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The recreational services value of the nearby periurban forest versus the regional forest environment

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ABSTRACT

Most previous valuation studies of forest recreational services using hedonic methods have focused on the direct proximity of housing to nearby forests while treating recreational services as homogeneous. However, households in urban and periurban areas may prefer diverse forest areas in their neighborhoods. The main objective of this study is to estimate and compare the impacts of proximity to forest recreational services based on the nearby forest and the regional forest environment, which includes spatially heterogeneous recreational quality. The regional forest environment is computed based on forest recreational services with respect to the travel time to housing. The empirical results show that differences exist between the forest valuations and their recreational services depending on which forest environment is considered. The size of the nearby forest is the only characteristic with a positive and significant impact on housing prices. Conversely, the regional forest environment positively influences housing prices based on certain parameters, such as large forest size, absence of protected areas and the existence of hiking and biking paths, which imply public access and maintenance.

Introduction

Urban and periurban forest ecosystems provide numerous ecosystem services. Among these services, cultural services (spiritual and religious, recreation and tourism, esthetic, inspirational and educational (World Health Organization, 2005)) play an important role in urban societies and are increasingly valued. This article does not analyze all cultural ecosystem services but focuses on the non-material recreational aspects of human–nature relationships, i.e., the recreational forest ecosystem services (Chan et al., 2011).

The hedonic price method provides a relevant tool for assessing amenity valuations in urban and periurban areas. Previous studies have used the hedonic price method to valuate urban and periurban environmental amenities, specifically, forests and green areas (Anderson and West, 2006; Cavailhès et al., 2009; Hobden et al., 2004; Thorsnes, 2002; Tyrväinen and Miettinen, 2000). These empirical studies have attempted to value the recreational properties of different ecosystems, including forest areas; however, they only address the direct proximity to the ecosystem (e.g., distances to forests or trees in cities (Sander and Haight, 2012)) without fully integrating the ecosystem characteristics and services. Local recreational services are not always known, which may explain this limitation. However, recent studies have estimated forest area values according to their ecosystem service characteristics. Abildtrup et al. (2013) used a choice experiment method to determine that spatial forest recreation preferences depend on recreational ecosystem services, such as the possibility of hiking. Bujosa Bestard and Riera Font (2010), Clough and Meister (1991) and Termansen et al. (2008, 2013), estimated the aggregate recreational forest service values at multiple sites using the travel cost method. Several articles have provided detailed estimates of natural site values using the hedonic price method with respect to the socioecological characteristics (Ham et al., 2012; Ham et al., 2015; Panduro and Veie, 2013; Tapsuwan et al., 2012) or ownership statuses (e.g., private versus institutional forest (Mansfield et al., 2005)) of the sites. Ham et al. (2012) estimated the marginal impact of proximity to the Pike National Forest when treating forests as heterogeneous goods. The study determined the housing proximities to the recreational and "working land" portions of the forest. The latter proximity exhibited a significant negative effect. Panduro and Veie (2013) provided a non-market valuation of green spaces (using a broad definition of the latter term). Their estimates are based on ecosystem service classifications in those areas, as are those in Bell et al. (2007), which included recreational ecosystem services such as parks, lakes, nature, sports fields and others. The

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study showed that the impact on the housing price differs according to green area categories based on maintenance and accessibility. Similarly, Tapsuwan et al. (2012) included recreational quality indices of parks, lakes and rivers in a hedonic framework to estimate the impacts of spatially heterogeneous recreational services related to different natural sites. They showed that housing prices significantly increased with the attractiveness index and the proximity to the natural amenity.

These previous studies focused on the diversity of recreational sites (e.g., lakes, sports fields or green urban parks) and their impacts on housing prices. However, they did not consider the diversity of recreational ecosystem services, as noted by the Millennium Ecosystem Assessment (World Health Organization, 2005), which represents the spatial heterogeneity of recreational quality levels of specific natural areas such as forest areas. To our knowledge, no studies have used the hedonic price method that considers not only the nearby forest areas but also the diversity and multiplicity of forest areas. This study estimates the value of the regional natural environment, including the spatial heterogeneity of local recreational ecosystem services. This approach can improve the estimates of the benefit of periurban forests for policy makers and urban planners.

An amenity can be multi-site and have spatially heterogeneous quality levels in terms of recreational services. Indeed, forest recreational amenities are not spatially homogeneous. For example, areas with intensive timber production or military land use may have negative impacts on the recreational value, while the presence of recreational facilities may increase the value (Griliches, 1971; Ham et al., 2012). Nearby forests are not necessarily the only forests considered by households when making a residential choice, as different forests are used for different purposes. Thus, considering only the nearby forests can generate an omitted variable bias and lead to flawed policy recommendations. The main objective in this study is to estimate and compare the impacts of different recreational forest services on housing prices based on the characteristics of nearby forests and the regional forest environment (all regional forest areas, including the nearby forest). The regional forest environment is computed from the forest recreational services based on the travel time to the housing. We use a regional survey of household activities in forests (Maresca, 2000) to define a regional typology of forest recreational services. Four services are considered: walking and hiking, biking and mountain biking, jogging and exercising, and observing plants and animals. We estimate the implicit price of the nearest forest recreational services and compare this price to the implicit price of the regional forest environment close to housing areas. This study was conducted using a large number of databases at the smallest national statistical level in France in the *département* of Seine-et-Marne. This paper is organized as follows. In the second part, we present the econometric models and estimation methods. Then, we explain the development of the data set and the calculation of localized variables. In part four, we present our results, and conclusions are discussed in part five.

Econometric model and estimation method

The model

As in the theoretical model developed by Rosen (1974), we assume that the prices of differentiated goods, such as housing, depend on the associated characteristics. Thus, a good is composed of a set of hedonic prices or implicit prices that depend on the specific associated number of characteristics. We use a standard hedonic price equation in this study:

$$P_i = f(X_i, \beta) + \varepsilon_i \tag{1}$$

where P_i is the price of the dwelling i, X_i is the matrix of explanatory variables (i.e., an intercept and the set of housing characteristics), β is the vector of parameters to be estimated and ε_i is an error term. In our case, the housing price is a function of three sets of characteristics, and the standard hedonic model in Eq. (1) can be expanded as follows:

$$P_i = f(L_i; S_i; N_i) + \varepsilon_i \tag{2}$$

where L_i represents a set of intrinsic characteristics used to specify the housing services (Muth, 1969). S_i is a set of variables that includes the neighborhood and town characteristics (local extrinsic characteristics (Baumont and Maslianskaia-Pautrel, 2016)). N_i includes the proximity and accessibility to the forest environment and recreational service variables.

The hedonic method is a two-step estimation. The first step is to analyze the hedonic function, and the second step aims to reveal the willingness to pay (WTP) of households based on the results of the hedonic function. In this study, we estimate only the first step due to our objective of focusing on the hedonic price function.

The large number of explanatory housing price variables implies the possibility of non-linearity. Therefore, different functional forms are commonly used for this model. This model can be constructed as a linear–linear, log–linear, log–log or Box–Cox transformation (Bello and Moruf, 2010). Another form is the partially linear model (PLM), which allows non-linearity within the non-parametric part of the model (Day et al., 2007). The hedonic price function in this study is estimated using a log–linear functional form, which is widely used in the hedonic price method literature (Cavailhès et al., 2009; Letombe and Zuindeau, 2001; Panduro and Veie, 2013; Sander and Haight, 2012). It allows non-linearity and includes the possibility of spatial price correlations. Moreover, this specification minimizes heteroskedasticity (Wooldridge, 2003), and the results can be interpreted as relative values rather than absolute values (Flachaire et al., 2007).

Estimation methods

Space and geographic localization are non-neutral in econometric models. Ideally, space should be considered explicitly in econometric models with georeferenced data (housing, neighborhood and accessibility attributes). In the present study, we apply spatial econometric models to account for spatial autocorrelation. In the case of hedonic pricing, accounting for spatial correlations improves the model estimation and the environmental services assessment (Wilhelmsson, 2002).

Baumont and Maslianskaia-Pautrel (2016) developed four factors underlying spatial autocorrelation in the housing market. First, spatial autocorrelation often occurs because neighboring homes are frequently built during the same period and use the same architectural and technical methods (e.g., thermic and acoustic). Thus, houses share the same intrinsic characteristics. Second, urban public policies such as urban renewal operations homogeneously modify neighborhoods in terms of socioeconomic and natural environments. Some of these public policies can improve the attractiveness of a neighborhood and increase housing prices by developing transportation networks or urban parks. By contrast, other public policies can deteriorate the neighborhood environment via industrial or road network development. Third, private owners and real estate agencies compare the price of a dwelling to those of neighboring houses. Finally, environmental awareness and knowledge of sustainable development affect housing preferences and residential choices. These four factors may not be fully observable; therefore, spatial autocorrelation may help to offset any omitted variables. Furthermore, Ordinary Least Squares (OLS) estimators are biased and non-convergent in the model when lagged variables are ignored in the spatial hedonic specification (Le