 2007).

This research will propose the concept of Street-based Local Area (SLA) with the aim to test the extent to which SLA has an effect on house prices. The study employs a multi-level hedonic price approach in estimating the Street-based Local Area effects on house price using the house price dataset of London in 2011. The remainder of the article is organised as follows: Section One introduces previous research on local area units; Section Two introduces the framework for defining Street-based Local Area; Section Three provides details for the multi-level hedonic price empirical method; Section Four introduces the case study of London and the hedonic price model dataset; Section Five reports the estimation results, and Section Six provides a general discussion of the findings and limitations.

### 1.2. Previous research

An under-explored topic within the field of urban planning and housing studies is the definition of a local area unit. Local area unit here is defined as a geographical unit that is larger than the immediate

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http://dx.doi.org/10.1016/j.cities.2016.08.008

home area, but smaller than the city (Kearns & Parkinson, 2001). It is related to the concept of neighbourhood in urban studies which encompass complex overlapping geographical, historical, socio-economic and perceptual constructs (Lebel, Pampalon, & Villeneuve, 2007; Galster, 2001; Kearns & Parkinson, 2001).

Census tracts or ward boundaries are administrative region-based local area units that are commonly used to capture neighbourhood characteristics. Due to convenience, these boundaries were often used in estimating hedonic price models or in defining housing sub-markets (Goodman & Thibodeau, 1998, 2003; Leishman, 2009). However, these local area units are seen as arbitrary as it cut across streets and buildings and researchers recognise these definitions do not necessarily capture the qualities of a neighbourhood (Coulton, Korbin, Chan, & Su, 2001; Ellen and Turner, 1997). Fig. 1 illustrates an area in London known as the Isle of Dogs being overlaid with the Middle Super Output Area (MSOA) UK census boundary. The mapping shows disjointed boundaries of MSOA in red that cuts across the central office areas of Canary Wharf in blue.

One problem of these 'arbitrary' or 'ad-hoc' (Orford, 1999; Goodman, 1978) administrative local area unit is that it creates inconsistent empirical results. Goodman's early studies (1978; 1985) showed traces of this investigation when he found coefficient differences in estimating a hedonic price model comparing between the block level and census tract level for the case study of New Haven. In 1985, Goodman, found segregation indices differed when applied through different levels of aggregation using the case study of Baltimore. Differences can be attributed to the fuzziness of local area geographies. These problems are extended to housing submarket identification as noted by Leishman (2009). For example, Bourassa (Bourassa, Hamelink, Hoesli, & MacGregor, 1999) compared housing submarkets defined using either individual dwellings or census tract level data in both Sydney and Melbourne. He found grouping dwelling data achieved different results than grouping census tract ones. These early research found inconsistencies when calculating segregation indices, when estimating multi-level hedonic price models and when defining housing submarket. Recent research also suggests resident perception maps of neighbourhood could be more meaningful than administrative boundaries (Coulton et al., 2001). It is for these reasons this research will propose the concept of Street-based Local Area (SLA).

## 2. Conceptual framework

### 2.1. A framework for Street-based Local Area (SLA)

Street-based Local Area (SLA) is defined as a local area that is; first street-based, second topological/ configurational, third has membership in discrete form and fourth is larger than a home area but smaller than a city. The concept of SLA borrows from two field, network science and space syntax research. It borrows from network science the concept of community structure which is a characteristic found in many social and biological networks (Girvan & Newman, 2002). It also borrows from space syntax research, the use of a spatial network dual graph in representing a city. This research in particular will ask;

*Research Question: to what extent do street-based local areas, as defined by the topology of the street network, associate with house price. Secondly, how do street-based local area units compare with ad-hoc administrative region-based local area units in associating with house prices?*

Fig. 2 illustrates the comparison between these two types of local area units.

This research conjectures that SLA has significant effect on house price and is preferred to ad-hoc administrative region. The plausible reasons are firstly, people perceived the local area on a street network. The street network is therefore able to capture, more precisely subtle differences in an urban environment and more accurately the perceptual definition of a local area than ad-hoc region. Second, the topology of the street network reinforces the socio-economic similarity overtime. As people identify these local areas, this would have an effect on house price. Further discussions would be presented in the last section. In order to define Street-based Local Area, this research will borrow from network science, community detection techniques and from space syntax, the dual graph representation of the city. We will first describe these methods separately and how combining these two sets of methods can construct Street-based Local Area.

### 2.2. Community detection method

The objective of community detection is to define a set of subgraphs that maximises internal ties and minimises external ties using strictly the topology of the graph. These techniques found strong association with social, functional and geographical network groupings (Girvan & Newman, 2002; Guimer`a, Mossa, Turtschi, & Amaral, 2005; Caschili, De Montis, Chessa, & Deplano, 2009). A key reason in the use of community detection techniques on defining SLA is the spatial homogeneity within a network cluster could be related to the social-economic or perceptual homogeneity found in neighbourhoods or local areas. Previous research did not apply such techniques on the street network to find locality. Therefore, a key contribution of the research is the application of community detection techniques on the street network dual graph.

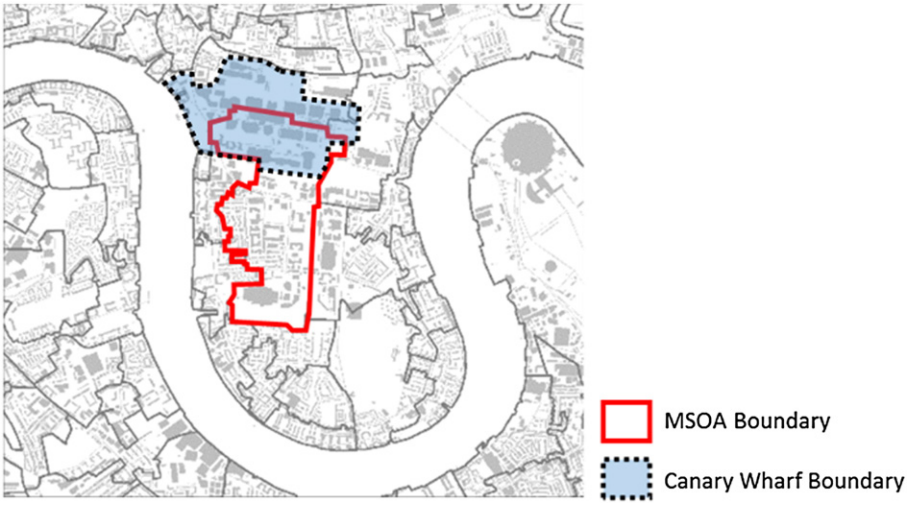


**Fig. 1.** Canary Wharf Boundary in blue overlaid with MSOA boundary in red.