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The Hedonic Model of the Land for Agricultural Purposes Market Value

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ABSTRACT: The authors identified and evaluated the key hedonic factors of agricultural land in the Arsk municipal district of the Republic of Tatarstan of the Russian Federation market value. The authors studied the composition of hedonic characteristics included in the specification of the model, taking into account the characteristics of the terms of the transaction. In order to identify the observed factors determining the value of land plots, a linear specification of the regression hedonic model of market value according to the data on 35 land plots in the Arsk municipal district in 2019 is constructed. The empirical estimates of the specifications presented in the article confirmed the hypothesis of the relationship between the market value of the land plot with its area and the availability of access roads with hard surface. The relationship of the land market value with the distance to the city, the population in the locality in which the land is located, the configuration of the site in the linear specification of the regression hedonic model was not confirmed. The quality of the results was tested using the coefficient of determination, Fisher test and Student test, the results of the official monitoring of prices for agricultural land in the municipal districts of the Republic of Tatarstan. The results of empirical estimates confirmed the feasibility of this approach practical use to the assessment of land market value.

Keywords: Hedonic model, comparative approach, land plot, regression, least squares method.

I. INTRODUCTION

Agricultural land can serve as an object of investment, as well as be the object of economic turnover, with respect to which a number of property relations are formed. The essence of the comparative approach to the assessment of market value is to obtain an assessment of market value using the analysis of market prices of transactions or proposals for the sale of objects that are comparable with the estimated object and took place in the market of the estimated object before the date of evaluation. In the comparative approach, there is also a method of assessing real estate objects using regression analysis. This method is useful for constructing evaluation models if the number of comparable objects exceeds the number of comparison elements by 5-10 times. The advantages of regression models of market value assessment are the following: to assess the regularity of the influence of the main factors on the value of the land, both in the aggregate and each of them separately; to describe the form of analytical dependence of the market value and to assess the closeness of this dependence; the ability to determine the market value of the land at specified values of factors. The sufficiency of the actual data on the prices of transactions or offers, the analysis of the main factors influencing their cost, and also determination of a market segment, allow apply ingregression models within the comparative approach to research of the market of the parcels of agricultural purpose. In our opinion, the regression model of the market value of a land plot can be considered as a hedonic model that links market prices with the value characteristics of land plots. The main idea of the hedonic model is that the market value of the land consists of the usefulness of the measured quantitative and qualitative value characteristics of the land as a commodity. The model analyzes the desire of the consumer to pay for certain clearly observed characteristics of the land. The coefficients in the hedonic model show the implicit price of each of the characteristics, that is, the value of each characteristic in the total value of the land. The first applications of the hedonic model to the analysis of prices were made in [1-3]. In [4-6] different functional forms of hedonic regression were compared in the problems of variation of office rent prices. As a rule, authors of works on commercial real estate [5-10] get similar results on the impact of the characteristics of the office on the price. Residential real estate was subjected to a closer analysis of researchers due to both social significance and data availability [11-16-21]. Publicly available and detailed data on the land market for housing construction are still insufficient, as are scientific papers devoted to its study. There is practically no econometric analysis of the land market, in particular the assessment of their market value, in Russian scientific practice. The aim of the study is to build a hedonic regression model

of the market value of agricultural land with a set of variables that can take into account the effects of improvements in land quality.

II. METHODS

When calculating the market value of the land to be sold, the comparative approach used a statistical method of calculating the cost - regression analysis. The method of regression analysis was considered the most appropriate for calculating the market value of the estimated land plot, since the number of comparable objects - analogues is large enough. Therefore, the use of this method will reveal the regularity of the influence of the main factors on the studied indicator - the cost of land. The evaluation of the land plot to be sold on the basis of regression analysis consists of the following sequence of actions:

1. formation of a sample of homogeneous land - analogues and collection of initial information;
2. selection of the main pricing factors affecting the cost of land;
3. estimation of the regression model on a sample of land-analogues;
4. verification of model estimates;
6. calculation of the land market value to be sold.

As a result of the analysis of the land market, proposals for the sale of analogues - land plots of the category "agricultural land" in the Arsk municipal district of the Republic of Tatarstan of the Russian Federation were identified. The sample consisted of 35 plots of land for which information was collected from websites of real estate, in particular such as https://www.avito.ru, http://realestateobjects.rf, https://torgi.gov.ru. was chosen as the main pricing factors that affect the value of the land for agricultural purposes: X1 - area of land; X2 – distance to the city, X3 – distance to the point of reception of agricultural products, X4 - availability of access roads with hard surface, X5 - the population in the village in which the land is located, X6 – configuration of the site.

The first pricing factor - area - refers to the physical characteristics of land. This element was included in the calculation of the regression model to identify its impact on the cost of land. Since the estimated land plot and all analogues are located in the Arsk municipal district, the distance from each comparable land plot to the administrative center of this municipal district – Arsk city was calculated as the second factor. To take into account the presence of access roads with a hard surface in the regression model, a fictitious variable was used: 1 - there are access roads with a hard surface, 0 - there is no. The configuration refers to the technological properties of agricultural land in terms of the suitability of similar land for mechanized processing, a fictitious variable is also used: 1 – convenient for mechanized processing, 0–no. Also, for each land plot, depending on its location in a particular locality, the number in this locality was found.

The estimation of the linearized model specifications is performed by the usual least squares method in the Gretl Software environment [17-19-20]. The model takes into account potentially influencing price-forming factors, according to which the compared land plots differ and the changes of which can affect the change in the cadastral value of land plots. The authors made intuitive check of the signs validity when the coefficients of the econometric hedonic model, that is, their conformity with the nature of the influence of pricing factors. To verify the quality of the obtained models the authors used the coefficient of determination, the average error of the approximation, the statistics of Fisher and Student's t-test.

III. RESULTSANDDISCUSSION

To determine the presence and strength of the relationship between the variables, a correlation analysis was carried out using the MS Excel analysis Package. The results of the correlation analysis are shown in Table 1.

Table1 shows that the variables X2 and X3 are collinear. Since the absence of correlation between variables and the more precise functional relationship between them is an important condition for factors included in multiple regression, it is necessary to exclude one of these factors from the model. Variable X2 describes the distance to the administrative center, and variable X3 – the distance to the point of reception, storage and processing of agricultural products. Based on the fact that both variables have a weak relationship with the remaining factors and also a weak relationship with the dependent variable, intuitive analysis is used to select the excluded variable. The distance to the administrative center is a more important factor compared to the distance to the point of reception, storage and processing of agricultural products, since not every owner may be interested in using the points of reception of agricultural products, for example, in the case of agricultural production on a relatively small area. Therefore, the variable X3 can be excluded from the model. After the X3 variable is excluded, a regression analysis should be performed. The results of the regression analysis are shown in Table 2.

Table 1: Matrix of pair correlation linear coefficients.

	Y	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*
Y	1						
x1	0,868366	1					
x2	-0,19252	-0,26793	1				
x3	-0,18471	-0,22424	0,862357	1			
x4	0,65093	0,481863	0,029557	-0,0561	1		
x5	-0,23664	-0,21952	-0,22584	-0,15862	-0,30562	1	
x6	0,118963	0,149008	0,204432	0,086704	0,224201	-0,23147	1

The source: obtained by authors in MS Excel

Table 2 shows that the relationship of variables X2, X5, X6 with the dependent variable Y – the market value of the land plot (P-the value of Student statistics for regression coefficients for these variables is greater than 0.1).

The exclusion of insignificant variables from the model allowed to obtain the following regression analysis result, shown in Table 3.

Table 2: The results of the regression analysis of the market value of land.

Regression statistics								
Multiple R	0.993742							
R-square	0.987523							
Normalized R-square	0.985372							
Standard error	24277,12							
Observation	35							
Analysis of variance								
	df	*SS*	*MS*	*F*	*P-value F*			
Regression	5	1,35E+12	2,71E+11	459,0518	1,14E-26			
Residual	29	1,71E+10	5,89E+08					
Total	34	1,37E+12						
	Factors	Standarderror	t-statistics	P-value	Lower 95%	Upper 95%		
Intercept	56583,32	17150,77	3,299172	0,002572	21506,06	91660,57		
x1	3,736456	0,100766	37,08052	5,49E-26	3,530366	3,942545		
x2	-890,897	626,5746	-1,42185	0,165736	-2172,39	390,5923		
x4	35575,26	11178,97	3,182336	0,003471	12711,69	58438,83		
x5	0,062612	1,24265	0,050386	0,96016	-2,47889	2,604118		
x6	-4294,54	9029,481	-0,47561	0,637913	-22761,9	14172,82		

The source: obtained by authors in MSExcel

Table 3. The results of the regression analysis after exclusion of insignificant variables.

Regression statistics								
Multiple R	0,993112							
R-square	0,986272							
Normalized R-square	0,985414							
Standard error	24242							
Observation	35							
Analysis of variance								
	df	*SS*	*MS*	*F*	*P-value F*			
Regression	2	1,35E+12	6,76E+11	1149,5	1,59E-30			
Residual	32	1,88E+10	5,88E+08					
Total	34	1,37E+12						
	Factors	Standard error	t-statistics	P-value	Lower 95%	Upper 95%		
Intercept	36819,19	8124,521	4,53186	7,7E-05	20270,08	53368,3		
x1	3,781715	0,093328	40,5208	4,49E-29	3,591612	3,971817		
x4	31409,44	10699,62	2,935566	0,006119	9615,028	53203,85		

The source: obtained by authors in MSExcel

Table 4: Statistics of Fisher and Student's t test.

Indicator name	**Value**	
F - Fisherstatistics	Actual	1149,5
	Critical(0,1;0,05;0,01)	2,477; 3,295; 5,336
T - Studentstatistics	Actual(β_0, β_1, β_4)	36819,19; 3,782; 31409,44
	Critical(0,1;0,05;0,01)	1,694; 2,037; 2,738

The source: obtained by authors in MSExcel

As can be seen from Table 3, the land area (X1) and the availability of access roads with hard surface (X4) explain 99% of the variation of the dependent variable the market value of the land. Only 1% of the variation in the market value of the land plot is explained by other value characteristics not taken into account in this regression model. According to the Fisher test (Table 4) at all possible significance levels, the null hypothesis of co-equality of regression coefficients to zero is rejected. The model is statistically significant and reliable. According to the Student test (Table 4) regression coefficients for factors X1 and X4 are statistically significant, which confirms at all possible levels of significance the existence of a linear relationship between the land area, the presence of access roads with hard surface and market value. Using estimates of the linear multiple regression model:

$y = 36819,19 + 3,781715 * x_1 + 31409,44 * x_4 + \varepsilon$ you can estimate the market value of the land to be sold. For example, the object of valuation is the market value of the land plot with a total area of 2 009 000 sq. m, located to the address: Republic of Tatarstan, Arsky municipal district, rural settlement Kalasinski. The distance of the land plot from the administrative center

(Arsk) is 8.3 km, the distance to the point of reception and processing of agricultural products is 12 km, the shape of the site is trapezoidal, there are access roads with hard surface. The market value of this site will be:
y = 36819,19+ 3,781715 * 2009000 + 31409,44 * 1= 7 665 694 rub.
Thus, the cost of $1m^2$. estimated land according to the correlation and regression analysis will be:
7 665 694/2009000 = 3,82 rub.
According to the monitoring of prices for agricultural land plots in the municipal districts of the Republic of Tatarstan, this value lies in the price range of land plots of this category located in the Arsk municipal district.

IV. SUMMARY

The simulation results can be summarized in several conclusions.
With an increase in the area of land per square meter, the market value of the land increases by an average of 3.78 rubles. This is understandable, as intuitively increasing the area of land leads to an increase in the value of the land. This feature should not be confused with the specific indicator of market value, which will decrease as the area increases. The presence of access roads with hard surface increases the market value of the land on average 31409.44 rub.
Among the factors of the market value of agricultural land plots, the relationship with the distance to the city, the population in the locality in which the land plot is located, the configuration of the site is not confirmed. This situation reflects the weak level of market competition in the market of agricultural land, caused by insufficient demand for agricultural land.

V. CONCLUSIONS

The diversity and internal heterogeneity of agricultural land requires adequate means of determining its value. Assessment of the market value of agricultural land plots is carried out mainly using the methods of income and comparative approaches. In the framework of the comparative approach, one of the adequate methods for determining the market value of agricultural land plots is the method based on the application of regression analysis of the characteristics of land plots - analogues.
The analysis of the features of evaluation of agricultural land plots shows that the specificity of evaluation of land plots of this category imposes certain restrictions on the choice and application of evaluation approaches and requires careful study of all factors affecting the value of agricultural land. An adequate method of evaluation of agricultural land consists of features related to the quality of land and economic characteristics and should be based on the principles of rental economy and the principles of evaluation.

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