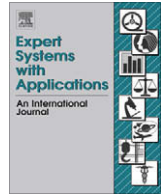




Contents lists available at ScienceDirect

Expert Systems with Applications

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

The use of fuzzy logic in predicting house selling price

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ARTICLE INFO

Keywords:

Fuzzy logic
House price
Local aspects
Prediction model
Real estate market

ABSTRACT

In this paper, a new grading model has been developed for prediction of the selling price of house-building. Fuzzy logic systems, considering the city plans, the nearness to cultural, medical, training and educational buildings, the public transportations systems, the other environmental factors and the increased technological upgrading deals with information about construction, have been employed in order to construct the model and achieve the aim. Such factors are used as the inputs. Besides, a questionnaire application including these factors has been applied to determine the values of fuzzy training and testing sets. In this way, the constructed model has been applied to the prediction of selling prices of houses located in different regions of Eskişehir city in Turkey. The predicted values and real selling prices determined by selling market have been compared with each other. Consequently, real selling price of house-building has shown variety with respect to the regional aspects and salesmen. The suggested fuzzy logic model can be capable and usable for similar applications.

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1. Introduction

Residence is kind of a wide phenomenon process, beginning with supply of refuge for people and being extended to be one of the most important financial tools, and presents a very large perspective in order to be investigated. In the housing market in which house services are taken place with the mechanism of supply and demand, changing the housing prices have been the interests of the governments, the managers and the individuals due to their influences on the socio-economic conditions and they have also other important effects on the national economic conditions. The housing price and the factors causing the irregular change of this price have been investigated for a long time by many experts from different disciplines such as economists, real estate investors, geographers, however, urban planners and politicians have begun to study related to this subject after association of the urban area usage with the housing market dynamics.

Housing price is a determination related to the residence properties, and this determination is not just the total of the residence unit itself and the constitutional properties of the residence, on the other hand, it is also the combination of the region's properties and location. In the determination of housing price, the consumers' appraisal of the residence unit's constitutional, physical and environmental qualities, and their same appraisal of neighboring properties also play effective parts. Besides, expectations of high capital income from housing investments can increase the demand

for house sales which cause the possibility of the high volatility in housing prices. Since the supply of housing cannot adjust this demand in the short run, housing prices will strongly increase. Furthermore, the housing market can be influenced by other variables as macro-economic variables, spatial differences, characteristics of community structure, and environmental amenities (Kim & Park, 2005).

The valuation of real estate is required to provide a quantitative measure of the benefit and liabilities accruing from the ownership of the real estate. Valuations are required, and often carried out, by a number of different players in the marketplace such as real estate agents, appraisers, assessors, mortgage lenders, brokers, property developers, investors and fund managers, lenders, market researchers and analysts and other specialists and consultants. Market value is estimated through the application of valuation methods and procedures that reflect the nature of property and the circumstances under which the given property would most likely trade in the open market (Pagourtzi, Assimakopoulos, Hatzi-christos, & French, 2003).

In literature, different methods are suggested to estimate the housing market value. Pagourtzi et al. have defined these methods in two different groups as traditional and advanced (Pagourtzi et al., 2003). In this study, the methods depending on several comparison methods such as a direct capital comparison in its simplest form in order to determine market value or the observation sets providing the determination of a regression model have been called as "Traditional". Comparable method, investment/income method, profit method, development/residual method, contractor method, multiple regression method and stepwise regression

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method can be given as examples for traditional methods. Additionally, the other methods simulating the thought processes of the market players in which the estimation of the exchange point is being attempted have been called as “Advanced” according to this study. Artificial neural networks (ANN), hedonic pricing method, spatial analysis method, fuzzy logic (FL), and Autoregressive Moving Average (ARMA) method can be said as the examples of advanced methods.

Most of the price studies have been performed by using the other methods based on hedonic method and multiple regression analysis. Basically, these methods are generally used and suitable for the certain estimation of the relation between prices and several variables. Nevertheless, these techniques can lead problems if the process of pricing is extended to contain the points of view as outliers, non-linearity, spatial and other kinds of relations between observations, discontinuity and fuzziness. Therefore, new lookups are being continued determining housing price by profiting from recent computer technologies. In this way, some approaches, presenting the influences on the real estate by analyzing many criteria for the determination of its price and revealing the best combinations according to these influences, have been developed. Dilmore may be the first expert who accepts the potential practice of FL for the properties of real estates. For instance, one of the studies performed by Dilmore has indicated many important points about FL (Dilmore, 1993).

In this study, it is aimed to predict the house unit prices (UPs) by using FL. The factors affecting the house prices have been determined and chosen as house factors, environmental factors, transportation factors and regional socio-economic factors. After then, these factors have been rearranged into related different groups to explain and model their effects on the house prices in detail. The data about these factors to be used in FL model have been obtained from a prepared questionnaire application. One hundred and sixty of these data have been used for training set and 40 of them have been used for testing set in the constructed FL model. UPs obtained from the model and the real UP values have been compared to each other to determine the precision of the FL model suggested in this study.

2. Related previous research

Many researches have been conducted on the investigation of the factors affecting the housing prices and the relations between them. The first study about the effective factors can be accepted as Alonso's hypothesis explaining the relations between in situ values and the usage. According to Alonso, if the spatial balance is existing, housing prices are decreasing since the location is getting far from the trade centers (Alonso, 1964). Muth, in his study about the housing prices at Chicago, has pointed out that the trade centers possibly far from the town center, the distance to social and cultural centers, transportation system and social structure of neighborhood have also some effects on the housing prices together with the properties of residence and the distance to town center (Muth, 1969). Wabe has studied the effects of the properties residence and urban on pricing by using regression equations. The objective of the study is to determine average residence qualities for each town observed (Wabe, 1971). Kain and Quigley have investigated dependent evaluation of quality variable of housing pricings and the properties of residences at United States of America in their study (Kain & Quigley, 1970).

The regression of housing prices evaluating the marginal contribution of the properties of a residence and the neighborhood relations is defined as the implicit and hedonic prices. Hedonic pricing method model depends on the Lancaster (1966). Since this theory has been adapted to the house market by Rosen, residential hedonic

method commonly to be used as an assessment tool for the market and urban analysis. The Rosen's theoretical study about hedonic house prices is an exactly detailed investigation related to the housing market, house prices and residential properties showing the way to experimental studies. In the mentioned study, a model has been explained the housing prices based on a great many of variables by hedonic price theory. Both the choices of salesmen and producers have also included besides the nature and the mean of market equilibrium (Rosen, 1974). Brown and Rosen, has conducted a study developing the Rosen's theoretical model and reflecting the supply–demand functions and market equilibrium to the hedonic price analysis (Brown & Rosen, 1982). Rabiega et al. have researched the effect of public housing project constructed nearby the present houses in Portland on the house prices of them by using hedonic price method (Rabiega, Lin, & Robinson, 1984). Stevenson has reexamined heteroscedasticity in hedonic house price model in his study by using the average ages of houses in Boston as data. The obtained results have supported the evidence of heteroscedasticity regarding the house age in the previous findings (Stevenson, 2004). Bin has estimated a hedonic price function using semi-parametric regression. The performance of price estimation has been compared to the conventional parametric models. In order to take the location attributes of houses into account, the data from geographic information system (GIS) has been used. The results revealed that the semi-parametric regression shows better performance in both in-sample and out-of-sample price predictions and it can be used for measurement and prediction of house prices (Bin, 2004). Kim and Park have made a study defining the spatial pattern of housing price changes and their determinants in Seoul and its neighbor towns. The results of the cluster analysis have noted that the spatial pattern of housing price change rates is not correlated with house prices (Kim & Park, 2005). Fan et al. have used the tree decision approach for evaluating the relationship between the house prices and the house characteristics (Fan, Ong, & Koh, 2006).

In recent years, ANN and FL approaches have been used as alternative tools to model systems of conventional property value. Din et al., in their study, they have discussed the standard linear regression model including ordinal variables for measuring environmental quality as the reference model and they have found that price indices of ANN models exhibit a similar behavior. However, it has also concluded that the detailed price behaviors of different models show significant differences depending on the input choices of environmental variables (Din, Hoesli, & Bender, 2001). Selim has compared the hedonic regression and ANN model to each other for determining the house prices. 2004 Household Budget Survey Data for Turkey has been used as the document for the data set. At the end of the study, by reason of hedonic regression's non-linearity, it has been explained that ANN can be a better alternative modeling technique in the determination of house prices in Turkey (Selim, 2009). In another study, the fuzzy neural network prediction model based on the hedonic price theory includes a database storing hedonic characteristics and coefficients affecting the real estate price level from the recently sold typical projects which are reflecting the local environment. The experimental results of the study have shown that fuzzy neural network prediction model has a great ability for the function approximation and available for real estate price prediction with respect to the quality of attainable data (Liu, Zhang, & Wu, 2006). Lokshina has compared multi regression, ANN, FL with each other. In the evaluation of real estate price, the applicability of ANN and FL has been proved and determined that appropriate results obtained by using artificial intelligence methods. Moreover, it is concluded that the performance of the multi regression application for house prices is quite well (Lokshina, Hammerslag, & Insinga, 2003).

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