



Mass appraisal of farmland using classical econometrics and spatial modeling

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ABSTRACT

Mass appraisals of properties traditionally use classical linear regression models (CLRMs); however, there has been the need to model the data spatially. Such modeling of the geographic effects has been used mainly in appraisals of urban areas, but the values of the properties in rural areas are also affected by the geographic location. This paper aims to use spatial regression econometric models in a sample of rural properties to elaborate the plan of values for an area of the North Fluminense Region – RJ, Brazil. The proposed methodology is to investigate and model the effects caused by the spatial autocorrelation on the CLRMs, evaluate their performance comparing them with the spatial models and produce the plan of values through ordinary kriging. The utilized sample consisted of 113 observations and 25 samples of verification. The performance of the obtained surfaces of values was evaluated through the Root Mean Squared Error (RMSE). The results showed that the spatial autocorrelation can have its effects controlled by Spatial Regression Models, because the Spatial Error Model (CAR) allowed to model the spatial dependence present in the residuals. Using the metrics of Akaike information criterion (AIC), R^2 and likelihood function (LIK), the CAR model showed better fit in comparison to the CLRM. The results showed that the surface generated by the CAR model showed the best performance with the lowest RMSE. The combination of the methodologies of classical and spatial regressions and the use of geostatistical techniques were adequate to elaborate and obtain the plan of values for rural areas, to be used for various purposes, such as taxation, financing, expropriations, indemnities (in case of creation of conservation units or even in environmental disasters), among others.

1. Introduction

Brazil is a country with continental dimensions, territorial surface of 8,514,876.599 km² and the rural properties occupy 71.10% of this surface. Thus, the techniques of mass appraisal of values of the properties are of great importance for a series of applications. One of the main applications is in the determination of the Rural Land Tax – RLT. In addition, another tax in Brazil that depends on the correct appraisal of the property is the Tax on the Transfer of Real Estate – TTRE, which is of total responsibility of the Municipal Governments. There are also many other actions in rural properties that also need correct determination of the values, such as: financing, expropriations, indemnities (in case of creation of conservation units or even in environmental disasters), real estate buying and selling, land reform, etc. Each one of these actions determines values that do not always follow evaluative techniques, generating different values for each situation. As to the RLT, according to the Federal Revenue Secretariat – FRS (BRASIL, 2012), the collection in 2012 was equal to R\$ 677 million¹. Using the

area estimated by the National Institute of Colonization and Land Reform – INCRA in the same year, 605,387,746.06 ha, the value in 2012 was 1.12 R\$/ha, which is considered to be too small and reflects an inefficient taxation.

The elaboration of the Plan of Generic Values - PGVs can use the statistical techniques of Multiple Regression, through the homogenization of the values of a sample of properties collected in the real estate market. However, there has been the need to incorporate variables of geographic location in the regression models, in order to model spatial effects. This modeling of the spatial effects, through spatial econometrics, has been used mainly in the PGVs of urban areas (Trivelloni, 2005; Hornburg, 2009), and the values of properties in rural areas are also affected by these effects (Santos, 2014).

However, there are no studies in the literature on the spatial analysis of values of rural properties for the determination of which is the best technique to obtain the PVG. Thus, the present study aims to treat the data statistically through Classical and Spatial Regressions, generate the surface of values through Geostatistics and thus elaborate the plan

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¹ In December 31, 2012, the exchange rate was 1USD = R\$2.04

of values for rural properties in the area of the PROJIR – Project of Irrigation and Drainage of Sugarcane in the North Fluminense Region – RJ, Brazil. It is expected with this study to evaluate the techniques that can be used in plan of values elaboration and that can be used in other regions of the country.

With the obtained information, it will be possible to implement, for example, other mechanisms of reduction in the RLT value, besides the ones that already exist for those properties that maintain environmental preservation areas in the form of legal reserves, permanent preservation areas or private reserve of natural protection, making it an instrument of environmental policy, through which the RLT would work as a compensation paid by the society to the landowner who preserved the environment.

This study aims to generate knowledge that will contribute to the solution of problems related to the determination of prices of rural properties in Brazil, with possible application of the methodology also in other countries. Therefore, this study will address one of the issues that involve rural land management, the mass appraisal for the determination of the value, which has multiple applications, including territorial taxation.

2. Studied area

For the application of the proposed study, it was selected an area of the PROJIR that encompasses part of the municipalities of São João da Barra, Campos dos Goytacazes, Cardoso Moreira, São Francisco de Itabapoana, Conceição de Macabu, Carapebús and Quissamã, in the state of Rio de Janeiro – RJ, Brazil (Fig. 1).

The PROJIR area is approximately located between the coordinates 21°17'15"S / 40°59'40"W and 22°04'55"S / 41°45'01"W, approximately 280 km away from the capital, Rio de Janeiro. This area was selected

for this study because it has basic maps that will support the research and the evaluation of the results. In 1982, surveys regarding Basic Cartography, Registration of Rural Properties, Maps of Soils and pedological profiles and Land Aptitude for Irrigation, besides other pedological, geological and hydrogeological maps, were performed in this area, which corresponds to approximately 250,000.00 ha.

The North Fluminense Region is considered of traditional predominance of agricultural activity, because its flat relief, typical of lowland, and tropical climate with dry winter season, Aw, according to Köppen-Geiger classification (Kottek et al., 2006), caused this region to structure its economy on the sugarcane crop. The region is bathed by the Paraíba do Sul and Muriaé rivers, which provide the availability of water to the practice of irrigated agriculture.

With the arrival of Petrobrás in the region, from the 1970's on, there has been a series of social and environmental transformations, because, with the construction of industrial centers necessary for petroleum production and the natural increase in the population, there were changes in soil use, followed by appreciation of the properties, as historically occurs in these cases.

Petroleum exploitation in the Pre-Salt layer, accompanied by infrastructure works and large industrial projects due to the construction of the COMPERJ – Petrochemical Complex of Rio de Janeiro, caused transformations in all segments of the real estate industry. Another large investment that promised to boost the region was the construction of the CLIPA – Logistic-Industrial Complex of the Açú Port. Rodrigues et al (2010) detected considerable modifications in the dynamics of the Municipality of São João da Barra. One of the changes was the super-appreciation of the properties in the municipality, for both rental and sale.

However, some recent factors can alter such dynamics in the prices of the properties of the region. First: the reduction of the petroleum barrel price to half, which on one hand decreases the royalties and on

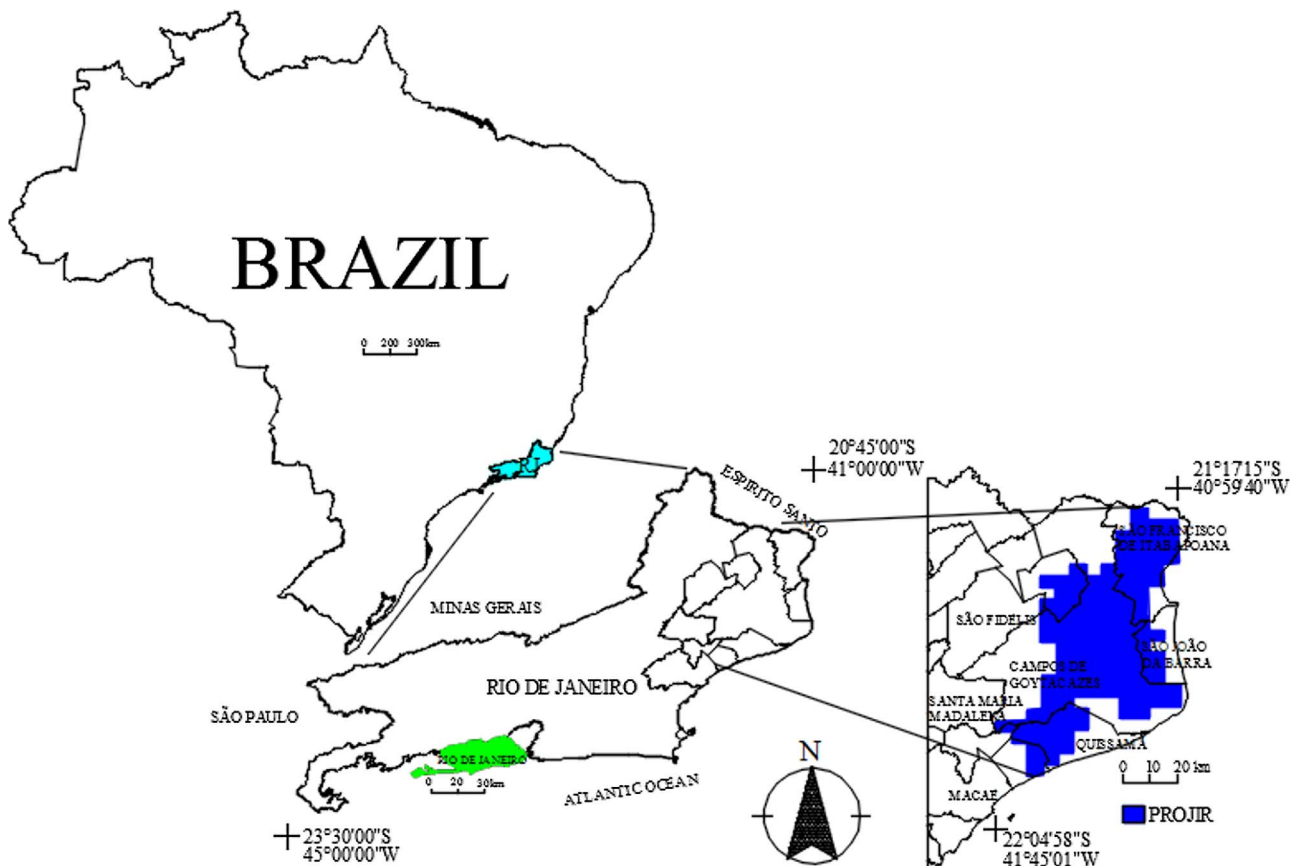


Fig. 1. Location of the study area (PROJIR project).

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