ESTIMATION OF THE HEDONIC VALUATION MODEL IN HOUSING MARKETS: THE CASE OF CUKURAMBAR REGION IN CANKAYA DISTRICT OF ANKARA PROVINCE

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Abstract
In the case study, estimation, contributions and related issues of the hedonic valuation model in housing markets were analyzed by means of hedonic models developed for the Cukurambar Region in Cankaya District of Ankara Province. The marginal effect of housing characteristics on house prices were examined by the hedonic valuation model, and structural, environmental and spatial factors that affect value in the housing market were analyzed.
In the case study analysis, the predictive performances and also, the results of the CLLS, stepwise regression and ANN models were compared with the Monte Carlo method, which is a model simulation technique, and the optimal model alternative in estimating the residential sales value was determined as the stepwise regression model. Although the use of spatial data in model increases the adjusted R^2, the conclusion is that the structural characteristics have a higher (46%) contribution over value compared to environmental and spatial characteristics.

Keywords: *Hedonic valuation, housing market, model estimation, Monte Carlo simulation, stepwise regression*

JEL Classification: *C10, R31, C13, C15*

I. INTRODUCTION

Changes in supply and demand, which determine the competitive conditions of real estate, are directly reflected in real estate values and especially changes in supply and demand of housing seriously affect economic growth. The monitoring of these changes in real estate values and the determination of economic factors that cause them are possible through objective valuation studies. However, the fact that each property has different and unique characteristics makes valuation a time consuming and costly process. Due to the fact that real estate valuation has not been in line with scientific principles and international standards, it is necessary to facilitate value appreciation processes in both academic and commercial studies as well as to develop certain statistical models such as the hedonic valuation model.

The hedonic valuation process consists of the steps of converting the characteristics of properties into massive data in a collective sense and relating these properties to the (sales) price. With the hedonic method developed, it is expected that sales price valuations will be performed in a standardized manner. In general, the hedonic model examines the effect of a product's characteristics on its price. When considered within the context of real estate, the hedonic valuation model enables a statistical association between the characteristics of properties and sales prices (Palmquist and Smith, 2001).

The hedonic valuation model in this study was used by examining the sales data provided from real estate websites of three neighborhoods with unique locations in Ankara. The analyzes were carried out at the scale of Çukurambar region, where slum areas have undergone a significant physical transformation. The selected neighborhoods are distinguished from each other by means of distances to important axes and the types of functions they have, and they exhibit a heterogeneous structure beyond administrative boundaries. Since the most dynamic and exogenous sector of the real estate market in Turkey is known to be the housing sector, the study has been carried out with housing sales data in the listings. The scope of the study consists of examining and comparing quantitative models that can be used to measure real estate values, selecting the most appropriate model, and evaluating the results obtained.

Values have been estimated by applying three different models in the study. The applied models are CLLS (constrained linear least-squares), SR (stepwise regression), and ANN (artificial neural network) where CLLS and SR have linear, while ANN has nonlinear structures. In the regression models, the listed sales price has been defined as a dependent variable. On the opposite side of the equation, fixed terms and eight independent variables including two dummies are defined. The results of the study were evaluated by means of comparing the performances of models based on error rates.

II. HEDONIC VALUATION MODEL: CONCEPTUAL FRAMEWORK

This concept which is commonly referred to in literature as the “hedonic pricing model” instead of “hedonic valuation” (Tanrıvermiş, 2016) is widely used for the creation of a price index for goods, estimating their values, and performing prosperity analysis of public goods (Hidano, 2002). The hedonic pricing model emerged with a new approach in consumer theory by Lancaster (1966), and is called the Lancaster Preference Theory. In his essay (1966), Lancaster emphasized that a product is heterogeneous and offers no benefit to consumers alone, and that the benefits stem from the characteristics it possesses. Hedonic models, which are basically regression equations, are estimated with the help of regression analysis. The model is based on the assumption that goods are heterogeneous, and each property is described as the sum of its individual properties (Aliefendioğlu, 2011).

At the forefront of addressing the need for shelter in urban spaces, which has been shaped in our days through large population movements, houses have changed form in line with social behavior, economic status and demands of individuals over time, have started to carry different qualitative and quantitative features, and even regarded as important investment and financing tools. This situation necessitated the examination of factors affecting the housing market in all types of real estate. Just like any other heterogeneous property, houses also contain more than one feature, and are sold as a collection of the features they have. Since it is very difficult to specify the price of goods with multiple features at a single total price and to analyze the market, the price of the goods is identified by determining the price of each feature of the good, and it is called hedonic pricing (Yentürk, 2011).

When it is necessary to define a property, its structural, environmental and spatial characteristics are utilized (Gundimeda, 2005). In terms of housing, characteristics such as age, area, number of rooms, number of bathrooms, type of residence, building materials, heating system, parking facilities, etc., environmental characteristics such as air quality, water quality, distance to motorways and airports; spatial characteristics of the region such as income status, infrastructure quality, ease of access to social infrastructure like schools and hospitals, proximity to public transport and stops, and proximity to the city’s central locations are in consideration. Each component included in the model has a certain influence on the real estate value. Assuming that the willingness to pay emerges from the structural, environmental and spatial characteristics according to the socioeconomic status of the individual, it is possible to argue that variables in the model could make it possible to measure the factors causing the willingness to pay.

III. ESTIMATION OF HEDONICS VALUATION MODEL IN HOUSINGS MARKETS: THE CASE OF THE ÇUKURAMBAR REGION

The Çukurambar Region, which lies between Eskişehir Road, Konya Road and 1071 Malazgirt Boulevard within the boundaries of Çankaya District of Ankara Province, has been designated as the study area (Figure 1). With works completed in low spatial quality areas of the city that has reached a high degree of saturation, the region has come to the fore in recent years. With the move of bureaucratic and public institutions to the sides of the Eskisehir Road, the population movement increased in the Çukurambar Region. The metro line, on which construction commenced in 2002 was completed in 2014 and the nature of the district changed with the development of prestigious urban projects on areas designated for urban work.

In the selected example region, only the housing market was dealt with in terms of the real estate market. Beyond the fact that the properties come in different types, their characteristic features such as location, direction, floors, and building quality also make each real estate unique. Since the value of each characteristic that constitutes the price of real estate can be determined by separating them from each other, it has been attempted to explain the theoretical structure of hedonic valuation model with examples from the housing market. In this way, it will also be possible to explain the influences of spatial characteristics such as shopping centers and important transport links on housing preferences. In the study, regression analysis was used to solve the relationship between sales prices and the structural, environmental and spatial characteristics of the property.

In the regression analysis, initially a filtering is performed on the data in order to exclude incorrect or incomplete data from the model. Then a multicollinearity test was applied in order to extract correlated high-order independent variables before they were included in the model.

Figure 1 – The boundaries of the study area

Providing Data

The distinguishing of residential properties in terms of their structural characteristics and locations makes it difficult to estimate the price for the highly heterogeneous housing market (Hill, 2011). In order to be able to reliably estimate values in the housing market, inclusion of actual sales data as well as the quality features and location information that differentiate houses from one another increases the explanation potential of the model and reduces the estimated error rate. In the case study, a sample model was attempted to be created using demanded prices. For this reason, information used about structural features of the houses has been retrieved from the real estate website Hürriyet Emlak (Hürriyet Emlak, 2016) due to its accessibility. It is possible to sort structural characteristics information retrieved on 01.01.2016 for a total of 163 dwellings in terms of the number of rooms, floors, directions, the age of the building, and whether part of a building complex or apartment building.

Initially, data for 327 houses were obtained; however, due to the necessity of working with reliable data sets in hedonic valuation, the data was filtered and the most reliable 50% was used in the model. In order not to increase the number of independent variables the model has in the study, distances from the residences to the previously determined main street (Konya Road) and the metro station (Söğütözü Metro Station) were queried with the help of Google Maps API (application programming interface) (Google Maps API, 2016).

Descriptive Statistics

According to the descriptive statistics formed by using this data, the average unit price of houses in Çukurambar is 3,985.00 TL/m², while the average rental fee for a unit is 13.56 TL/m². With a static calculation, housing investments in the region seem to be likely to return on average of 24 ((13.56 x 12 / 3,985.00) -1) years. In that case, it appears that investors have the expectation that houses in the region will gain value over time, and that they are behaving speculatively. On the other hand, there is also the possibility that the increase in household income is lagging compared to the increase in housing sales prices.

When the type of residences are examined, it is seen that they have an average of 4 rooms and an area of 150.00 to 250.00 m². The average number of floors is determined as 11, but 8 to 10 floor buildings comprise the majority in the region. It has been determined that the average building age in the district is 9 years. Only 21% of the housing data used in the model are located in housing complexes, while the characteristic features of the housing data reflect the commencement of the 5th Stage Urban Service Area Plan approved in 1991 and the 3rd Stage Karakusunlar - Çukurambar Peripheral Road Northern Implementation Plan approved in 2004.

Variable Selection

In the hedonic model estimates, which independent variables are to be included and excluded in the model are one of the issues to be emphasized. Similarly in the hedonic valuation model, a number of tests must also be completed before the model is set up to determine the independent variables. In the scope of the study, a multicollinearity test was conducted to allow a detailed observation of the problem of rank reduction. With the help of scattering graphs obtained, the correlations between the variables could be determined.

When the multicollinearity test is examined, it is seen that there is a high correlation of 84% between the number of rooms and the area of the dwelling. The variance inflation factor (VIF) value should be examined to see if there is any multicollinearity. Accordingly, it is expected that variables that score over 5.00 in the variance magnification factor test will be removed from the model in CLLS, which is one of the methods to be applied.

Since the correlations in number of rooms and area were high, the VIF values were also looked at, and for the area variable, this figure was found to be below the 5.00 limit (3.83). As a result, the number of rooms and field variables did not score high enough despite having high variance magnification factor values.

The calculated p-value for the statistical tests shows the probability of making an erroneous decision in the case of “a significant difference in relevant hypothesis test results”, and the smaller the p-value, the more reason there is for the rejection of the H0 hypothesis (Kul, 2014). It is estimated in the conducted studies that the inclusion of variables with p-values of less than 0.05 will be significant. In this context, after also examining the p-values of the data being worked on in order to be utilized in stepwise regression, the regression model should be decided on after completing the variable selection. In the study, the models were estimated with CLLS, SR and ANN, which are among the frequently applied models in the literature, and the most suitable model was determined by comparing predictive performances.

IV. Regression Model Selection

In the study, three different models, two linear and one nonlinear, were used to estimate functional forms that yield the best parameter estimates. As a result of the study, the most appropriate model for determining the value of each model will be decided on by means of measuring the predictive power. It has been observed that in studies investigated in the literature, location data is often not included as a variable in models due to the difficulty in obtaining location data, and therefore, the prediction levels in situations where spatial properties are used and not used have also been compared in the study. Thus, it becomes possible to determine to what extent location properties increase the efficiency of the model.

In literature analysis, it has been found that linear regression models OLS, CLLS and SR as well as multivariable nonlinear regression, ANN, and fuzzy regression non-linear regression models are frequently used. Three different models, CLLS, SR and ANN, which are frequently used in the literature and easy to implement, have been estimated in the study conducted as an example. CLLS was preferred as it allows for regression analysis by setting linear limits on independent variables in hedonic regression studies; SR for its being a model established by selecting the most suitable independent variables; and ANN because it can yield more flexible and realistic results than other statistical analysis methods when it comes to researching consumer behavior (Tolon and Tosunoğlu, 2008). The predictive performances of the models were taken into account when choosing the most appropriate regression model and the Monte Carlo simulation was used to compare the predictive performances of CLLS, SR and ANN models.

Linear Model Estimation with CLLS

In order to prevent rank deficiency before performing the regression, the variables with all zero values among the independent variables were excluded from the model. Then, as mentioned earlier, the VIF test was applied to solve the problem of multicollinearity. Since the correlation between the number of rooms and area variables is high according to the test result, the VIF value is examined for the area variable and it is determined that it does not score high enough that requires it to be removed from the model.

The sales value estimation equation of the CLLS model is defined as follows:

Sales Value = β1 x Area + β2 x Number of Rooms + β3 x Floor + β4 x Direction Score + β5 x Building Complex Score + β6 x Building Age + β7 x (1/Distance to Metro Station) + β8 x (1/Distance to Konya Road) + β9

Constraints: $\beta1>0$, $\beta2>0$, $\beta3>0$, $\beta4>0$, $\beta5>0$, $\beta6<0$, $\beta7>0$, $\beta8>0$, $\beta9>0$

It is estimated that among the parameters used, only higher building age will negatively affect the value, and the β value of building age in the model is determined to be less than zero. After the variable selection was completed, the Constrained Linear Least-Squares method was applied and the coefficients after the regression were calculated (Table 1).

Table 1. The regression coefficients of the CLLS model for the cases with GIS and without GIS

Çukurambar	Where GIS is not used	Where GIS is used
Number of Data	163	163
Field (m²)	1,537.12	1,512.08
Number of Rooms	21,473.88	25,045.12
Floor	16,920.47	16,582.48
Direction Score	14,399.79	14,178.70
Building Complex Score 0.00	0.00	0.00
Building Age	-21,093.69	-20,631.40
-1^{st} Power of Distance to Söğütözü Metro Station	-	5,371,619.14
-1^{st} Power of Distance to the Konya Road	-	4,408,602.16

Fixed Term	410,325.80	387,199.33
R²	0.70	0.78
R² Adjusted	0.69	0.77
Standard Deviation	262,098.60	262,098.60
RMSE	142,125.60	139,254.30

Linear Model Estimation with Stepwise Regression

In order to obtain the best model in a stepwise regression, a new independent variable is added or subtracted each time (Çakır Zeytinoğlu, 2007). When the regression is applied, the p-values of the variables are examined firstly, and inclusion of variables with p-value lower than 0.05 in the model is considered meaningful. The p-values of the room number and direction variables were determined as 0.0693 and 0.0622 (higher than 0.05) respectively. First, it is estimated that the number of rooms variable with the highest p-value (0,0693) should be excluded from the model (Table 2), and when the test is reapplied without this variable, the p-value of the façade variable has fallen below 0,05 (0,0309) (Table 3).

Table 2. P-value of variables

Variables	P-values
Field (m²)	5,4742x10-9
Number of Rooms	0.0693
Floor	5,2779x10-7
Direction	0.0622
Being Inside a Complex	0.0101
Building Age	1,6082x10-9
Distance to Metro Station	1,4361x10-7
Distance to Konya Road	0.0009

Table 3. P-value of variables after the number of rooms has been removed from the model

Variables	P-values
Field (m²)	1,1122x10-7
Floor	4,8876x10-29
Direction	0.0309
Being Inside a Complex	0.0028
Building Age	3,0483x10-9
Distance to Metro Station	3,1401x10-7
Distance to Konya Road	0.0024

After the variable selection is complete, coefficients of the variables are determined by applying stepwise regression. Unlike CLLS in the stepwise regression, positive or negative values of the coefficients are automatically determined when the model is applied, and it is found that the residence being in a complex has a negative effect in Çukurambar (Table 4). Thus, this makes it clear as to why complex score in CLLS is zero. Despite this unexpected result, it should be emphasized that the decision to be positive in CLLS on the assumption that the inside a complex parameter will have a positive impact must be reassessed in future studies.

Table 4. The regression coefficients of stepwise regression model for the cases with GIS and without GIS

Çukurambar	Where GIS is not used	Where GIS is used
Number of Data	163	163
Area (m²)	1,734.50	1,854.90
Floor	17,619.00	13,664.00
Direction Score	14,948.00	10,569.00
Building Complex Score 0.00	-73,816.00	-74,407.00
Building Age	-21,064.00	-16,712.00
-1st Power of Distance to Söğütözü Metro Station	-	100,680,000.00
-1st Power of Distance to the Konya Road	-	24,110,000.00
Fixed Term	465,570.00	316,020.00
R²	0.72	0.78
R² Adjusted	0.71	0.77
Standard Deviation	262,098.60	262,098.60
RMSE	142,000.00	125,000.00

Non-Linear Model Estimation with ANN

Due to the need to compare with linear regression and test the results, the model was also estimated with artificial neural networks. Although it is possible to establish a nonlinear relationship by means of artificial neural networks, due to the structure formed by weighting the distances between neural networks - as in the case of linear regression - the model can be described in terms of coefficients, and the sole housing price is estimated as model output. In the literature, it appears that artificial neural networks yield better results when working with too many houses (Peterson and Flanagan, 2009).

When choosing a model, difficulties were encountered in choosing algorithms and specifying topology properties. In the model, the number of hidden nodes is set to +1 of the number of independent variables. LMB (Levenberg-Marquardt backpropagation) or BRB (Bayesian regularization backpropagation) were chosen as learning methods and the measurement of performance criterion was based on MSE (mean-squared error).

Model Comparison and Selection

The case study in the Çukurambar area was carried out on 163 houses listed for sale. In the study, three different models with two linear (CLLS and SR) and one nonlinear (ANN) were applied and estimation results were obtained for each model and Monte Carlo simulation was used to compare the models in question. Monte Carlo simulation enables the production of all possible output distributions and the testing of performance measures of different alternatives.

Since the RMSE values were lower when the GIS was included in previous sections, the performances of the three regression models in which location variables were included in the Monte Carlo simulation were compared and a performance comparison based on out of sampling RMSE values of the models was performed (Table 5). RMSE is an inferential statistical value used to determine the error rate between the measurement value and the model estimate. RMSE values' getting close to zero indicates that the predicted model is close to reality.

Table 5. Monte Carlo simulation result

Results	Models			
	CLLS	**SR**	**ANN (BRB)**	**ANN (LMB)**
Mean Value Error (TL)	105,089	103,355	183,114	159,458
Average Percentage Error (%)	13	12	24	21
In-Sampling Standard Deviation of Values	251,558	251,558	251,558	251,558
In-Sampling RMSE	138,284	121,212	76,050	176,156
Out of Sampling Standard Deviation of Values	286,986	286,986	286,986	286,986
Out of Sampling RMSE	144,786	138,564	387,153	221,904

As a result of the performance comparison with the Monte Carlo simulation, it is understood that stepwise regression has a lower out of sampling RMSE value. In this respect, it is possible to assert that the stepwise regression model performs much better than models created with CLLS and ANN. The performance of the artificial neural network model constructed with the BRB learning method is lowest, as is apparent from the average percent error and out of sampling RMSE values. As a result, a linear model has a better predictability than a nonlinear model, while a model with location features has a better estimate than a model without. Therefore, the analysis results of the model with the best predictive performance, stepwise regression will be evaluated in the rest of the study.

The Best Performing Model and the Results

The stepwise regression method, which performed the best among the applied regression models, is used to determine the few variables that contributed most to the model when the number of independent variables is high. One of the linear models designed in the study has used stepwise regression method, and performance was found to be superior in terms of evaluation criteria and level of statistical significance. It is seen that the high performance exhibited in SR is the result of variables included in the model and the coefficient mark in the front being determined by the model; in other words, as a consequence of not introducing any external limitations on variables in the SR model.

In the hedonic model based on the estimation of the sales value of the houses and the factors affecting the value in the Çukurambar region, there are 7 explanatory variables that best describe the model although there are 8 descriptive variables in total. The hedonic model is estimated as:

Sales Value = $\beta 1$ x Area + $\beta 2$ x Floor + $\beta 3$ x Direction Score + $\beta 4$ x Complex Score + $\beta 5$ x Building Age + $\beta 6$ x (1/Distance to Metro Station) + $\beta 7$ x (1/Distance to Konya Road) + $\beta 8$

In the SR model, the percentage effect of structural, location and environmental properties were examined for each observation. Structural properties represent area (m^2), floor, direction, whether it is in a complex or not, age of building; location is the distance from the Söğütözü Metro Station; while the environmental feature refers to the distance from Konya Road, which is an intercity transportation hub. Although the distance from Konya Road is perceived as a location feature, it is more appropriate to evaluate it in the category of an environmental feature due to the road being a threshold.

In the stepwise regression model using spatial data, $R^2 = 0.78$ was calculated (Table 5). The said ratio indicates that about 78% of the difference in residential sales price is explained by variables included in the model. According to the results of the study, it was observed that the effect of the structural features on the price was dominant, the sales values of the houses were influenced 38% by fixed terms, 46% by structural features, 11% by spatial features, and 5% by environmental features. It is possible to argue that an investor who invests in the housing market in the Çukurambar area pays 38% of this for the neighborhood's name.

It has been understood that, in the model the variable of residential area (m^2) is the most influential parameter on house value. The hedonic regression result shows that 1.00 m^2 increase in area in the region increases the value of housing by 1,854.90 TL. The average floor level in the district was determined as 11 and it was found that houses located in lower floors caused the value to decrease and that being located one floor higher increased the value of the house by 13.664,00 TL.

Another factor affecting housing preferences is the direction. In Ankara where the average annual temperature is 12 °C (Republic of Turkey Ministry of Forestry and Water Affairs, 2016), people prefer houses that are exposed to the sun. According to the results obtained in Çukurambar, a house being located on the south side positively affects the value compared to other directions. The directions that make the most positive impact on value after the southern are eastern and northern directions respectively, and the effect on the value is low when the house is facing the west where the light is sharp. In this case, it would be appropriate to construct the common use areas of the buildings in the western direction. In the model, the houses were rated according to the name and number of directions they face. For example, if a house is facing three fronts - the south, the east and the north - the total score of the directions (4, 3 and 2, respectively) multiplied by 10,569.00 (10,569.00x9 = 95,121.00) represents the contribution of the facade in its value.

In regression analysis, the residences are grouped as those inside and outside complexes. There are no villas or detached houses in the sample set. According to the results obtained, a house being inside a complex has a negative effect on the value. Although it is assumed that being inside a complex will have a positive impact on the value of housing, in a region such as Çukurambar where commercial real estate has a high premium, safeguarded usage in real estate project areas means a lower return. Single apartment buildings built on land lots, where entrances and entresols are planned for commercial usage, can find buyers at higher values due to higher land values. It was determined that only 21% of the 163 dwellings in the sample set were located inside a complex, and the value of a dwelling in a complex dropped by 74,407.00 TL.

The increase in the age of real estate usually results in the cost of maintenance and renovation, and unmaintained real estate carries the risk of losing economic value over time (Winson-Geideman et al., 2011). That there is an inversely proportional relation between the values of properties with no historical value and the age of the building is expected. Similarly, it was calculated that the sales value of the house in Çukurambar dropped by 16,712.00 TL when the building age increased by 1 unit, and it was determined that the building age variable is a factor that decreases the housing value.

In the regression models, it has been proven comparatively that the corrected R^2 data is increased when the location parameters are added. In the regression model, the distance from Söğütözü Metro Station was taken as the location data. On the assumption that for houses closer to Söğütözü Subway Station, the model will affect the value positively, the figure obtained by the multiplication of the -1st power of the distance in meters with the fixed term expresses the contribution of the distance from Söğütözü Metro Station to the value of the house. It has been determined that the value of the residence is increased by 201,360.00 TL when it is 500.00 m, and by 106,680.00 TL when it is 1 km away from the metro station.

Although the distance to the Konya Road in the regression model is perceived as a location feature, it is evaluated in the environmental feature category, because the road is considered to be a threshold. Similar to the influence of location characteristic, it is assumed that being close to Konya Road will positively affect the value, and the figure obtained with the multiplication of the fixed term with the -1st power of the distance in meters expresses the contribution of the distance from Konya Road to the value of the house. The residence being 500.00 m from Konya Road increases its value by 48,220.00 TL.

V. CONCLUSION

One of the biggest challenges in real estate valuation is the determination of the factors that affect the value and their levels of influence. The differentiated values of real estate are explained by their unique distinctive characteristics. Each property is a heterogeneous good competing with another, and the features that distinguish them from one another are commonly classified as structural, locational, and environmental characteristics. The distinctive features come together to reveal the differentiated market value. With the hedonic approach it is possible to calculate the effects of real estate characteristics on value. The greatest advantage of the hedonic method is that factors are based on analysis, and it is possible to make reliable market analysis by producing completely scientific and unbiased results in real estate valuation with the hedonic method.

In the study, the use of hedonic models in the real estate market and the contributions it provided were analyzed, and the housing market in Çankaya's Çukurambar District of Ankara was analyzed with hedonic models. In the study, the relationship between housing values and structural, locational and environmental characteristics was estimated. In regression analysis, CLLS, stepwise regression and ANN models were compared, and it was determined according to the RMSE data that the regression model with the highest performance among these was stepwise regression model incorporating the positional data set as a linear model.

The most important takeaway of the study is that the inclusion of location features into the model is significant. As stated by Aliefendioğlu and Tanrıvermiş (2015), measurement of the positive and negative characteristics that can affect the value of real estate and conducting research required to measure the real estate values of different location properties is one of the most important problems encountered in valuation. The study is significant in that location features are used in the model. As an important consequence of the use of location features, it has been determined that the increases in residential area values created by Eskisehir Road and Konya Road which have similar characteristics, differ significantly.

Another important consequence of the work is that the result does not match the expectations when the coefficients of variables are not constrained. For example, according to the results of regression, a dwelling in Çukurambar being located in a complex reduces the value. Dwellings located in building complexes in Turkey are preferred by the middle and upper classes due to the social facilities and safe environments they provide. On the other hand, Çukurambar has a structure in which the residential function is embedded with a commercial one. Additionally, this situation may be related to the development status of the land in which the houses are located. In such a case, it seems likely that real estate investors tend to produce ground-floor commercial and upper-floor residential individual apartment blocks in order to benefit from high economic-rent commercial use.

Another important point is to test the entire work on the actual data and report the results. It seems possible to obtain lower error rates if actual data is included in the model. It has been observed that in most hedonic valuation studies in the literature, models are developed over the time series they have. Although time-based price changes can be determined for the houses, changes such as possible maintenance and repair works houses can undergo over time and changes on the projects have been ignored. A very comprehensive and rich data set is needed for such a study. The study being carried out within a rich data set also creates an important potential for testing the models in a reliable way.

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