The Convenience of Applying Multilevel Modeling on Real Estate Valuation

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Abstract
There are many economic agents interested in valuing big amounts of real estate assets. One of these agents are the financial institutions, which must value their vast mortgage portfolios periodically. In this paper we analyze the use of the Hierarchical Linear Model to value real estate portfolios. This model gives valuable information compared with the traditional OLS models and is more accurate, as it takes into account the hierarchical structure of the data.

Keywords: hierarchical linear model, real estate valuation.

Introduction

Accurate accounting information is necessary for investors, regulators, governments etc. This is specially truth in the case of banking institutions, as the present financial crisis has proved. Investors and regulators must have access to information regarding the valuation of the assets included in the balance of the banks. One of the most important assets regarding the volume and the demanded risk management are those related with mortgages and those real estate assets that serve as collateral in the event of default. Therefore, banks should update the value of this real estate portfolio periodically applying a statistically sound method which is easy, automated and inexpensive to implement and public these values in their accounting reports. Using a rapid, accurate and inexpensive methodology is of great importance to achieve these goals.

The remainder of the paper is structured as follows. Section 2 presents a brief literature review regarding the different methodologies usually applied to mass valuation. Section 3 introduces the proposed methodology, i.e., the hierarchical linear model and the database employed. Finally, Section 4 concludes.

Literature Review

There are different methodologies that can be applied to value big amounts of real estate assets, such as decision trees (Fan, Ong & Koh, 2006), rough set theory (d’Amato, 2007), artificial neural networks (Selim, 2009), support vector machines (Kontrimas & Verikas, 2011) or random forest (Antipov & Pokryshevskaya, 2012), among others.

Furthermore, econometric models, more specifically, hedonic regression models, have been extensively applied in the literature and its use is widely spread among both academics and practitioners in residential real estate mass appraisal. These studies apply different econometric models with different complexity levels, like the traditional hedonic regression models (Downes & Zabel, 2002), ridge regression (Ferreira & Sirmons, 1988) or quantile regression (Farmer & Lipscomb, 2010), just to mention some examples.

Proposed Methodology: The Hierarchical Linear Model

In addition to the already employed methodologies cited in the previous section, we propose the application on mass appraisal of the Hierarchical Linear Model. This methodology has already been used...
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Although the application of the Hierarchical Linear Model is very promising, its use in real estate valuation has been very limited. To our best knowledge, this model has not been employed yet on mass appraisal.

The general model to be estimated is:

$$Y_{ij} = \beta_0 + \sum_k \beta_k x_{ijk} + \sum_j \beta_j G_j + \epsilon_{ij}, \quad i = 1, ..., I; j = 1, ..., J$$

where $Y_{ij}$ represents the price for apartment $i$ in postal code $j$, $x_{ijk}$ represents the $k$ explanatory variable, and $G$ is the vector of geographical fixed effects. The parameters to be estimated are $\beta_k$ and $\beta_j$, and $\epsilon_{ij}$ is the error term.

In the simplest formulation of the Hierarchical Linear Model we consider the one-level random-intercept model:

$$Y_{ij} = \beta_0 + \sum_k \beta_k x_{ijk} + u_j + \epsilon_{ij}$$

where $u_j$ is the group random effect (group-level residual) for group $j$. Thus, the overall conditioned mean is $\beta_0 + \sum_k \beta_k x_{ijk}$, but the conditioned mean for the group $j$ is $\beta_0 + \sum_k \beta_k x_{ijk} + u_j$, so that $u_j$ can be understood as the difference of group $j$’s mean and the overall mean.

The basic assumptions on the group-level residuals are that they are independent normally distributed with zero mean, $u \sim N(0, \sigma_u^2 I)$; the individual-level residuals verify the same assumptions $\epsilon \sim N(0, \sigma_\epsilon^2)$; and group-level residuals are uncorrelated with individual-level residuals, thus total variance for individual $ij$ is $\sigma_u^2 + \sigma_\epsilon^2$.

In the traditional econometric models, the influence of housing characteristics on the price is considered to be constant, regardless the location of the house. This assumption cannot correctly reflect the reality, as the characteristics of a neighborhood are not independent from the house characteristics and may interfere with each other. Following Basu and Thibodeau (1998), when spatial autocorrelation exists in the error term in a hedonic price equation, the assessment results of the parameters may be subject to error. Furthermore, incorrect coefficients may be caused in the explanatory variables in the model, which leads to wrong conclusions.

As stated by Brown and Uyar (2004), the Hierarchical Linear Model can be applied to overcome these problems and correctly assess the implicit price of a house with non-constant variance and spatial heterogeneity. That is, the Hierarchical Linear Model can be used to separate the variation in housing prices into that portion that depends on house-specific characteristics and that portion that depends on neighborhood-specific characteristics.

**Conclusions**

In this paper we propose the application of the Hierarchical Linear Model to residential real estate mass appraisal. Mass appraisal, the automated valuation of a big number of real estate assets, is of great importance for many economic agents, like financial institutions. While multilevel models have been already used in many fields like education, sociology or politics, to the best knowledge of the authors, this is the first time that this methodology is applied on mass appraisal.

Compared to the traditional hedonic regression models, the Hierarchical Linear Model explicitly considers that the price of the apartments located in the same neighborhood is not independent, as the
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price will be influenced by characteristics of the neighborhood. In a real estate appraisal context Ordinary Least Squares will yield biased and inefficient results, as it cannot take into account within-group correlations or interactions between residence and neighborhood attributes.

References


