Journal of Housing Economics 25 (2014) 104–123

Contents lists available at ScienceDirect

Journal of Housing Economics

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

Spatial issues on a hedonic estimation of rents in Brussels

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ARTICLE INFO

Article history:
Received 21 December 2011
Revised 3 April 2014
Accepted 7 May 2014
Available online 29 May 2014

JEL classification:
C21
C24
C25
C34
Q53
R21

Keywords:
MAUP
Interval regression
Spatial dependence
Spatial heterogeneity
Brussels

ABSTRACT

Using Belgian microdata, we assess the impact, on a hedonic regression, of the distortions arising from the choice of either a specific zoning system or the delineation of the study area. We also evaluate the biases that arise when spatial effects are not accounted for. Given that the dependent variable is interval-coded, controlling for spatial dependence in this context is challenging. We address this problem with two alternative strategies. Firstly, we use the Gibbs Sampling algorithm to estimate spatial econometric models which extends the interval regression model. A major drawback of this approach is that the implied estimation is proned to the endogeneity biases inherent to our hedonic regression model. To circumvent the endogeneity issues triggered by the first estimation strategy, we also use a two-stage estimation procedure with locational fixed effects. In all specifications, results are sensitive to the Modifiable Areal Unit Problem (MAUP) and to the choice of the delineation of the study area. Moreover, they confirm the existence of substantive spatial dependence. Conversely to the previous results with a negative elasticity for the percentage of the area covered by agriculture and a positive elasticity for the potential accessibility to jobs, the second approach implies opposite effects for those two variables. This indicates that dwellings close to agricultural areas and with a lower accessibility to the main employment centers are highly demanded and that endogeneity biases are not negligible.

1. Introduction

The increasing concerns about sustainable development and the growth of urban areas have facilitated a renewed enthusiasm for the use of quantitative models in the field of transportation and spatial planning.

Some spatial issues may arise from the implementation of those quantitative models. One of them is that their implementation requires a massive amount of geographic data collected from various sources, and often at different spatial scales. Another issue is that the definition of agglomerations or, more broadly, the delineation of the study area may differ in the various case studies. All those problems are likely to influence and bias spatial econometric analyzes. Moreover, spatial autocorrelation is also likely to have significant impacts on statistical findings.

In this paper, we check the magnitude of those "spatial" biases and we propose some suggestions to control or at least limit them. To do so we will base our econometric investigation on the first-stage hedonic regression model, which is well represented in the OPUS/UrbanSim platform as the Real Estate Price Model.

In a conceptual point of view, the problem of spatial autocorrelation and the issues of the choice of spatial scales and of the study area boils down to spatial dependence and spatial heterogeneity problems. Spatial dependence is one of the main methodological problems that has to be tackled in first-stage hedonic regression. In general terms, it may be "considered to be the existence of a functional relationship between what happens at one point in space and what happens elsewhere" (Anselin, 1988, p. 11).

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http://dx.doi.org/10.1016/j.jhe.2014.05.002
1051-1377/

Two broad causes may lead to spatial dependence: the nuisance and the substantive spatial dependence (Magrini, 2004). The nuisance spatial dependence refers to the by-product of measurement errors for observations in contiguous spatial units. In several cases data are collected only at aggregate scale. As it implies a poor correspondance between the spatial scope of the phenomenon under scrutiny and the delineation of the spatial units of observations, it may entail measurement errors. Those errors will tend to spill over across the frontiers of spatial entities as one may expect that errors for observations in one spatial unit are likely to be correlated with errors of neighboring geographical entities (Anselin, 1988).

Such measurement errors may be caused by problems of spatial aggregation or by arbitrary delineation of spatial units of observations. The aggregation of spatial data is not benign regarding statistical inference. The question of the sensitivity of statistical results to the choice of a particular zoning system is well known as the Modifiable Areal Unit Problem (MAUP).

Several contributions have assessed the impact of the MAUP on multivariate statistics (Gehlke and Biehl, 1934; Fotheringham and Wong, 1991; Amrhein, 1995; Briant et al., 2010). Gehlke and Biehl (1934) outline the tendency for the correlation coefficient to increase as the size of spatial units increases. In a recent contribution, Briant et al. (2010) analyze the impact of size distortions on the behavior of simple regression coefficients. The context of our study is somewhat different since, as the dependent variable and several covariates are individual dwelling attributes, aggregation biases apply only to a subset of regressors.

Nuisance spatial dependence may also arise because of the arbitrary delineation of basic spatial units (BSU). In a literature review on regional convergence, Magrini (2004) makes an interesting survey of the question. He asserts that the use of administratively defined regions raises two fundamental problems: on the one hand, since output is measured at workplaces while population at residences, the measured levels of per capita income will be highly misleading. On the other hand, processes of decentralization or recentralization of residences relative to workplaces is likely to affect per capita income growth rates for administratively defined regions.

A related but less investigated issue is the one arising from the choice of the delineation of the study area. This issue points more to spatial heterogeneity, i.e. the lack of uniformity of the effects of space. Any structural instability of a given relationship across space would entail different econometric results for distinct study areas. More intuitively, different limits of agglomeration entail distinct geographic structures; and therefore unequal features in terms of degree of urbanization and accessibility. Our contribution focuses on Brussels. For this specific city several delineations may be considered: administrative delineations, morphological delineations (Donnay and Lambinon, 1997; Tannier et al., 2011; Van Hecke et al., 2009), functional delineations (Cheshire, 2010; Van Hecke et al., 2009; Vandermotten et al., 1999), etc. While each way of defining Brussels may be consistent according to a given standpoint, considering administrative definitions can be harmful since administrative borders do not capture the essence of economic phenomena and transportation issues that often spill over boundaries. In this paper, we analyze nuisance spatial dependence and spatial heterogeneity by investigating the impacts of choices of the aggregation scale and of the delineation of the study area.

The substantive spatial dependence is more fundamental and is due to varieties of interdependencies across space. Location and distance do matter and formal frameworks proposed by spatial interaction theories, diffusion processes and spatial hierarchies structure the dependence between phenomena at different locations in space (Anselin, 1988). It has been amply demonstrated that the neglect of spatial considerations in econometric models not only affects the magnitudes of the estimates and their significance, but may also lead to serious errors in the interpretation of standard regression diagnostics such as tests for heteroskedasticity (Kim et al., 2003).

In this paper, we also assess substantive spatial dependence by considering three components of the spatial econometrics toolbox: the Spatial AutoRegressive Model (SAR), the Spatial Durbin Model (SDM) and the General Spatial Model (SAC). Several contributions investigate the spatial dependence issue in cross-sectional hedonic price analyzes through the estimation of Spatial Models (Gawande and Jenkins-Smith, 2001; Kim et al., 2003; Brasington and Hite, 2005; Löchl and Axhausen, 2010).

In most of these contributions, the dependent variable (house price or dwelling rent) is continuous. In this paper, we have to face an extra problem: the information about the dependent variable (here: dwelling rent) is collected through a categorical variable. Each modality of this discrete variable refers to a unique interval of dwelling rents. Therefore, we have to resort to techniques designed to estimate spatially dependent discrete choice models.

There are two ways to handle this issue. The first approach consists on using a Gibbs Sampling algorithm to design "Spatial Interval Regression" models. The second approach implies the use of a two-step procedure where we perform in the first step an interval regression on structural characteristics and fixed/locational effects. Then, in the second step we retrieve fixed/locational effects to obtain averages of log of rents within the basic spatial units and we regress them on a set of observed location characteristics. This last approach has the advantage of avoiding endogeneity bias caused by locational characteristics. Indeed, one may suspect reverse causality between dwelling rents and location characteristics like average income.

This paper is organized as follows. The next section describes the study area and Section 3 presents the data used for estimation. The fourth section is devoted to a detailed presentation of the estimation strategy. Then, Section 5 presents the results of estimations and Section 6 concludes the paper.

2. Delineation of the study area and basic spatial unit

2.1. Delineation of the study area

We restrict the focus of our analysis to the private renting market of Brussels. Here comes the first spatial issue as there is no univocal definition of Brussels. Several