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A Dualistic Manner In Spatial Analysis: Location And Sector Based Investigations For Housing Price Determinants

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Regional Integration:
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A Dualistic Manner in Spatial Analysis: Location and Sector-Based Investigations for Housing Price Determinants

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Abstract:

Investigation of the patterns in housing preferences has always been a strong emphasis on spatial analysis literature, mostly to the extent that housing price varies within urban macro form. The purpose of this paper is to examine the variances of housing prices in Istanbul, by using different determinant sets in separate models which are based on housing price models, employing location and sector-based investigations. The first model, based on multiple regression model, measuring the effect of distance and/or proximity on housing price variances. The second model measures the land price effect as a most prominent indicator in residential market. The paper finalizes with a comparison of the results obtained from location and sector-based models. Concluding remarks indicate that spatial variations in housing price, predicted within these two models can also estimate the segmented structure of the city, Istanbul and residential market itself. Such a dualistic manner which corresponds to combination of statistical and spatial analysis techniques can be useful in order to comprehend the residential market in a spatial pattern.

Keywords:

Real Estate Markets (R3), Housing Supply and Markets (R31), Spatial Models (R31)

Introduction

Investigation of the patterns in housing preferences has always been a strong emphasis on spatial analysis literature, mostly to the extent that housing price varies within urban macro form, that urban and land economics mostly deal it, as well. Hence, one of the most important research interests of location models becomes a definition of the changes to house prices in urban and land economics studies. Land and housing market studies, which aimed to investigate the demand patterns in housing preferences, usually carried this strong emphasis on spatial determinants of the extent to which housing price varies within urban macro form. The hedonic price model (as one of the important urban economic studies) also include the spatial determinants effect on housing price while examining the demand side of housing with different attributes (Griliches, 1971). This model assumes that a property is a retail product, to be implicitly priced with a bundle of characteristics (Rosen, 1974; Freeman, 1979), to be achieved with factor analysis.

The purpose of this paper is to examine and compare the variances of housing prices in Istanbul, by using different determinant sets in separate models which are based on hedonic price models, employing location and sector-based investigations (Data used in this paper are obtained from two publications of the author. Models are revised due to the purpose of this paper) Former model, based on a multiple regression model, measuring the effect of distance and/or proximity on housing price variances. In this model, distance among the bundle of alternative characteristics is assumed to affect any property price, as a retail product. Although this paper does not accomplish a full hedonic price model, it calculates the effect of distance and/or proximity determinants in housing prices in Istanbul (Koramaz and Dökmeçi, 2012). The latter model measures the land price effect as one of the most prominent indicator in residential market. In this model, land price effect in the variance of housing price is investigated in order to illustrate the emergence of residential market (Alkay and Koramaz, 2010).

The urban location theory examines the urban development patterns with respect to spatial, economic and demographic indicators (Alonso, 1964). Among these indicators, proximate locations in both the production and exchange of a variety of economic activities (Mills, 1972) and the variations in land and housing price are first concerns in urban and land economics consisting the advantages in low transportation and exchange costs (Henderson, 1977). The early studies of location theory, which is defined as the role of accessibility to central locations on land or housing prices, were mainly concerned with the environmental attributes (Richardson, 1971; Pollakowski, 1982), the negative effects of air pollution (Anderson & Crocker, 1970), and travel costs (Henderson, 1977).

Distance effect as a part of locational domain in hedonic price model which represents the demand side of housing price and especially referred in housing preferences and mobility studies. Besides this, the hedonic model had been used to measure spatial characteristics impact on housing price (Bender & Hwang, 1985; Blackley et al., 1986; Heikkila et al., 1989) including CBD proximity effect. Addition to this, distance to CBD, transportation nodes, public amenities and the other locational characteristics are indicated to explain half of the variance in housing price values.

Studies related to housing price models in Istanbul highlight that among spatial determinants only the distance to the CBD did not have a statistically significant influence on the spatial distribution of property values (Ozus et al., 2007), in line with the polycentric development theories in the literature (Richardson et al., 1990). As centrality was interpreted as an insignificant factor in many empirical housing price studies in the world, Istanbul is defined with a polycentric structure in which households perceive access to other public services and amenities is more important (Alkay, 2008) than access to the CBD in housing price values (Dokmeçi et al., 2003), the reflection to this, distance to sub-centres may explain the effect on housing price, then. The other spatial determinant, accessibility, is also found to be an insignificant factor in housing prices of Istanbul in many empirical studies (Keskin, 2008). A review of the results, from the related hedonic studies in Istanbul, expresses that location on Bosphorus shore and proximity to a sub-centre are more significant predictors in spatial determination of housing prices in Istanbul than other determinants.

The latter model measures the land price effect as a most prominent indicator in residential market. In this model, land price effect in the variance of housing price is investigated in order to illustrate the emergence of residential market. Within this investigation residential market is defined depending on land values whether there are areas where land prices are high but housing prices are relatively lower, or vice versa. In other words, if land and housing prices are not in consistency, there may be possibility of changing residential market features, to be interpreted with the inclusion of changing determinants.

Conventional housing market studies explained the price variances in terms of the attributes of housing stock characteristics, household status and type or location. Besides, housing markets could be the outcomes of land use changes and land price where it concomitantly change the variances of occupancy patterns, social groups status and behaviour, and housing quality (Leishman, 2003; Knox and Pinch, 2006). If housing has been defined as a composite good (and its demand is thus derived from the demand for its component attributes given above), the heterogeneity within housing market could be also measured with the reflections on land price variances as well.

As one of the main determinants of economic property is land, each square foot of land is worth marginally more (or less) for marginal changes in any access attributes (Srouf et al., 2002). In other words, price is supposed to be a fact related with and/or reflecting accessibility characteristics combined with the size of the property. Then the models, conducted in this paper will indirectly validate whether land price variance can substitute the locational determinants, or vice versa.

The paper mainly consists of four parts. In the introduction section, contextual framework has been already given with a general literature review and discussions, reflecting the motivation of the paper. Furthermore it continues with methodology and results sections, where housing price variances in Istanbul is determined with two separate models. Then it finalizes with a comparison of the results obtained from location and sector-based models. Concluding remarks indicate that spatial variations in housing price, predicted within these two models can also estimate the segmented structure of the city, Istanbul and residential market itself. Such a dualistic manner which corresponds to combination of statistical and spatial analysis techniques can be useful in order to comprehend the residential market in a spatial pattern.

Methodology

This paper investigates housing price values by conducting two separate models, which respectively measure the distance / proximity and land price effect on housing price. Models, are conducted with distance values (in the first model) and land price values (in the second model) combined with housing unit size. These investigations are applied with two different multiple regression analyses and then by using the interpolation technique which is generated to predict the spatial pattern of housing price on a continuous surface while visualizing the concluding remarks from the regression models. Finally the results from each multiple regression analyses and surface generated interpolation models are validated with the residual analyses conducted from the housing price models.

The spatial determinants in the first model are distance to CBD, sub-centres, main transportation arteries and the coast. In the second model, land price is independent variable instead of distance variables mentioned above. Density of neighbourhood units, housing unit sizes are both used as control variables. Additionally both models have a dummy variable of location in a Bosphorus coastal region. In this paper, housing price is used as the dependent variable and it is gathered from asked prices published weekly in the real estate supplement of a national newspaper (Hürriyet Emlak; 2009) from May to June 2009. In the model of this paper, housing price is used as dependent variable that prices range from from \$27,450 to \$5,000,000, with an overall mean of \$321,210 and median value of \$205,855 (Table 1). The independent variables used in multiple regression analyses were given in the table below.

Table 1. Variables with basic descriptive statistics

codes	variables	mean	median	std. dev.	minimum	maximum
Y	House Price (\$)	321,210	205,855	395,100	27,447	5,000,000
X ₁	Housing unit size (m ²)	165	140	94	40	910
X ₂	Distance to CBD (m)	10,214	10,087	8,036	25	76,129
X ₃	Distance to sub-center (m)	7,228	5,323	6,734	93	76,227
X ₄	Distance to trans. arteries (m)	843	367	1,680	1	14,261
X ₄	Distance to coast	1,571	1,171	1,381	16	7,127
X ₅	Density (p/ha)	187.87	206.37	92.96	0.81	655.91
X ₆	Location in Bosphorus coasts	0.19	0.00	0.39	0	1
X ₇	Land Price (\$)	216.35	232.20	119.13	5.83	510.71

Housing price value, as the dependent variable of both models is assumed to be a logarithmic function where independent variables' natural logarithmic values are assigned to the model. As stated in the beginning of this section, the assumption of each square meter's worthiness of property in any changes of distance attributes, firstly conducted by Kockelman (1997), is aimed to be confirmed in the explanation of housing price variances in Istanbul. Kockelman's approach is stated in housing price literature as being useful to examine especially land price affected by the accessibility characteristics (Srour, et al., 2002). In this paper, firstly spatial determinants combined with housing size, secondly land price variance combined with size, as well, are functionalized in two separate log-log regression model.

Results

Results of the multiple regression models are discussed whether both models have significant explanation for the influence on housing price value, or not. The results for Model 1 and Model 2 are presented in Table 2 (and equations for Model 1 and Model 2). Adjusted R² scores are respectively 0.663 and 0.648. For a regression model that include limited independent variables, these level of adjusted R² scores are considered fairly high. When these scores are compared, Model 1, explaining the distance effect has higher explanation power than Model 2, determining the land price effect on housing price. All variables in both models, produce significant effect on the variance of housing price level in Istanbul, which is consistent with the related literature, based on the issues of centrality and accessibility, and their effect on property prices.

Table 2. Multiple regression models based on the assumption of housing price

variables		coeff.	std. error	t statistics	sig.
Model 1					
Constant		6.383	0.230	27.712	0.000
ln(X ₀)	Housing unit size (m ²)	1.967	0.054	36.181	0.000
ln(X ₀) x ln(X ₁)	Size x Distance to CBD (m)	-0.025	0.004	-6.397	0.000
ln(X ₀) x ln(X ₂)	Size x Distance to sub-center (m)	-0.028	0.006	-4.777	0.000
ln(X ₀) x ln(X ₃)	Size x Distance to trans. art. (m)	-0.010	0.003	-3.588	0.000
ln(X ₀) x ln(X ₄)	Size x Distance to coast	-0.028	0.003	-9.277	0.000
ln(X ₅)	Density (p/ha)	-0.083	0.027	-3.029	0.003
X ₆	Location in Bosporus coasts	0.329	0.049	6.720	0.000
Model 2					
Constant		6.105	0.230	26.560	0.000
ln(X ₀)	Housing unit size (m ²)	0.972	0.040	24.124	0.000
ln(X ₅)	Density (p/ha)	-0.062	0.025	-2.432	0.015
X ₆	Location in Bosporus coasts	0.509	0.038	13.426	0.000
ln(X ₀) x ln(X ₇)	Size x Land price (\$)	0.061	0.004	14.851	0.000

Dependent variable = ln (housing price)

Model 1: F ratio = 329.690; Adj R² = 0.663; p: 0.000

Model 2: F ratio = 539.522; Adj R² = 0.648; p: 0.000

Model with distance effect

$$\ln(Y) = 6.383 + \ln(X_0) [1.967 - 0.025 \ln(X_1) - 0.028 \ln(X_2) - 0.010 \ln(X_3) - 0.028 \ln(X_4)] - 0.083 \ln(X_5) + 0.329 X_6 \quad (\text{Model 1})$$

Model with land price effect

$$\ln(Y) = 6.105 + \ln(X_0) [0.972 - 0.061 \ln(X_7)] - 0.062 \ln(X_5) + 0.509 X_6 \quad (\text{Model 2})$$

As one of the strongest variable in the explanation of housing price value in Istanbul via distance variables or land price variable, housing unit size has coefficient values as 1.967 (in Model 1) and 0.972 (in Model 2) while this variable also interacts with the independent variables in both equations. The coefficients on the housing unit size are respectively +1.967 and +0.972, signifying that this result is strongly consistent with Kockelman's (1997) use of the hedonic price model which confirms the worth of the property's size in the price value. The coefficients of the independent variables suggest that housing unit size contributes the most to the price of housing in Istanbul.

Distance variables in Model 1 have significant effects on the housing price model. The negative effects on the distance-related coefficients suggest that closer distances add the most to the price of a housing unit in a certain size. In terms of centrality, distance to CBD and sub-centres are the two stronger determinants than the others where housing price value significantly decreases as a negative effect when a distance increase occurs. Coefficients of distance variables in Model 1 indicates that the regression model estimates a possible 1% total rise in entire distance variables to contribute to a direct fall in the dependent variable (housing price value) of 9.1% in total. On the other hand, coefficient of land price in Model 2 indicates that the regression model estimates 1% total rise in land price variable to contribute to a direct fall in the dependent variable (housing price value) of 6.1%.

On the other hand, dummy variable of location on Bosphorus coastal region has significant effects on the variance of housing prices in each model. As the dummy variable of location in a Bosphorus coastal region coefficient values as 0.329 in Model 1 and 0.509 in Model 2, results confirm that one of the strongest factor among the main predictors in both models is location in a Bosphorus coastal region which has relatively higher coefficient value than most.

As determined as a control variable, depicting the neighbourhood characteristics in hedonic model, density variable significantly affects housing price value in both models. The coefficients indicate that the model estimates 1% rise in this variable to contribute to an 8.3% (in Model 1) and 6.2% (Model 2) falls. In particular, the districts which have unplanned or squatter settlement characteristics have higher density levels than the ones which have planned settlement characteristics with organized urban facilities and infrastructure.

After examining the results of the statistical analysis used to predict housing price value in Istanbul, actual housing prices (Figure 1), predicted values of both models (Figure 2 and 3) and their residuals (Figure 4 and 5) are all involved in spatial analysis so called interpolation technique. By the use of this technique, housing price value in Istanbul is modelled in a continuous grid surfaces within its entire borders to be estimated from the sampled data. For modelling the housing price in this paper, the Kriging interpolation technique is conducted using ArcGIS 10.1 Geostatistical Analyst module.

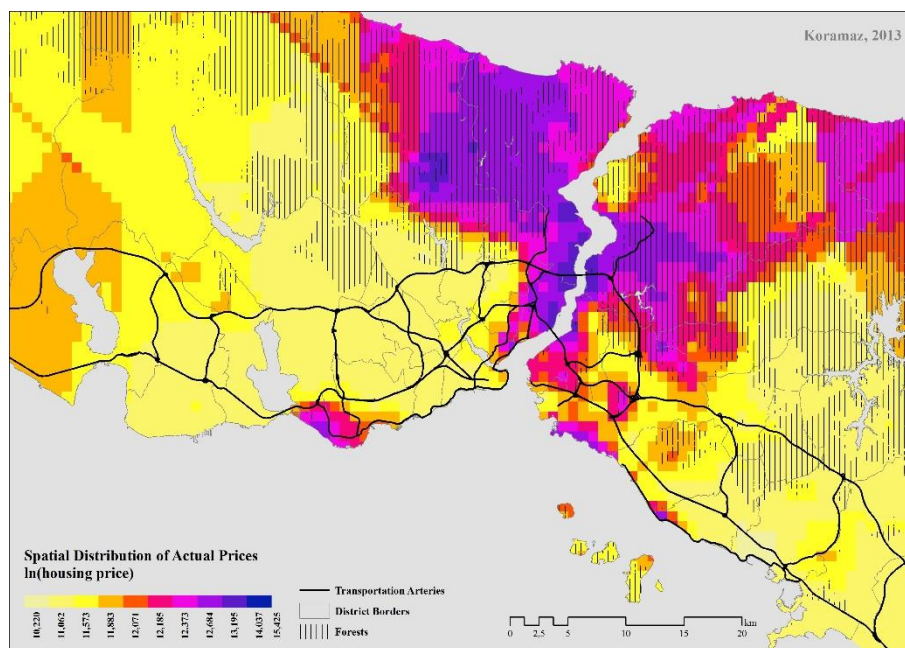


Figure 1. Spatial Distribution of Actual Prices in Istanbul

Figure 1 shows the spatial distribution of the changing levels of actual housing prices in Istanbul. The Kriging interpolation method, used in this paper, successfully indicates the better locations representing housing price values, which have logarithmic values changing from 10.67 to 15.64. Higher values represent the higher actual housing price in Istanbul. The highest values, obtained from the Kriging interpolation map illustrate three significant housing markets

in Istanbul which are the coastal regions of the Bosphorus and the close surroundings of the central business district in the north of Istanbul; peripheral housing development for high income households; and planned housing settlements. These remarks, interpreting the visual representation of Kriging map, reflect distance variable effects as these neighbourhoods stated above, are the ones which has relatively favourable features in terms of centrality and accessibility. Then it can be concluded that these spots also have highest priced land market characteristics, as well. The figures below, in interpolation technique used in this paper, concern the predicted values from Model 1 and 2 (Figure 2 and 3).

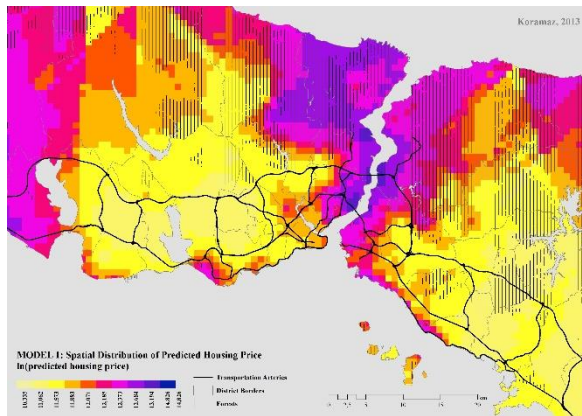


Figure 2. Spatial Distribution of Predicted Housing Prices from Model 1 (distance effect)

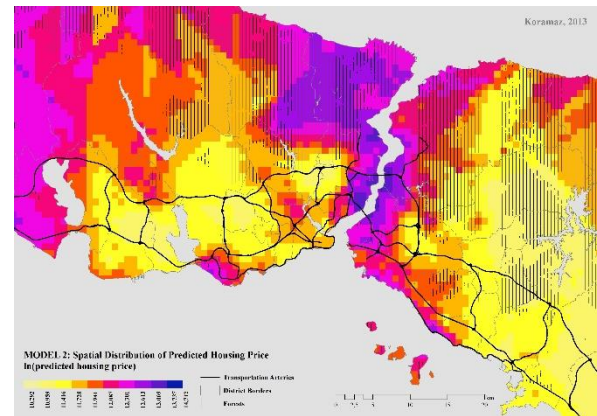


Figure 3. Spatial Distribution of Predicted Housing Prices from Model 2 (land price effect)

The highest values obtained from the interpolation maps of predicted housing prices are mostly similar with the interpolation map of actual housing prices reflecting the importance of the Bosphorus coastal region and the close surroundings of the central business district in the north of Istanbul; peripheral housing development for high income households; and planned housing settlements in the southern shores of the city. But there are still some significant dissimilarities that can be considered as below:

- Central locations, where land price values are higher with favourable transportation connections, but housing prices are relatively lower,
- Peripheral locations, where land price values are lower with less transportation connections, but housing prices are relatively higher.

After modelling the actual and predicted data of housing price, the Kriging interpolation method is lastly used to test the consistency of multiple regression analysis from the values of residuals, and is calculated with the difference between actual and predicted values. Within the limits of this study, there is limited predictors which are included in the multiple regression models. With a residual analysis, derived from the regression models (in terms of error, ϵ_{price}), influence of neglected variables effect on price in each model can be compared and visualised with the utilization of interpolation technique (Figure 4 and 5).

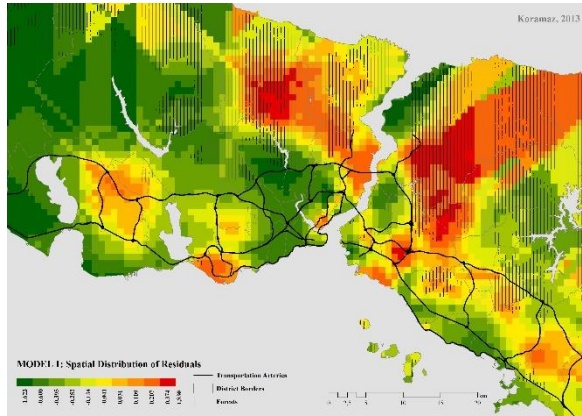


Figure 4. Spatial Distribution of Residuals in Model 1 (distance effect)

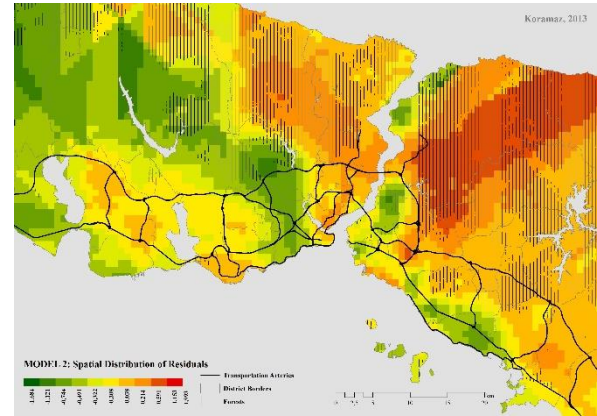


Figure 5. Spatial Distribution of Residuals in Model 2 (land price effect)

Table 3 gives the basic descriptive statistics for predicted values and residuals, obtained from Model 1 and 2. In order to compare two models, normality of residuals are evaluated while discussing to what extent housing price value, in this case, have more consistent functional form or less missing (neglected) significant variables than the other. Table 3 indicates that Model 1, has skewness score closer to “0” although the difference between mean and median is higher than Model 2. Skewness scores indicate that distribution of residuals in Model 1 is more symmetrical around the mean than Model 2. Kurtosis which is supposed to be equal to 3 for the best normal distribution result, both figures show similar scores in both models.

Table 3. Predicted values and residuals for the models

	mean	median	std. dev.	skewness	kurtosis	minimum	maximum
Actual Value	12,294	12,235	0,813	0,569	0,472	10,220	15,425
Model 1 :							
Predicted Values	12,294	12,187	0,663	0,703	1,048	10,335	14,826
Residuals	0	-0,005	0,471	0,212	0,859	-1,622	1,830
Model 2 :							
Predicted Values	12,294	12,248	0,655	0,494	0,992	10,292	14,712
Residuals	0	-0,047	0,482	0,503	0,953	-1,684	1,993

Conclusion

The distance and land price effect have statistically significant effect on the spatial distribution of housing values as proved in this paper, then it is distinguishable from previous models that highlight the polycentric development in Istanbul. Although centrality in Istanbul was interpreted as an insignificant factor in the empirical studies (Ozus, et al., 2007), sub-centres in both Anatolian and European sides were developed with employment opportunities and housing projects, after the 2000s. Meanwhile, Istanbul has important regeneration projects and policies in and close to the surroundings of the city centre which may have an eventual increasing effect on housing price, where the residuals of the models have depicted the potential housing sub-market classifications (Koramaz and Dökmeçi, 2012).

The results of this paper not only confirm the significant effect of accessibility on housing price in Istanbul directly, but also indirectly re-evaluate the polycentric urban growth in the city suburban neighbourhoods and accessibility issue in urban infrastructure as described in literature in accordance with housing market in Istanbul (Dökmeçi et al., 2003).

On the other hand, results from this paper indicate that housing market characteristics which can be detailed with further studies, are also consistent with land prices and eventually land market characteristics in general. But there are some sub-markets, where land prices explain housing prices better than the other parts, can be interpreted as residential transformation areas of Istanbul (Alkay and Koramaz, 2010). Determination of the spatial distribution of these areas may help politicians and practitioners to prevent the further deterioration of these areas and to attract investment for improving housing environment. This paper figures out the potential possibilities for further studies which may consist of the influence of other location and sector-based determinants, such as the inhabitants' willingness to pay for. Such an approach related to combination of statistical and spatial analysis as held in this paper can be extended by including different domains affecting housing price as a subject for those further researches.

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