CONSTRUCTION AND THE ANALYSIS OF THE MODELS OF MASS APPRAISAL OF RESIDENTIAL REAL ESTATE IN RIGA AND DAUGAVPILS

Oksana Ruzha, Svetlana Ignatjeva
Daugavpils University

Abstract

Mass appraisal of real estate is one of the most classical economic tasks in accomplishing of which econometric modeling is successfully applied. The following article dwells upon three models used for estimating the commercial value of residential real estate. For the purposes of the research the market of residential real estate of two cities (i.e. capital of Latvia - Riga and the regional centre – Daugavpils) has been studied. The statistical analysis of the sales data for 2010-2011 has allowed distinguishing pricing factors of the residential real estate, both at the regional level, and at the level of a building and object of real estate. Modeling was conducted with the use of correlation and regression and cluster analyses. The additive and multiplicative models based on the regression equation and the model of the cluster analysis based on the method of parallel sectioning have been presented.

Keywords: mass appraisal of residential real estate objects, additive regression model, multiplicative regression model, cluster model

JEL Classification: L85

Introduction

As it is proved by the world experience, the increase of the residential housing is one of the most important prerequisites for the way out of the social economic crisis in any country. Therefore one of the main indicators of life standard and level of consumption is the provision of inhabitants with dwelling. With the initialization of the divest of monopoly in the area of construction and use of real estate, the necessity of reorganizing the mechanism in transformation of management relations in this particular branch is becoming more and more topical. The main problem in transformation of this mechanism is the elaboration of theoretic and methodological issues for the management and appraisal of real estate that would correspond to the economic, political and social aspects. This particular factor has determined the choice of the research theme. Considering dwelling as an object of an economic assessment implies research of such circle of problems as: economic bases of an appraisal of residential real estate studied in the work of such researchers as (Шевчук.А, 2007); existing approaches and methods of individual and mass appraisal of residential real estate (Игнатов, 2003), (Эккерта, 1997), (Елисеев, 2003), (Allan, Hoesli, & Bender, 1989-2000), (Francke & Gerjan, 1989) their comparison for the purpose of exposure of the most acceptable ones for the use in Latvia (Харрисон, 1994); econometric pricing models (Pace, 1995), (Kunovac,

Dozovic, Lukinic, and Pufnic, 2008), (Бэстенс & Бэрг, 1997), (Бывшев, Богомолов, & Костюнин, 2008), (Studies, 2010), (Berrens & McKee), (Leung, Chen, & Daouk, 2000), (Moore & McCabe, 1999), (Ramsey, 1969), (Specht, 2008), (Wittkemper & Steiner, 1996).

In the present study for the mass appraisal of real estate used econometric modeling based on regression and cluster analysis (Picard, Antoniou, & De Palma, 2010), (Benjamin, Guttery, & Sirmans, 2012), (Standart on Mass Appraisal of Real Property), (Fox, 2008).

The purpose of the present research is elaboration of a methodological approach to mass appraisal of residential real estate on the basis of econometric systems.

The comparative approach has been used as the main approach to mass appraisal. The main advantage of the comparative approach is the actual reflection of the demand and supply of the objects appraised, since the value of the deal made is more integrally concerned with the situation in the market. Availability of a sufficient amount of trustworthy information about recent contracts of sales, use of a comparative method in practical appraisal, method of comparing sales, in particular, provides a more impartial value of the market cost of the objects on sale.

Modernization of a classical algorithm of the comparative approach to mass appraisal of residential real estate has been carried out in the following areas:

- market modeling through methods of multi-dimensional correlation regression analysis;
- development of methods of the discrete spatial-parametric analysis (cluster analysis).

Since both areas have their own advantages and can be implemented through the collected database, several models of various types have been constructed and analyzed in work in order to select the best option for use in various applied situations.

Methodology

Mass appraisal is a systematized method of receiving estimation of market cost indexes for the big group of homogeneous real estate objects applying methods of statistical processing of information on the basis of comparative analysis of a considerable amount of analogues with the use of objectively measured pricing factors which are common for all analogues.

The method of correlation and regression analysis and a sectioning method as an option of cluster analysis are among the most well-known modern statistical methods of real estate market research.

Correlation method is related to one of the basic methods of mass appraisal. The basic applied task of the correlation analysis is quantitative determination of closeness between a dependent feature from one side and a set of factorial features from another. The closeness of linear connection is quantitatively expressed by a correlation coefficient. The task of regression analysis is to determine the direction and connection form between the dependent and factorial features.

Thus, correlation and regression analysis can be specified as a set of mathematical procedures intended for measurement of closeness, direction and analytical expression of the form of connection. The data-out of such analysis should qualitatively (structurally) and quantitatively specify the statistical model:
$V=f\ (x_1, \ldots, x_k)$, where k - quantity of factors; V – an expectation value of a dependent feature at the given values of factors of cost $x_1, \ldots, x_k$.

It is possible to distinguish two principal models, each of which has its own specificity.

The additive model is as follows:
$V = C + B_1x_1 + \ldots + B_kx_k$
where $x_1, \ldots, x_k$ - characteristics of a real estate object, B_i - numerical coefficients at variable characteristics of the object, showing the contribution of corresponding characteristics to the cost.

The multiplicative model is as follows:
$V = B_0 * x_1^{B1} * \ldots * x_k^{Bk}$

The simple multiplicative model is reduced to an additive type through finding the logarithm.

Along with a method of correlation and regression analysis for mass appraisal it is possible to use methodology of cluster analysis. The basic idea of this methodology implies that mass appraisal is created by sectioning (grouping, stratification) of the initial set of data about the prices of real estate objects according to pricing factors, mainly correlated with the prices of objects, and calculation of the model coefficients by comparing average values of the initial and truncated sets.

The analysis of factors influencing the commercial value of residential real estate in Riga and Daugavpils

Data collection and analysis are conducted at three levels: regional (City), local (Residential district), and at the level of the building (Type of the building, Number of floors, Material of building's external wall) of the residential real estate object (Number of rooms, Plan of rooms, Flat outer space, Sanitary facilities, Technical condition, Number of group of room, Total space, Value of the deal).

Features of the residential real estate market at the regional level are as follows: administrative status and scale of a city, specificity of its industrial and cultural

development, availability of the export-focused, competitive industries; structure and condition of fixed funds of a city; distance from capitals and other large centres, neighbouring countries; specificity of transport, trade and economic relations with them; environmental conditions; ecological conditions.

The work dwells upon the analysis of the real estate market in two cities of Latvia, i.e. Riga and Daugavpils. Riga is one of the largest cities of the Baltic region, the capital of Latvia. Daugavpils is the largest city of the eastern province of Latvia - Latgale. Specific features of these cities make direct impact on the results of the appraisal of residential real estate.

In capitals, large regional, transport, cultural centre's with high level of financial flows, effective investments and good prospects of development, the market of residential real estate develops quickly enough, and the prices for the residential property are established in due course at rather high level.

The analysis has shown that apartments (from one-room to four-room) in Riga are considerably more expensive than similar apartments in Daugavpils. The cost of one-room apartments in Daugavpils varies from 2000 Ls to 16000 Ls concerning the average value of 4845 Ls with an average standard deviation of 1759 Ls. In Riga the average cost of similar apartments is 15328 Ls, and the maximum reaches 31000 Ls, and the cost of the half of sold apartments exceeds 14759 Ls. Even bigger differences are observed in the cost of apartments consisting of several rooms. Thus, the average cost of three-room apartments in Riga is 55201 Ls, while in Daugavpils the average cost of such apartments is 13226 Ls.

The significant difference in the price can be seen, having compared apartments of the same type in Riga and Daugavpils. Thus, the average cost of apartments of the 103rd-series and Lithuanian design in Riga is 29082 Ls while similar apartments in Daugavpils are sold at the average of 8622 Ls.

The cost of an apartment in the city is usually influenced by the residential district. In Daugavpils the cost of apartments in the centre differs significantly from the cost of apartments in other districts of the city that in their turn show no significant differences in cost. In Riga the cost of apartments in Mezciems district is lower than that of the apartments in the centre, and higher than that in Teika district; but these distinctions are not statistically significant.

Apartments in Purvciems and Plavnieki districts cost cheaper and show no significant difference in cost, but their price differs considerably from the price of apartments in other districts of the city. This can be explained by the fact that for the last two years few apartments have been sold in these districts and those sold were mainly in bad technical condition (without renovation).

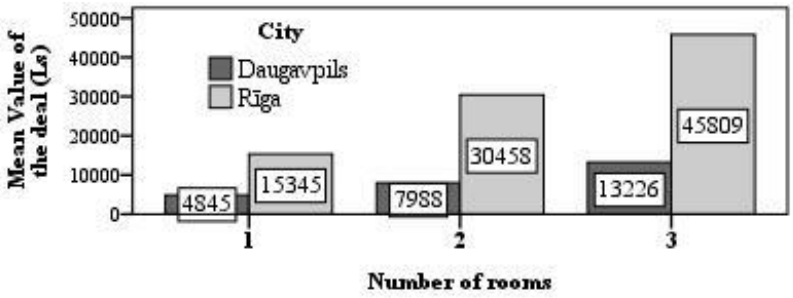

Figure 1. Average commercial value of apartments with different number of rooms in Daugavpils and Riga.

It should be mentioned that the distance from the city centre alone cannot explain why in equidistant from the centre districts the prices vary so greatly. It can be assumed that city division into districts is reasonable to conduct according to the social and town-planning features that consider simultaneously the quality of both the dwelling and the district of its location. It is also necessary to consider differentiation of urban population according to the level of income that stipulates tendencies of its spatial placing: movement of poor population from the city centre towards the suburbs, formation of districts inhabited by the poor and the rich. It is the so-called factor of social geography.

The Project type is the factor characterizing the building as a whole, but making significant impact on the cost of apartments (ANOVA, $p < 0.05$). Comparison of the cost of one-room apartments in Daugavpils shows that the price of apartments of "Prewar" and "Stalinist" type (Multiple Comparisons, Bonferroni, $p < 0.05$) differs considerably from the cost of apartments of other types, the cost of which shows no significant statistical distinctions. Two-room apartments of the 103rd-series and Lithuanian design differ dramatically in cost from the apartments of series 318, 602, 467 (Multiple Comparisons, Bonferroni, $p < 0.05$) and do not differ from apartments of type "Special project".

In Riga the cost of one-room apartments in "Prewar" and "Stalinist" buildings, similarly to Daugavpils, differs from the cost of apartments of other types but, unlike Daugavpils, they are cheaper and these differences are statistically significant. Two-room and three-room apartments in "Prewar" and "Stalinist" buildings, similarly to Daugavpils, are more expensive. In Riga only three-room apartments in houses of the 103rd-series and Lithuanian design are more expensive than apartments in houses of series 318, 602, 467 while in Daugavpils these distinctions are already significant at the level of two-room apartments. In Riga two-room and three-room apartments of type "Special project" are cheaper than apartments in "Prewar" and "Stalinist" buildings but are more expensive than apartments of 103rd-series and Lithuanian design. In Daugavpils three-room

apartments of 103rd-series and Lithuanian design are more expensive than apartments of the type “Special project”.

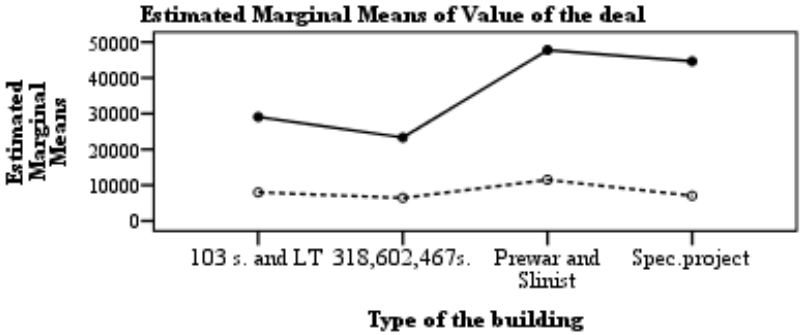

Figure 2. Average commercial value of apartments of different types in Daugavpils and Riga.

There is a statistically significant direct ratio between the area of an apartment and its commercial value. In Daugavpils these values correlate more considerably (Spearman's Correlation Coefficient r=0.811) than in Riga (Spearman's Correlation Coefficient r=0.715). The apartment’s area makes an especially dramatic impact on the cost of three-room apartments (r=0.701 - Daugavpils, r=0.548 - Riga), and has little impact on the price of two-room apartments (r=0.389 - Daugavpils, r=0.359 - Riga). The cost of one-room apartments in Daugavpils depends significantly on their area (r=0.518) while in Riga this dependence is not significant (r=0.183, p=0.317).

The comparison of the cost of two-room apartments of the different layout has shown that Riga inhabitants have the traditional preference for apartments with isolated rooms. However, both in Riga and Daugavpils, distinctions in the cost of apartments of the different layout are revealed only at the level of the statistical tendency (t-test for Equality of Means, $0.05 < p < 0.1$). Both in Daugavpils, and in Riga the interdependence between the type of two-room apartments and the layout (Chi-Square Tests, $p < 0.05$) is observed. The largest number of apartments with adjoining rooms refers to series 318, 602, 467. 68% of such apartments in Daugavpils and 17% in Riga have been sold. 8% of “Prewar” and “Stalinist” type apartments with adjoining rooms in Daugavpils and 29% in Riga have been sold. In spite of the fact that in Riga apartments with isolated rooms cost more and this distinction in the price is especially noticeable with apartments of “Prewar” and “Stalinist” type, the effect of joint influence Room planning * The project type is not statistically significant (Tests of Between-Subjects Effects, p=0.480).

The comparison of the cost of apartments in panel and brick houses shows that apartments in brick houses are more expensive both in Riga, and in Daugavpils ((t-test for Equality of Means, $p < 0.05$).

There is a significant dependence between the Material of external walls and The Project type (Chi-Square Tests, $p < 0.05$). The houses of "Prewar" and "Stalinist" type are basically brick ones while 103rd-series and Lithuanian design are panel ones.

The comparison of the cost of apartments with joint and separate bathrooms shows that apartments in brick houses with separate bathrooms are more expensive both in Riga and Daugavpils. In Daugavpils these distinctions are statistically significant (t-test for Equality of Means, $p < 0.05$).

There is an essential dependence between Sanitary rooms and Project type (Chi-Square Tests, $p < 0.05$). In apartments of 103rd-series and Lithuanian design sanitary rooms are generally separated while more than a half of apartments of series 318, 602, 467 have joint bathroom units.

Availability of a balcony or loggia is able to significantly increase the cost of apartments of "Prewar" and "Stalinist" type and the cost of apartments of the 103rd-series and Lithuanian design (t-test for Equality of Means, $p < 0.05$). Thus availability of a balcony or loggia in an apartment correlates essentially with the type of apartments, both in Daugavpils and in Riga (Chi-Square Tests, $p < 0.05$). Among apartments of "Prewar" and "Stalinist" type only 20 % in Daugavpils and 25 % in Riga have Apartment's external rooms. About 60 % of apartments of the 103rd-series and Lithuanian design and series 318, 602, 467 have external rooms.

The technical condition makes a significant impact on the cost of apartments in all micro-districts of Daugavpils (ANOVA, $p < 0.05$). In Riga in spite of the fact that apartments in a better condition have a higher price in all micro-districts, except for Mezciems, these distinctions are significant only in the micro-district Purvciems (ANOVA, $p=0.003$). The effect of the mutual influence of such factors as a Micro-district and Technical condition is absent both in Riga and in Daugavpils (Tests of Between-Subjects Effects, $p=0.832$, $p=0.831$). There is a statistically significant dependence between a technical condition of the sold apartments and the city in which they are located in (Chi-Square Tests, $p < 0.05$).

In Riga 25% of the sold apartments were in the excellent condition, in Daugavpils such apartments made up just 5%. In Daugavpils 65% of the sold apartments were in satisfactory condition while in Riga such apartments made up only 19 %.

Thus, dependence between the technical condition of apartments and micro-district in which they are located is statistically significant only in Riga (Chi-Square Tests, $p < 0.05$). In Daugavpils such dependence is not observed (Chi-Square Tests, $p=0.284$). While in the centre of Riga 60% of the sold apartments were in the excellent condition, in Mezciems such apartments made up less than 6%.

Technical condition of apartments makes significant impact on the cost of apartments of different type, the better condition of an apartment is, the more expensive it is (ANOVA, $p < 0.05$).

The effect of the mutual influence of two factors Type and Technical condition is observed in Daugavpils: apartments of "Prewar" and "Stalinist" type in excellent technical condition are much more expensive than apartments of the same type in good or satisfactory condition (Tests of Between-Subjects Effects, $p < 0.05$).

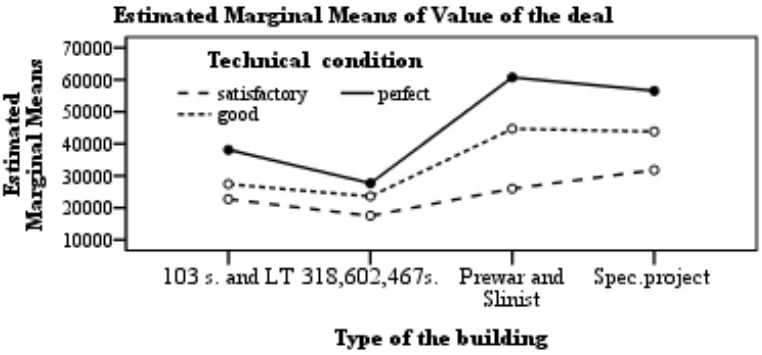

Figure 3. Average cost of apartments of different types with different technical condition in Riga.

We do not observe statistically significant relations between technical condition of the sold apartments and the micro-district they are located in (Chi-Square Tests, $p=0.177$). In Riga this dependence is revealed at the level of the statistical tendency (Chi-Square Tests, $p=0.076$). 39% of apartments of "Prewar" and "Stalinist" type sold in Riga were in excellent condition. Only 28 % of the apartments of the 103rd-series and Lithuanian design and 16% of series 318, 602, 467 were in excellent condition.

The effect of mutual influence of such factors as a Floor (the first, last) and Project type is observed in Riga (Tests of Between-Subjects Effects, $p=0.05$). The apartments located on the first and last floors of multiple dwelling in Riga are considerably cheaper. In Daugavpils this factor does not make dramatic influence on the cost of apartments.

In Daugavpils there is a considerable interconnection between the type of the sold apartments and floors they are located in (Chi-Square Tests, $p < 0.05$). 22% of apartments of "Prewar" and "Stalinist" type were located on last floors of multiple dwelling, 13 % - on the first floor, while only 12 % of apartments of the 103rd-series and Lithuanian design were located on last floors.

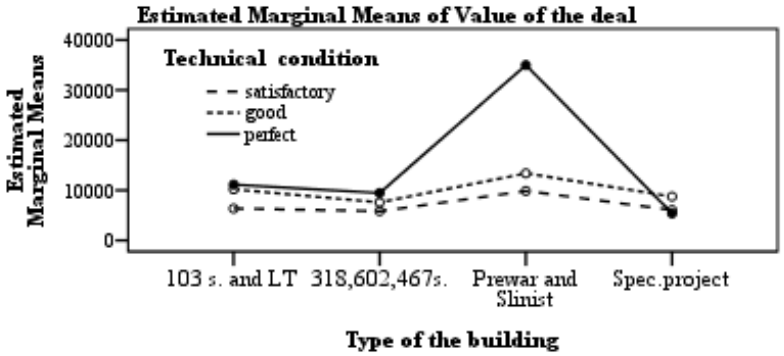

Figure 4. Average cost of apartments of different types with different technical condition in Daugavpils.

Thus, having analyzed the real estate market in Riga and Daugavpils according to the sales implemented for the last 2 years, it is possible to draw the following conclusions:

- Residential real estate is the only economic welfare whose value is determined not only by consumption properties of a particular object, but also by the location. Apartments in Riga are more expensive than these in Daugavpils. Apartments in the centre of cities are more expensive than apartments in other districts.
- The influence of certain factors that determine the cost of apartments is revealed in different ways in Daugavpils and in Riga. Therefore, it is reasonable to carry out separate analysis of the influence of factors on formation of the cost of apartments in these cities.
- Such factor as Micro-district makes significant impact on the cost of the sold property, both in Daugavpils and Riga. City centre is a special micro-district where apartments are generally more expensive.
- Such factor as Project type also makes a significant impact on the cost of apartments. "Prewar" and "Stalinist" type apartments are more expensive than others.
- Such factors as Materials of external walls, Sanitary rooms, Room planning are able to influence the cost of apartments, but they, as a rule, are related to such factor as Project type.
- Technical condition of the apartment makes a considerable impact on its cost. Good renovation in an apartment is able to significantly increase its cost.
- One of the most important factors determining the cost of apartments is its area. The number of rooms closely relates to this factor.

Econometric models of the assessment of commercial value of residential real estate objects
The additive model based on the method of regression analysis

The formula for calculation of the commercial value of an apartment is deduced as the equation of plural linear regression where value of the deal acts as a dependent variable and the factors able to influence the apartment value act as independent variables.

Characteristic features of the objects of real estate that bear a price-making factor of the regression model can vary. Part of them are quantitative features (area of an object), others are discrete (amount of rooms, storey), another group is of qualitative character (type of the building, features of flat layout, etc.). The case of combination of various characteristics has the most applied significance.

Methods of the regressive analysis are the methods of processing numeric values. Non-numeric features for their accountability in the regression model come to a quasi-qualitative type through the procedure of digitization, i.e. through assigning some numeric labels to them. Binary features can be digitized arbitrary, although in linear regression models their gradation is assigned values 0 and 1 for the purpose of visualization. The nominal feature having more than two gradations can be described by the system of binary variables.

In the considered B case such fictitious variables as z1, z2, z3 have been introduced, which has allowed considering *Residential district, Technical condition, Type of the building.*

z1=1 if *Residential district=Centre*, and z1=0 if the flat is situated in another district if the city. z2=1 if *Technical condition = perfect* or *Technical condition = good*. z3=1 if *Type of the building = Prewar and Stalinist*, z3=0 if *Type of the building <> Prewar and Stalinist.*

As an algorithm of an exception of independent variables the Stepwize method has been applied. It is a step-by-step method that initially includes all independent variables into the equation of regression, and then serially deletes all variables whose correlation with criterion has a significance value above the set threshold value. The basic idea of this method is the change of a share of influence of an independent variable on a criterion at occurrence of other independent variables in the equation. If the influence of any of the included variables becomes too weak, it is excluded from the equation.

The following formula has been received as a result:

*Value of the property (f1)=Area*B+z1*B1+z2*B2+z3*B3+C* *(formula 1)*

Table 1. Regression coefficients (formula 1)

Unstandardized Coefficients	*Daugavpils*	*Riga*
B	*238*	*817*
B1 (Residential district=Centre)	*3329*	*9764*
B2 (Technical condition = perfect)	*2859*	*10580*
B2 (Technical condition = good)	*924*	*5571*
B3 (Type of the building = Prewar and Stalinist)	*1236*	*9735*
C	*-4178*	*-21966*

Positive coefficients at independent variables indicate that they increase value of a dependent variable. However, the ratio of coefficients does not allow making a conclusion about influence of this or that factor on a dependent variable. To solve this problem the standardized coefficients of linear regression (β), reflecting private correlations of dependent and independent variables are used. Private correlation is understood as the influence made on a dependent variable by one independent variable at fixed values of other independent variables (taking into account influence of the latter). The more the given independent variable correlates with other independent variables, the less absolute value of its coefficient β is.

Table 2. Standardized coefficients of regression (formula 1)

Standardized Coefficients	*Daugavpils*	*Riga*
β	*0.659*	*0.604*
β1 (Residential district=Centre)	*0.325*	*0.219*
β2 (Technical condition = perfect)	*0.137*	*0.230*
β2 (Technical condition = good)	*0.094*	*0.138*
β3 (Type of the building = Prewar and Stalinist)	*0.114*	*0.215*
R	*0.879*	*0.834*
R^2	*0.773*	*0.695*

Having analyzed the received equation of regression it is possible to draw a conclusion that the commercial value of an apartment is determined by its area. Such factors as Micro-district (if it is the centre), Technical condition (if it perfect or good), and Project type (if it is Prewar or Stalinist type apartment) significantly increase value of an apartment. The impact of the Micro-district is more considerable on the value of apartments in Daugavpils, and that of Technical condition and Project type is stronger in Riga.

The coefficient of multiple correlation *R* is a measure of connection of the whole set of independent variables and a dependent variable. Value R^2 (determination coefficient) is equal to a share of a dispersion of a dependent variable caused by the impact of independent variables. Thus, 77,3 % (in Daugavpils) and 69,5 % (in Riga) dispersions of a variable value of the property are determined by cumulative influence of variables *Total area of rooms, Micro-district, Technical condition, Project type*.

There is a direct significant strong connection between *value of the deal* and *value of the propertu (f1) (Spearman's Correlation Coefficient, r=0.887).* The least precise received formula allows us to forecast the value of one-room apartments in Riga (*Paired Samples Test, p <0.05*). It can be explained by the fact that the vale of this particular type of apartments does not depend on its area.

The multiplicative model based on the method of regression analysis

The model represents the product of characteristics and their scales. Hence, characteristics can compensate each other, which enables using parametres connected with each other. The model is more accurate than the additive one.

*Value of the property (f2) = Area^B*B1*B2*B3*C* *(formula 2)*

Table 3. Coefficients (formula 2)

Unstandardized Coefficients	*Daugavpils*	*Riga*
B	*1.15*	*1.3*
B1 (Residential district=Centre)	*1.44*	*1.3*
B2 (Technical condition = perfect)	*1.36*	*1.42*
B2 (Technical condition = good)	*1.16*	*1.21*
B3 (Type of the building = Prewar and Stalinist)	*1.08*	*1.23*
C	*78.78*	*125.26*

Coefficient of determination of the constructed model for R^2Daugavpils is 0,84, for Riga - 0,75. In practice a value greater than 0,7 is an acceptable value of this coefficient.

The model of cluster analysis based on the method of parallel sectioning

The method of sectioning is a method of constructing models of mass appraisal of real estate objects based on the methodology of cluster analysis. It assumes subdividing the estimated set of objects into groups having common features, finding a single cost for the group within each group and calculation of coefficients of the model based on the comparison of the costs of groups. Parallel sectioning is subdivision of initial sample into a number of homogeneous groups of objects according to individual group features.

Models of an estimation of the commercial value of residential real estate objects, based on the cluster analysis, are implemented within the limits of the expression:

*Value (mm) = V*K1*K2*K3* *(formula 3)*

Here *V* – the basic rate of the cost (cost of a square metre of the total area of the basic estimated object);

K1 - location coefficient; *K2* - coefficient of technical condition;*K3* - coefficient of type of the building.

The average price of a square metre of the total area of an apartment (for all objects of an experimental sample) is accepted as the basic rate of the cost *V*. Value of the coefficient of location of the target zone *K1* is calculates as the ratio of average price of a square metre of the total area of all sampled objects in this zone to the average price of a square metre in the whole experimental sample. Central districts of the cities are selected as one of target zones, while all other districts are united into the second zone. For calculating values of the coefficient Technical condition *K2* the average values of prices for the objects in different technical condition are calculated at first, and then their ratio to the average price of all considered real estate objects is found. Calculation of values of the coefficient Type of the building *K3* should be preceded by calculation of the average price of a square metre of apartments of type *Prewar and Stalinist*, having separated them from all other types that form the second target group. The ratio of average prices in the target groups will give a value of the coefficients that are being calculated.

Table 4. Coefficients of the cluster model (formula 3)

Coefficients	*Daugavpils*	*Riga*
V	*173*	*595*
K1 (Residential district=Centre)	*1,37*	*1,37*
K1 (Residential district≠Centre)	*0,87*	*0,85*
K2 (Technical condition = perfect)	*1,24*	*1,31*
K2 (Technical condition = good)	*1,14*	*0,95*
K2 (Technical condition = satisfactory)	*0,92*	*0,74*
K3 (Type of the building = Prewar and Stalinist)	*1,33*	*1,32*
K3 (Type of the building ≠Prewar and Stalinist)	*0,91*	*0,88*

The commercial value of an apartment corresponding to the cluster model can be calculated by the following formula:

*Value of the property (f4) = Value (mm) * Area* *(formula 4)*

Analysis of the quality of econometric models

The comparative analysis of constructed econometric models shows that the most accurate of the presented is the multiplicative model. This model gives significant differences from the observable commercial value only for two-room apartments in Daugavpils (Paired Samples Test, $p < 0,05$). The observable cost is 7988 Ls, while the forecasted one is 7737 Ls. The model of the cluster analysis proved to be the least accurate. It forecasts the results only for three-room apartments in Riga and Daugavpils, and these results are not significantly different from those observed (Paired Samples Test, $p < 0,05$).

Figure 5. Commercial value of apartments in Daugavpils and its forecasting on the basis of the constructed econometric models.

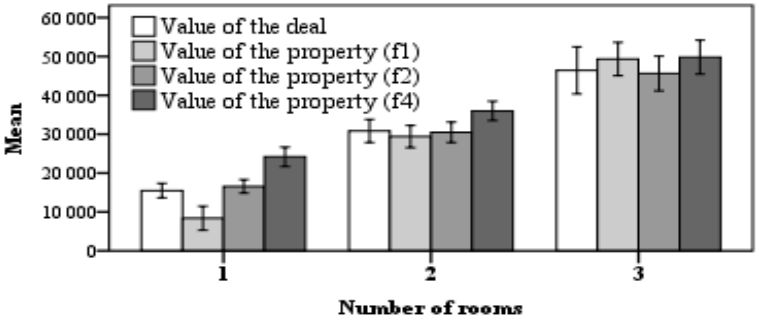

Figure 6. Commercial value of apartments in Riga and its forecasting on the basis of the constructed econometric models.

There is a significant direct correlative connection between the observable and forecasted cost of apartments in Daugavpils and Riga for all constructed models. The strongest connection occurs between observable marketable value and its estimation received on the basis of the multiplicative model.

Table 5. Coefficients of correlation between observable and forecasted commercial value of apartments in Daugavpils and Riga

	Value of the deal	
	Daugavpils	*Riga*
Value of the property (f1)	0,909	0,821
Value of the property (f2)	0,917	0,847
Value of the property (f4)	0,687	0,691

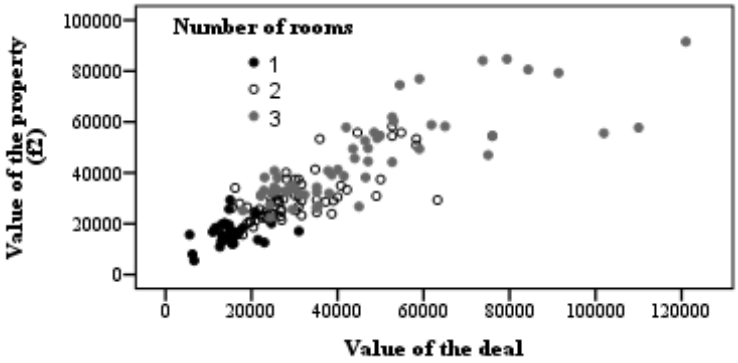

Figure 7. Dependence between the observable value and estimation of apartments according to the multiplicative model in Riga.

Summary

The appraisal of the commercial value of real estate objects as a process consists of the study of the estimated object itself and the market of the estimated object, creation of economic-mathematical model of this market and estimation of the real estate objects entering this market.

The application of regression models is considered to be perspective development of the appraisal practice in solving the problems of mass appraisal of residential real estate objects within the frames of the comparative approach. However, at creating models of the cost estimation it is necessary to search for the compromise between complexity of the appraisal and accuracy of the result. As it is proved by the calculations above, specific indicators of three considered models are comparable to each other. Multiplicative regression model is the most universal and accurate one. However, for its construction it is necessary to have computer software and some knowledge of mathematical statistics.

The approach of the cluster analysis, the method of sectioning (groupings), can be regarded as an alternative to the regression analysis at creating models of the cost estimation. From the theoretical point of view the method of sectioning is "rougher" than the method of regression analysis, but it is rather simple and not labour-intensive. For provision of statistical trustworthiness of the formula received in work it can be supplemented by additional coefficients representing the factors that influence the cost of real estate objects, such as the number of rooms in an apartment, its layout, storey etc.

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DIE KONSTRUKTION UND DIE ANALYSE DIE MODELLE DER MASSENEINSCHÄTZUNG VON WOHNIMMOBILIEN IN RIGA UND DAUGAVPILS

Oksana Ruzha, Svetlana Ignatjeva
Daugavpils Universität

Die Masseneinschätzung Immobilien ist einer am meisten klassisch für die Sphäre der Wirtschaft der Aufgaben, in den die ökonometrische Modellierung erfolgreich verwendet wird. Im Rahmen des vorliegenden Artikels sind drei Modelle für die Einschätzung des Marktwertes der Wohnung angeboten. Für die Forschung wurde der Markt der Wohnfläche der zwei Städte studiert: der Hauptstadt Lettlands Riga und des regionalen Zentrums – der Stadt Daugavpils. Die statistische Analyse der gegebenen Verkäufe für 2010-2011 Jahre hat zugelassen, die den Preis bildenden Faktoren Wohnimmobilien, wie auf dem regionalen Niveau, als auch auf dem Niveau des Baus und des Objektes Immobilien zu wählen und die folgenden Schlussfolgerungen zu machen.

- Wohnimmobilien ist der einzige wirtschaftliche Vorteile, deren Wert nicht nur von den Konsumeigenschaften des konkreten Objekts, sondern auch von den Eigenschaften des Standortes hängt. Apartments in Riga sind teurer als in Daugavpils. Apartments im Zentrum der Stadt sind teurer als in anderen Bezirken.
- Die Auswirkungen der einzelnen Faktoren, die die Kosten einer Wohnung bestimmen, in Riga und Daugavpils sich in unterschiedlicher Weise manifestiert. Daher ist es zweckmäßig, den Einfluss von Faktoren auf die Bildung des Wertes der Wohnungen in diesen Städten getrennt durchzuführen.
- Solcher Faktor wie den Wohnkomplex leistet den bedeutsamen Einfluss auf den Wert der verkauften Wohnfläche, wie in Daugavpils, als auch in Riga. Aus allen Wohnkomplexen der Stadt ist das Stadtzentrum der besondere Wohnkomplex wo die Wohnungen teuerer in der Regel sind.
- Solcher Faktor wie den Typ des Projektes des Gebäudes leistet auch den bedeutsamen Einfluss auf den Wert der Wohnungen. Bedeutsam teuerer als andere sind die Vorkriegswohnungen und die Wohnungen im Haus des Baus von 1935 bis 1960.(Stalinzeit)
- Solche Faktoren wie das Material der Wände des Gebäudes, der sanitären Anlagen, das Planieren der Zimmer sind fähig, den Wert der Wohnung zu beeinflussen, aber sie sind mit solchem Faktor wie den Typ des Projektes des Gebäudes in der Regel verbunden.
- Der Bedeutsame Einfluss auf den Wert der Wohnung leistet ihren technischen Zustand. Die gute Reparatur in der Wohnung ist bedeutsam begabt, ihren Wert zu vergrössern.
- Einer der wichtigsten Faktoren, die den Wert der Wohnung bestimmen, ist ihre Fläche. Eng verbunden mit diesem Faktor ist die Zahl der Zimmer in der Wohnung.

Die Modellierung wurde unter Ausnutzung der Korrelation und Regression und Clusteranalyse durchgeführt. Additive und multiplikative Modelle sind vorgestellt und analysiert. Sie sind auf den Basis der Regressionsgleichung und das Modell Cluster-Analyse gebaut und auf der Methode der parallelen Schnitte gegründet.

Die Formel für die Berechnung des Marktwertes der Wohnung wird wie die Angleichung des pluralen linearen Rückschritts herausgeführt, wo als die abhängige Variabele die Summe der Schenkung auftritt, und als die unabhängigen Faktoren solche Faktoren, die fähig sind, auf den Wert der Wohnung zu beeinflussen.

Als Algorithmus der Ausnahme der unabhängigen Variabelen war die Methode Stepwize verwendet. Das ist die schrittweise Methode, die zuerst aufnehmend in die Angleichung des Rückschritts alle unabhängigen Variabelen, und dann alle Variabelen, wessen Korrelation mit dem Kriterium das Niveau der Bedeutsamkeit höher als die aufgegebene Schwellenbedeutung hat. Von der Hauptidee dieser Methode ist die Veränderung des Anteiles des Einflusses der unabhängigen Variabelen auf das Kriterium beim Erscheinen in der Angleichung anderen unabhängigen Variabelen. Wenn der Einfluss irgendwelchen aufgenommen Variabelen viel zu schwach wird, wird sie aus der Angleichung ausgeschlossen.

Es war die Formel daraufhin bekommen:

*Den Marktwert(f1)= Die Fläche *B+B1+B2+B3+C* *(Formel 1)*

Tabelle 4. Die Koeffizienten des Rückschritts (Formel 1)

	Daugavpils	*Riga*
B	*238*	*817*
B1 (Den Wohnkomplex = Das Zentrum)	*3329*	*9764*
B2 (Den technischen Zustand =Ausgezeichnet)	*2859*	*10580*
B2 (Den technischen Zustand = Gut)	*924*	*5571*
B3 (Den Typ des Gebäudes = Bis zu dem Militär)	*1236*	*9735*
C	*-4178*	*-21966*

Die positiven Koeffizienten sagen bei den unabhängigen Variabelen darüber, dass sie die Bedeutung der abhängigen Variabel vergrössern. Jedoch lässt das Verhältnis der Koeffizienten nicht folgern, dass dieser oder jener Faktor auf die abhängige Variabele einwirkt. Um dieses Problem zu erlauben werden die standardisierten Koeffizienten des linearen Rückschritts (β), die widerspiegelnden privaten Korrelationen abhängig und unabhängiger der Variabelen verwendet. Unter der privaten Korrelation wird die Einwirkung verstanden, die auf die abhängige Variabele durch eine unabhängige Variabele bei den fixierten Bedeutungen anderer unabhängigen Variabelen geleistet wird (unter Berücksichtigung des Einflusses der Letzten). Je mehr korreliert die vorliegende unabhängige Variabele mit anderen unabhängigen Variabelen, desto weniger ist absolute Größe ihres Koeffizienten β.

Tabelle 5. Die standardisierten Koeffizienten des Rückschritts (Formel 1)

	Daugavpils	*Riga*
β	*0.659*	*0.604*
β1 (Den Wohnkomplex = Das Zentrum)	*0.325*	*0.219*
β2 (Den technischen Zustand = Ausgezeichnet)	*0.137*	*0.230*
β2 (Den technischen Zustand = Gut)	*0.094*	*0.138*
β3 (Den Typ des Gebäudes = Bis zu dem Militär)	*0.114*	*0.215*
R	*0.879*	*0.834*
R^2	*0.773*	*0.695*

Die bekommene Angleichung des Rückschritts analysierend, kann man die Schlussfolgerung darüber ziehen, dass sich der Marktwert der Wohnung von ihrer Fläche klärt. Bedeutsam vergrössern den Wert der Wohnung solche Faktoren wie, den Wohnkomplex, wenn es das Zentrum ist, den technischen Zustand, wenn es ausgezeichnet oder gut ist, und den Typ des Projektes des Gebäudes, wenn es die Wohnung der Vorkriegsperiode oder des alten Typs ist. Der Einfluss des Wohnkomplexes leistet den stärkeren Einfluss auf den Wert der Wohnungen in Daugavpils, und der technischen Zustand und der Typ des Projektes des Gebäudes beeinflussen den Wert der Wohnungen stärker in Riga.

Der Koeffizient der pluralen Korrelation R ist ein Maß der Verbindung der ganzen Gesamtheit der unabhängigen Variabelen und abhängigen Variabelen. Die Größe R2 (der Koeffizient der Determination) ist dem Anteil der Dispersion von der abhängigen Veränderung gleich, die vom Einfluss durch die unabhängigen Variabelen bedingt ist. So klärt sich 77,3 % (in Daugavpils) und 69,5 % (in Riga) die Dispersion der Variabele der Summe der Schenkung von der vereinten Einwirkung den Variabelen die Gesamtfläche des Raumes, den Wohnkomplex, technischen Zustand., den Typ des Projektes des Gebäudes.

Das Multiplikationsmodell, das auf der Methode der Regressionsanalyse gegründet ist, stellt das Werk der Charakteristiken und ihrer Gewichte dar. Also können die Charakteristiken einander kompensieren, was die Nutzung der verbundenen miteinander Parameter ermöglicht. Das Modell ist genauer als das additive Modell.

*Den Marktwert (f2)= Total space^B*B1*B2*B3*C* *(Formel 2)*

Tabelle 3. Die Koeffizienten (Formel 2)

	Daugavpils	*Riga*
B	*1.15*	*1.3*
B1 (Den Wohnkomplex = Das Zentrum)	*1.44*	*1.3*
B2 (Den technischen Zustand =Ausgezeichnet)	*1.36*	*1.42*
B2 (Den technischen Zustand = Gut)	*1.16*	*1.21*
B3 (Den Typ des Gebäudes = Bis zu dem Militär)	*1.08*	*1.23*
C	*78.78*	*125.26*

Der Koeffizient der Determination des aufgebauten Modells für R2Даугавпилса 0,84, für Riga - 0,75. In der Praxis als annehmbare Bedeutung dieses Koeffizienten nimmt sich die Bedeutung größer 0,7 vor.

Die Methode der Schnitte – die Methode der Konstruktion der Modelle der Masseneinschätzung der Objekte Immobilien, die auf der Methodologie der Cluster Analyse gegründet ist. Sie vermutet die Zersetzung der bewerteten Gesamtheit der Objekte auf die Gruppen, die die allgemeinen Merkmale haben, den Verbleib des einheitlichen Gruppenwertes innerhalb jeder Gruppe und die Berechnung der Koeffizienten des Modells aufgrund des Vergleiches gruppen- Werten. Die parallelen Schnitte – die Zersetzung des Ausgangsabrufes auf die Reihe der gleichartigen Gruppen der Objekte nach den individuellen Gruppenmerkmalen.

Die Modelle der Einschätzung des Marktwertes der Objekte Wohnimmobilien, gegründet auf die Cluster Analyse, werden im Rahmen des Ausdruckes realisiert

*Den Marktwert (mm) = V*K1*K2*K3* *(Formel 3)*

Hier V – der grundlegende Satz des Wertes (der Wert des Quadratmeters der Gesamtfläche des grundlegenden Objektes der Einschätzung);
K1 - Der Koeffizient der Lage;
K2 - Der Koeffizient des technischen Zustandes;
K3 - Der Koeffizient als der Bau.

Als grundlegender Satz des Wertes V übernimmt der mittlere nach allen Objekten des experimentalen Abrufes Preis des Quadratmeters der Gesamtfläche der Wohnung. Die Bedeutung des Koeffizienten der Lage der zweckbestimmten Zone K1 wird wie die Beziehung des mittleren Preises des Quadratmeters der Gesamtfläche aller sich in dieser Zone befindenden Objekte des Abrufes zum mittleren nach dem ganzen experimentalen Abruf Preis des Quadratmeters gerechnet. Als eines der zweckbestimmten Zonen heben sich die zentralen Bezirke der Städte heraus, alle übrigen Bezirke werden in die zweite Zone vereinigt. Für die Berechnung der Bedeutungen des Koeffizienten des technischen Zustandes K2 werden die mittleren Bedeutungen der Preise der Objekte in verschiedenem technischem Zustand zuerst ausgerechnet, und dann rechnet es ihre Beziehung zum mittleren Preis aller betrachteten Objekte Immobilien aus. Für die Berechnung der

Bedeutungen des Koeffizienten als der Bau K3 muss man vorläufig den mittleren Preis des Quadratmeters der Wohnungen als Prewar and Stalinist rechnen, sie von anderen abgetrennt, die die zweite zweckbestimmte Gruppe bilden. Die Beziehung der mittleren Preise in den zweckbestimmten Gruppen wird die Bedeutung der gerechneten Koeffizienten geben

Tabelle 6. Die Koeffizienten der Clustermodelle (Formel 3)

	Daugavpils	*Riga*
V	*173*	*595*
K1 (Den Wohnkomplex = Das Zentrum)	*1,37*	*1,37*
K1 (Den Wohnkomplex ≠ Das Zentrum)	*0,87*	*0,85*
K2 (Den technischen Zustand =Ausgezeichnet)	*1,24*	*1,31*
K2 (Den technischen Zustand = Gut)	*1,14*	*0,95*
K2 (Den technischen Zustand = Befriedigend)	*0,92*	*0,74*
K3 (Den Typ des Gebäudes = Bis zu dem Militär)	*1,33*	*1,32*
K3 (Den Typ des Gebäudes ≠ Bis zu dem Militär)	*0,91*	*0,88*

Der Marktwert der Wohnung, der Clustermodell entspricht, kann nach der Formel ausgerechnet sein.

Die Analyse der Qualität der gebrachten Modelle lässt zu, die Schlussfolgerung darüber zu ziehen, dass die Anwendung Regressionsmodellen bei der Lösung der Aufgaben der Masseneinschätzung der Objekte der Wohnimmobilien im Rahmen des vergleichenden Herangehens eine perspektivische Entwicklung der Bewertungspraxis ist. Jedoch muss man bei der Bildung der Modelle der Bewertung den Kompromiss zwischen der Komplexität der Einschätzung und der Genauigkeit des Ergebnisses suchen. Wie die vorgestellten Berechnungen vorführen, sind genaue Kennziffern drei betrachteter Modelle miteinander vergleichbar. Der vielseitigste und genau ist die multiplikative Regressionsmodell. Jedoch muss man für ihre Konstruktion die Computerversorgung und einiges Wissen der mathematischen Statistik haben.

Als Alternative der Regressionsanalyse kann die Analyse bei der Bildung der Modelle der Bewertung das Herangehen der Cluster Analyse − die Methode der Schnitte (die Gruppierungen) verwenden. Vom theoretischen Standpunkt die Methode der Schnitte "grober" der Methode der Regressionsanalyse, aber für ihn ist die Einfachheit und der nicht hohe Arbeitsaufwand charakteristisch. Für die Versorgung der statistischen Glaubwürdigkeit der in der Arbeit bekommenen Formel können in sie die zusätzlichen Koeffizienten, die die Faktoren vorstellen, beeinflussend auf den Wert der Objekte Immobilien beigefügt sein.