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Research Paper

Valuation of landscape amenities: A hedonic pricing analysis of housing rents in urban, suburban and periurban Switzerland

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HIGHLIGHTS

- We examine the value of landscape amenities in different community types.
- We find that many land use variables are correlated with centrality of location.
- We account for correlations in the interpretation of the hedonic estimates.
- We present a systematically revised set of parameter estimates.

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ABSTRACT

The hedonic pricing approach has been successfully applied to estimate the economic value of environmental amenities in urban settings, but the results for landscape variables remain relatively inconsistent across studies. Here, we use national-level data and an existing typology of communities to examine how land use and environmental amenities and disamenities affect rental prices across urban, suburban, periurban, and affluent communities in Switzerland. To make the analysis and the results as transparent as possible we examine largely a priori model specifications, and we systematically report and discuss the patterns of correlation among explanatory variables. Two-level models show that about 70 percent of the price variation is found at the apartment level and about 30 percent at the community level. Models for the different community types suggest that, although we include a sophisticated variable for central services, the centrality of location is not fully controlled in our models and thus picked up by correlated peripheral and central amenities such as open space, forest or urban parks. Analysis of these correlations allows us to qualify our results and present a revised set of relatively reliable estimates. Positive effects on rental prices are identified for views, various types of recreational infrastructure and vicinity of lakes, wetlands, undisturbed areas, nationally significant landscapes and cultural sites. Negative effects are found for several disamenities including road noise, railway noise, industries and power lines. We suggest that systematic hypothesis testing and reporting of correlations may contribute to consistent explanatory patterns in hedonic pricing estimates for landscape amenities.

1. Introduction

The hedonic pricing method has become a primary approach for the economic valuation of local public goods. Many applications are directly policy relevant for instance in policies to internalize traffic externalities (e.g. FOSD, 2012). Numerous recent studies have also used hedonic pricing models to examine implicit prices of various environmental and landscape amenity variables, and the literature is rapidly increasing. Among a sample of hedonic studies analyzed by Kuminoff, Parmeter & Pope (2010, p. 147), 84 percent of the studies examined spatially delineated amenities such as air quality or open space. The picture that emerges for landscape variables is not simple or uniform, however. A review of 46 hedonic pricing studies on landscape variables found that only about half of the studies report a positive effect of an increased share of nearby open space or forest on real-estate prices (Waltert & Schläpfer, 2010). The studies

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more often reported significant amenity effects when conducted in urban rather than rural areas. Hence, some of the variation in reported effects may be explained by differences in locations or preferences, for instance due to different degrees of urbanization (Cho, Bowker, & Park, 2006). Further heterogeneity may be due to differences in variable definition as observed by Panduro & Veie (2013) who examine the hedonic prices of different types of urban green space.

Substantial additional variation in reported amenity effects, however, may arise from differences in specifications. The mentioned review of landscape valuation studies found that in cases where multiple models with different sets of explanatory variables were reported, the effects of the amenities were frequently sensitive to the choice of specification. The problems involved in model specification and related hypothesis testing in hedonic pricing studies are well understood in principle (e.g. Anderson & West, 2006; Freeman, 2003; Yoo, Im & Wagner, 2012; Gibbons & Overman, 2012). Most importantly, if the true explanatory variables are correlated, but not all of these relevant variables are included in the model, then some of the included variables may pick up effects of the missing variables. This 'omitted variables' problem is not always adequately considered in empirical applications. Empirical studies sometimes use narrow sets of explanatory variables and readily interpret any significant coefficients as causal effects. In addition, the process of variable selection is not always transparent, implying that the statistical analysis may be rather exploratory in nature and may therefore not support a standard interpretation of statistical tests (Andersson, 2000). Furthermore, discussion about how multicollinearity and omitted variables may have influenced the coefficients in the presented models is sometimes fairly limited.

Our focus in the present study is not to estimate parsimonious hedonic models for the purpose of prediction but rather to test hypotheses about the effects of individual environmental and landscape characteristics on housing prices. With this objective in mind we apply the following multiple strategies: (1) We estimate hedonic models using specifications determined largely *a priori*, thus keeping non-significant variables and variables with counterintuitive coefficients in the model. (2) We include a wide range of potentially relevant explanatory variables. (3) We systematically report correlations among variables. (4) We propose and apply explicit rules for interpreting the estimates in light of multicollinearity and potentially omitted variables. The application is based on a national dataset including 162′000 apartments offered for rent in Switzerland during the years of 2001 to 2007. The explanatory variables include GIS-based environmental and landscape variables measured at different spatial scales. We first use two-level models including apartment and community level variables to estimate variance components. Second, we use the subsamples from different community types and community-level fixed effects to estimate the implicit prices of apartment-level amenities and disamenities across the urban-periurban gradient.

The paper is organized as follows. Section 2 provides a brief review of background literature. In Section 3 we describe how we select and define the variables. Section 4 presents the results. Sections 5 and 6 offer Discussion and Conclusions.

2. Literature background

2.1. Hedonic prices of spatially delineated amenities

The theoretical framework underlying the hedonic pricing method is presented in Rosen (1974) and subsequent work. Hedonic analysis of house or apartment (rental) prices isolates the marginal valuations or 'implicit prices' of individual housing attributes from a regression of prices on the attributes of the dwelling. The attributes include structural characteristics, environmental quality variables and other variables such as accessibility to services and labor opportunities or tax rates.

Today a large fraction of the hedonic literature examines the effect of spatially delineated environmental amenities on housing prices. Geographic information systems are frequently used to construct variables describing local environmental characteristics. Spatial relationships have been measured in many different ways. Recent studies have used distance to specific amenities (Netusil, Levin, Shandas & Hart, 2014), shares of specific land use types, number of objects or length of linear elements within a given radius (Ready & Abdalla, 2005), views on amenities in tree-dimensional space (Baranzini & Schaerer, 2011), or various landscape or land use indices in a property's surroundings (Yoo et al., 2012).

The study that is probably most similar to ours in terms of its national scope, its detailed set of amenity variables and its model specification is a recent study examining transaction prices in Great Britain (Gibbons, Mourato & Resende, 2014). The authors report the results of a semi-log regression of about 1 million property prices on variables for land cover shares and distances to natural amenities along with a series of control variables including accessibility by railroad and roads, population density, distance to district centers, and distance and quality of schools. The authors find highly significant effects for environmental variables including many variables for shares of specific land uses and for distance to amenity sites. They find that their estimates were fairly insensitive to changes in specification but also report a lack of local neighborhood data on many further attributes.

There are also several recent studies from Switzerland which examined environmental and landscape variables in hedonic regressions. A summary of this evidence, both peer-reviewed and non-peer-reviewed, is provided in the Appendix. Consistent effects are reported for the "traditional" variables such as lake view, lake distance, traffic noise, and urban parks. The studies report only few non-significant coefficients. For instance, open space (other than urban parks) or agricultural area is reported in only two studies in both of which the effects are significant (Baranzini & Schaerer, 2011; Schaerer, Baranzini, Ramirez & Thalmann, 2007). Unfortunately, we do not know if open space or agricultural area was also examined in some of the other studies but dropped in the process of variable selection. Nevertheless, these studies together cover a range of amenity variables that are also included in the present study. The set of studies from the same region provides a basis to explore how different sets of explanatory variables may affect the estimated amenity effects (see Discussion).

2.2. Identification issues in hedonic pricing models

Misspecification of the hedonic price function can seriously undermine the reliability of resulting estimates (Kuminoff, Parmeter & Pope, 2010). There are two main issues. The first issue is omitted variable bias. In the empirical literature, a routine response to the issue of omitted variable bias has been to use functional forms of the hedonic equation that have been shown to perform relatively well in the presence of omitted variables (Cropper, Deck & McConnell, 1988). More recently, the performance of this approach has been critically re-examined by Kuminoff, Parmeter and Pope (2010) who find that large gains in accuracy can be realized by using spatial fixed effects and quasi-experimental approaches. Unfortunately, quasi-experimental approaches are only applicable in special situations in which sources of variation are clearly exogenous. Another common approach has been to apply standard spatial econometric techniques which, however, do little to solve the problem of identification of causal effects in a spatial setting (Gibbons & Overman, 2012). Compared with these approaches, relatively little effort has been made to account for omitted variable bias through