



Neighborhood green and services diversity effects on land prices: Evidence from a multilevel hedonic analysis in Luxembourg



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HIGHLIGHTS

- First multilevel hedonic model with landscape amenities and neighbourhood services.
- Opposite effects of landscape diversity at different distances.
- Spatial heterogeneity effects in the valuation of local land-use diversity.
- No impact of services diversity at sub-municipal scale.
- Multilevel model captures context effects and spatial autocorrelation.

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ABSTRACT

The article aims at revealing the role of green space diversity and the mix of neighborhood services on the price of residential land in Luxembourg. We use a multilevel approach to estimate a hedonic model in order to benefit from the hierarchical structure of the data and to reveal spatial heterogeneity in the valuation of these neighborhood qualities. In addition to standard accessibility and socio-economic variables, we include geographical variables in the form of neighborhood mix indices and a Shannon diversity index of land-uses. Via a spatial cross-regressive specification we also test whether our nested levels are able to capture most of the spatial dependence. Our results show that the presence of a mix of services and green space does not directly impact prices, but that the diversity of land-uses (Shannon index) matters, and has negative effects when considered within immediate proximity and positive effects within a walking distance. Land use effects however vary spatially and emphasize the contrast between regions that are particularly attractive and picturesque, and the former industrial conurbation. In our case we also show the ability of the multilevel approach to capture spatial auto-correlation effects.

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1. Introduction

The spatial distribution of residential land values around cities mainly arises from trading-off accessibility to jobs against housing consumption (Alonso, 1964; Fujita, 1989). However neighborhood qualities and landscape features add up to this trade-off and add further complexity to the spatial structure of land values. Cheshire and Sheppard (1995) emphasized the need to consider a broad

range of location-specific attributes, and over the last 20 years numerous studies have attempted to include local amenities in the analysis of land prices to better understand how much these local features are decisive in residential choice. Since urban growth patterns challenge sustainability and social goals, and many urban and land-use planning actions seek to address them at the local scale (municipality or smaller), it is particularly important for the success of urban policies that the benefits of local amenities are well understood to design effective and acceptable neighborhood plans. Of particular attention here is the presence, spatial distribution and diversity of both land-uses and green space, and neighborhood retail and services around residential places.

Recent theoretical advances have shown that the local arrangement of green space impact on urban form and its scattered or leapfrogging nature (Caruso, Peeters, Cavailhès, & Rounsevell, 2007; Caruso et al., 2011). Brueckner, Thisse, and Zenou (1999)

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also showed the impact of urban versus exurban amenities on the income sorting of households and it is well-known since [Tiebout \(1956\)](#) that the provision of local public goods is an important aspect of residential competition. On the empirical side, results are less clearly conducive (see below) but there is a trend to use more micro-scale data and GIS to better measure these elements. Many hedonic studies now embed local amenities and proximity to services or shops. However very few consider the diversity of both services and land-uses and very few look at the spatial heterogeneity of their valuation. We can hypothesize that those local effects vary considerably with the wider landscape or socio-economic context, even after controlling for the most important socio-economic drivers that would proxy a Tiebout effect and the center-periphery contrast. We contribute such an analysis here using developable land transactions in the Grand Duchy of Luxembourg as a case study. We use a multilevel approach, which is still uncommon in spatial hedonic analysis. Our expectation is to capture additional contextual effects after controlling for neighborhood scale attributes and standard center-periphery trade-off. Moreover the structure of the data available in Luxembourg lends itself to the multi-scale approach.

The remainder of the paper is organized as follows: in Section 2 we conduct a short review of the empirical literature that is most directly linked to our thematic scope and methods. Then we present the study area and the different data-sets (Section 3). The implementation of the approach is then described as applied to our case study (Section 4). Results are discussed in Section 5 before concluding.

2. Literature review

2.1. The value of neighborhood services and green

We review here some empirical literature on the value of proximity and diversity of both neighborhood services and land-uses. This review is not meant to be exhaustive but to pick up the rationale for our empirical experiment and the closest related work.

The impact of local public goods and externalities within the city has been largely discussed since [Tiebout \(1956\)](#). Residential land consumers benefit from the presence of different local urban amenities (e.g.: public services, education and sports facilities, health care, retail). [Fujita and Thisse \(2013\)](#) claim that, as for commuting to work, consumers rather prefer short trips to retail and services. Moreover, the spatial pattern of exogenous amenities in a city (e.g.: natural and historical amenities) impacts on the location of different income groups within the urban area ([Brueckner et al., 1999](#)). Several hedonic pricing studies have investigated the impact on property values of distance to different local urban amenities ([Des Rosiers & Thériault, 2006](#); [Öner, 2013](#); [Thériault, Des Rosiers, & Vandersmissen, 1999](#); [Youssofi, 2011](#)).

Urban amenities generally accounted for are, among others, measures of school quality ([Clapp, Nanda, & Ross, 2008](#); [Kiel & Zabel, 2008](#); [Thériault et al., 1999](#); [Uyar & Brown, 2007](#)), distance to public open-space ([Espesy & Owusu-Edusei, 2001](#); [Mahmoudi, Hatton MacDonald, Crossman, Summers, & van der Hoek, 2013](#); [Wu & Dong, 2014](#)) or the proximity of retail and services ([Thériault, Des Rosiers, & Joerin, 2005](#); [Youssofi, 2011](#); [Öner, 2013](#)). Besides proximity to different local urban amenities, a rich diversity of the offer has been shown to have a positive marginal effect on individuals' utility ([Brueckner et al., 1999](#); [Youssofi, 2011](#)). Considering explicitly the diversity of urban amenities is however not so frequent in the hedonic pricing context and we do not know of studies that would have analyzed its spatial variation in a multi-scalar context.

The role of local green and diversity has been addressed in many hedonic pricing studies. Over 52 studies addressing the valuation

of open-space, mainly at micro-scale, have been identified and analyzed in [Brander and Koetse's \(2011\)](#) meta-analysis. These studies include either distance measures to different green amenities ([Cho, Poudyal, & Roberts, 2008](#); [Des Rosiers, Thériault, Kestens, & Villeneuve, 2002](#); [Kestens, Thériault, & Des Rosiers, 2004](#); [Shultz & King, 2001](#)) and/or consider landscape amenities in varying buffer zones ([Cavailhès et al., 2007](#); [Kadish & Netusil, 2012](#); [Melchiar & Kaprovà, 2013](#); [Sander, Polasky, & Haight, 2010](#); [Youssofi, 2011](#)). Using the same data-set as herein, [Glaesener \(2014\)](#) has tested for these spatial proximity effects at aggregated scale but showed that the lack of spatial precision for this particular data-set does not allow to capture close proximity effects with sufficient robustness. Besides proximity to different green amenities, the purchase decision of land consumers is also influenced by the configuration of the neighboring land-uses. [Geoghegan, Wainger, and Bockstael \(1997\)](#) show that increasing land-use diversity affects property values in two ways: negatively as they introduce higher chances of negative visual and noise externalities, but in the meantime positively as diversity may implicitly signify the proximity of important local urban amenities. Based on their findings, increased land-use diversity is expected to be valued negatively in immediate proximity, while within walking distance a positive impact is expected. Furthermore, spatial variation in the marginal effects of land-use diversity can be expected. [Geoghegan et al. \(1997\)](#) show that diversity is valued differently by consumers with distance to CBD and that it is generally not a desirable feature in the suburban area. In this study, we follow this literature stream on pricing the presence and proximity of land-uses. We also consider the spatial heterogeneity (as [Geoghegan et al., 1997](#) or [Cho et al., 2008](#)), but we do so via a multi-scale setting that fits our data and, we expect, can identify non-stationary marginal effects across space.

2.2. Spatial effects and the multilevel approach

The hedonic pricing method ([Rosen, 1974](#)) is applied to estimate the implicit value of the non-market attributes composing land prices, from which consumers obtain utility, under the assumption of a unitary market in equilibrium. This assumption however prescribes that the implicit prices of the attributes are invariant.

However, market segmentation might arise when consumers' demand for a particular structural or location-specific characteristic is highly inelastic and that the preference for this characteristic is shared by many other consumers ([Goodman & Thibodeau, 1998](#)). Such market segmentation usually causes the emergence of sub-markets, in which "*persistent and significant disparities in attribute prices are present across housing bundles and urban space*" ([Orford, 2000, p.1645](#)). Spatial heterogeneity is likely to arise if the price-attribute relationship varies spatially by such sub-markets, so if the marginal price of a plots characteristics' varies substantially with its location in space ([Le Gallo, 2004](#)). Consequently OLS estimates, imposing spatial homogeneity, will be miss-specified and affect the validity of diagnostic tests ([Anselin & Lozano-Gracia, 2009](#)). Different methods to account for this spatial heterogeneity have been considered in the hedonic context (i.e.: geographically weighted regression; [Cho et al., 2008](#), spatial expansion method; [Geoghegan et al., 1997](#)).

Besides spatial heterogeneity, spatial dependence might also bias estimation results, and different auto-regressive estimation methods have been developed to account for this (among others [Anselin, 1988](#); [Elhorst, 2010](#); [Ward & Gleditsch, 2008](#)). These models should allow to identify and correct for the potential bias induced by spatial dependence and have been largely applied in hedonic literature, that will not be further reviewed here.

According to [Orford \(2000\)](#) the auto-regressive functions developed in spatial econometrics literature can be seen as "technical fixes" to the problems of modeling spatial data, especially as they

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