Irrigation Water Valuation Using Spatial Hedonic Models in GIS Environment

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ABSTRACT

Hedonic pricing is an indirect valuation method that applies to heterogeneous goods investigating the relationship between the prices of tradable goods and their attributes. It can be used to measure the value of irrigation water through the estimation of the model that describes the relation between the market value of the land parcels and its characteristics. Because many of the land parcels included in a hedonic pricing model are spatial in nature, the conventional regression analysis fails to incorporate all the available information. Spatial regression models can achieve more efficient estimates because they are designed to deal with the spatial dependence of the data. In this paper, the author presents the results of an application of the hedonic pricing method on irrigation water valuation obtained using a software tool that is developed for the ArcGIS environment. This tool incorporates, in the GIS application, the estimation of two different spatial regression models, the spatial lag model and the spatial error model. It also has the option for different specifications of the spatial weights matrix, giving the researcher the opportunity to examine how it affects the overall performance of the model.

Keywords: Geographic Information Systems, Hedonic Pricing Method, Irrigation Water Valuation, Spatial Econometrics, Spatial Regression Models

INTRODUCTION

Water resources are very important for the humans and the natural environment. The availability of adequate water quantities for all uses is also important for the economic development of every country, because water is a necessary input to production in the most of all economic sectors. Agriculture is the biggest consumer of fresh water among all economic sectors in many regions of the world. The most significant problem in the agriculture sector is the intense use of water, in conjunction with its low efficiency. It is widely accepted in the literature that water must be treated as an economic good and more efficient water prices must be introduced, in order to achieve an efficient water allocation. The establishment of more efficient water prices requires reliable estimation of the economic value of water.

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revealed preference ones. The main methods, which are widely used, and can be used, for the estimation of the economic value of water resources are: hedonic pricing, travel cost, contingent valuation, and choice experiment. The first two of the above belong to the category of indirect methods while the other two to that of direct methods (Birol et al., 2006).

The hedonic pricing method is commonly used in real estate appraisal, real estate economics and consumer price index calculations, but there are also many examples of the use of the method in irrigation water valuation, like the applications of the method presented by Milliman (1959), Hartman and Anderson (1962), Torrel et al. (1990), Faux and Perry (1999).

In a hedonic pricing method application a heterogeneous good, usually land property or housing, is treated as a sum of individual goods (characteristics or attributes) that cannot be sold separately in the market (Nelson, 1978). Then the individual values of the characteristics of the good under study are estimated (for example the agricultural land value and the individual values of its attributes, such as size, irrigation water etc.) by means of ordinary least squares regression analysis. One of the important assumptions in an OLS regression analysis is that the error must be constant across the sample in order to obtain unbiased parameter estimates, but this is not the case in the most of the hedonic pricing applications. The reason is that the sample, which is used for the estimation of a hedonic pricing model, consists of land property characteristics that are distributed across the study area and, therefore, according to Tobler’s “first law of geography”: “…everything is related to everything, but closer things more so…” (Tobler, 1979). In other words spatial dependence is here not exception but the rule, and is known as “spatial autocorrelation”.

There are many statistical techniques that have been developed to deal with the problem of spatial autocorrelation. According to Anselin and Berra (1998), spatial autoregressive models are more appropriate for economic data. These models confront the problem of spatial dependence by means of spatial weights and spatial lag operators. The spatial weights define for each observation (property), the “neighborhood sets”, i.e., those locations that interact with it. Therefore, the present research is focused on the estimation of the hedonic pricing function using two well known autoregressive models and, more specifically, the spatial lag and the spatial error model. In a previous work (Mallios et al., 2007b), a specific approach on estimating the value of irrigation water using spatial regression models produced better parameter estimates compared to those obtained by the conventional OLS regression.

In this paper, an important issue on the estimation of the spatial regression models is examined and particularly how the definition of the neighborhood sets of each observation affects the model parameters estimates. The questions arising are how the neighbors of each observation are selected and how each of the neighbors affects the price of it. Here is examined how the specification of the spatial weights matrix affects the overall performance of spatial regression models. More specifically, it is examined if all the neighbors affect in the same way the price of each observation or if this price depends on the distance of each of the neighbors. For this purpose an add-in tool has been developed using ArcObjects and Microsoft Visual Basic technology for the ArcGIS Desktop environment, capable to produce parameter estimates of spatial regression models and providing the user with the option to specify the spatial weights matrix and select the one that improves the overall performance of the model.

**METHODOLOGY**

The hedonic pricing method is based on the characteristics theory of value developed by Lancaster (1966) and Rosen (1974), which suggests that a good can be described as a bundle of characteristics. These are contained at different levels in the good under study, affecting the price of the good. It is assumed that the commodity under study is described by a vector of m attributes (characteristics), denoted by x =
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