Modeling the Impacts of Rail Transit Investment on the Values of Residential Property: A Hedonic Price Approach in the Case of Izmir Subway, Turkey*

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Abstract

Location theory states that accessibility benefits will be capitalized into property values. This study attempts to model the relationship between residential property values and changes in accessibility caused by a rail transit investment in public transportation in the case of Izmir Subway, Turkey. To test the research question, hedonic price model was used to determine whether improved accessibility due to a public transportation investment has had any effect on residential property values. The effects associated with accessibility have been measured using distance and travel times.

The models indicate that proximity to the subway stations is a statistically significant determinant of the market price of residential property units. Each additional meter a way from subway station decreased the price of residential units.

I. Introduction:

It is known that there is a strong relationship between location and value of a property and improved accessibility is expected to increase property values. Also, it is expected that investment in transportation system will bring economic benefits into urban areas. These benefits can range from user benefits to employment – income growth, social, and urbanization benefits (Cambridge Systematics., 1998). Furthermore, there is a growing interest in decision – making process to measure the economic impacts of investments associated with transportation. Measuring the economic impacts of transit projects is one of the main subjects of planning practice around the world. However, there is a lack of empirical

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studies in the developing countries. Within this context, this study examines the impact of rail transit investment on the residential property values using the hedonic price model (HPM) from the perspective of a city located within a developing country.

Location theory suggests that "*any improvement in transportation infrastructure is capitalized into land values in a short – term urban partial equlibrium*" (Alonso, 1964; Muth, 1969; Mills, 1972). Many empirical studies have tested this theoretical premise applying with different economic and econometric techniques like regression models and repeat sales comparisons. The impacts caused by transportation investment have been analyzed in terms of income, land use, employment-population density, and property value (residential, commercial, and office) in different urban areas. In Alonso, Muth, and Mill's model known as access-space models, transportation costs are traded off against land rents. It assumes that an improvement in transportation infrastructure reduces commuting costs via savings in the commuting time. Having easy access or proximity to rail transit stations may decrease time and cost of traveling to Central Business District (CBD), or the other employment centers. In this sense, it is a premium paid for residential units in the impact area of relative transportation investment (Bajic, 1983).

Within this context, the purpose of this study is to report the impacts of a rail transit investment in the case of Izmir Subway, Turkey using a Hedonic Price Model (HPM). In this study, since the review of existing literature would be voluminous to present here, we will focus on the empirical studies analyzing the impacts of rail transit investments. Fistly, we will discuss theoretical framework and the evidence of the existing literature associated with the impact of rail transit investment on property values. Section III describes study area and data used in this study. Modeling methodology is explained in Section IV. The findings of the study are presented in the fifth section and conclusions are reported in the final section.

II. Theoretical Framework and Literature Review:

In theory, the relationship between the location of a land and land rent has been discussed since the beginning of the twentieth century. Transportation has played an important role in urban economic theory. Pioneering studies in urban economics modeled a mono-centric city For example, in monocentric city; the bid rent function is explained with transportation costs from center. Different land uses compute for locating in central lands to gain accessibility benefits. According to Hurd, "*since value depends on economic rent, and rent on location and location on convenience, and convenience on nearness, we may eliminate the intermediate steps and say that value depends on nearness*" (Alonso, 1964; p.6). Then, Alonso (1964), Muth (1969), and Mills (1972) assumed that all the employment took place at the city center. In monocentric urban model, travel costs increase with distance to Central Business District (CBD). The rent is expected to be highest at the city center.

Thus, theory assumes that savings in transportation costs and access to transportation services may be capitalized into housing or property values. Although today's cities may not only be mono-centric city, many empirical studies have confirmed this theory. However, there is still no consensus in the literature on the capitalization impact of rail transit investments empirically.

The economic impacts of a transit investment can range from regional to local level. Certain changes in the productivity of a region, employment-population level, and land-use may be monitored if investment improves existing transportation system (Bollinger and Ihlanfeldt, 1997). On the other hand, local impacts increasingly occur around the transit stations. These impacts are strongly related to improved accessibility for urban areas. Within the context of the study, this review discusses local impacts of transit investments. The research question underlying these arguments is that whether proximity to light rail transit stations brings a value premium or what is the impact of an improvement in public transportation infrastructure on housing price. In addition, the impacts can not be measured in short term period. Some impacts such as changes in land use may take long term. Cervero and Landis (1997), for example, examined the impacts of Bay Area Rapid Transit System (BART) 20 years after BART was opened. While Bollinger and Ihlandfeldt (1997) studied economic impacts of Atlanta's MARTA (Metropolitan Atlanta Rapid Transit Authority), Cervero (1994) examined Washington D.C. Metrorail System and Atlanta Marta System. These studies analyzing long-term effects used different indicators. Average rents, densities, rent curves, income, and employment-population levels are important indicators for these studies. There were certain developments around transit investments, but these developments may not exactly attribute to the rail investments. Recent experiences about the property value impacts of rail transit investments were studied in California counties: San Diago, Santa Clara, and Los Angles real estate markets using HPM for residential and commercial properties. Transit-Oriented

Development (TOD) is dominant factor in the urban pattern of the counties (Dunphy et al., 2004).

Moreover, two different data sets are used: cross-sectional and time series (longitudinal) data. The time series data set allows the analysts to do before and after comparisons such as rent curves and land use changes. Before and after comparisons using time series data include three main time interval: before the years rail transit stations were opened, the years rail transit stations were opened, and after the years rail transit stations opened. These comparisons are based on reliable and comprehensive data set. The data set can be obtained from Real Estate Agents, Country Property Tax Records, Surveys, Multiple Listing Services published by Real Estate Board, and Transit Commission Services.

Hedonic price model is one of the often used techniques for modeling land rent variation due to transit investments especially in the short-term impact studies. The dependent variable of the model is the price of property and a vector of attributes associated with location of property, neighborhood characteristics, and property characteristic are entered into the models as independent variables. In these studies, as mentioned above, the measurement of accessibility is a key factor in determining land values and location decisions. For this reason, proximity variables are focus variables in this study. This is a generally physical distance to transit stop or transit line (Hennebery, 1998; Gatzlaff and Smith, 1993). On the other hand, travel times from location to chosen destinations can be used for measuring the impact from rail transit investment (Bajic, 1983).

Proximity to light rail transit (LRT) stations has two different effects on the value of properties: positive or negative. Positive effects are related to improved accessibility to LRT users. In contrast to this, noise and crime factor around LRT stations may have a decreasing effect on house values. Therefore, there is a not consensus in all studies. While some studies found a significant positive impact on property values (Chen et al., 1997; So et al., 1997; Laakso, 1992), some studies were not able to find any significant positive effects (Hennebery, 1998; Forrest et al., 1996).

In addition, although studies have reached varying results, the case studies have shared certain similarities. In the existing literature, empirical studies occurs in the developed countries especially North-American Cities (Cambridge Systematic Inc, 1998), Los Angles (Cervero and Duncan, 2002), Atlanta (Cervero, 1994; Bollinger and Ihlandfeldt, 1997), Washington D.C. (Cervero, 1994), Toronto (Dewees, 1976), Hong Kong (So et al., 1997), Sheffield (Henneberry, 1998). Since the rail transit industry is determined by increasing returns to scale implying a large amount of output with constantly decreasing marginal and average costs, transit investments appear in richer developed countries due to high initial cost requirement of such investment. In the scope of Turkey, as a developing country, in Izmir and Istanbul, rail transit investments have not still been completed unfortunately. Also, monitoring and measurement of the impacts of these types of investments neceessiatate a consistent and sufficient database which is often a big problem for empirical studies in developing countries (Celik and Yankaya, 2006).

GIS is widely used to calculate distance measures such as distance to a nearest LRT stations, and distance to C.B.D. Also, in the studies, a quarter-mile buffer was drawn around each station. This distance is accepted as walking distance, but it is obvious that the effects of rail line vary with distance factor. For this reason, different distance levels can be used: one-quarter to one half mile, one-half to one-mile to two-miles etc. from 100 meters to 500 meters on the other hand or every a 100 meter interval. Positive effects are shown within 100 meter and 200 meter boundries. However, negative effects such as noise, traffic congestion may reduce property values. These effects of rail line may vary from positive to negative. In some cases, its effect may be small. Negative impacts are strongly related to noise, congestion, and visual intrusion, while positive impacts are related to improved accessibility.

III. Study Area and Data Organization:

The study area, Izmir is the third largest city in Turkey after Istanbul (10 millions) and Ankara (3.6 millions), and has a population of 3.2 million with very rapid growth. Izmir is located at the western part of Turkey. It is expected that the population growth and employment will continue in the coming years. The population in the year 2010 is forecasted to be 4 million and 47 percent of this population will commute to city centre as daily (Izmir Light Rail Transit Project: Prequalification Documents, 1992). This growth is considered to increase congestion levels in roads, so it is needed to improve existing transportation infrastructure and to prepare proposals for a new transit system for coming decades. Like Izmir, in the big cities of Turkey, new rail transit investments have been held nowadays. There is a growing interest in rail transit investments policies for local governments.

Izmir Transportation Study for Greater City of Izmir prepared in 1992, and projected a total of 50 km tract-line. It is intended to expand into all around the city: Narlıdere, Buca, Bornova, and Cigli to each other and to the city center, Konal located within CBD (Figure 1).

The construction of the first phase of the subway system was started in 1993, and completed in 2000. In the existing system, there are 10 stations. These stations as shown in figure 2 are Uçyol, Konak, Cankaya, Basmane, Hilal, Halkapınar, Stadyum, Sanayi, Bölge, and Bornova stations. The existing subway system lies from Ucyol district to Bornova district and its length is 11.7 km. The 10 stations and nearby are the focus of the study. This line connects major business, industrial, public establishments, and residential areas in the city, but residential areas concentrated around Ucyol and Bornova districts (Figure 2). In Sanayi, Halkapinar, Hilal, Stadyum stations, there are many industrial, public, and commercial establishments. The CBD includes Cankaya, Konak, and Basmane stations. Residential properties are not dominant land-use for these stations. The four of the stations on the existing line (Ucyol, Konak, Cankaya, and Basmane) are underground. Since the study aims to measure the impacts on the value of residential properties, real estate agent survey conducted with only Ucyol and Bornova districts.

Total residential population in the impact area of the line is around 422.000 people. Approximately 1,435 hectares residential area is served by the existing subway line. The gross residential density in the service area is around 300 persons/hectare. Approximately 500 hectares industrial, 257 hectares commercial (141 ha of which is the CBD), 300 hectares Aegean University Campus (located at Bornova Station), 236 hectares Public Agencies, 50 hectares of an international fair area, and a football stadium are located within the buffer zones of the subway in Izmir. The data set were obtained from only multi family apartment buildings.

A quarter of a mile ring (500 meters) as walking distance was created around all the subway stations using Geographical Information Systems. In addition, one-half mile (1 km) was drawn around each station as secondary impact zone. The data were obtained from these buffer zones. Spatial-related variables (accessibility variables): distance to nearest subway station and bus stop were measured using GIS as linear distance. The data were collected through a survey including all real-estate agencies in the area from December 2003 to March 2004 since dependable database concerning real-estate transactions in Turkey were not available, and data used in the study is cross-sectional.

Two main data sets are used in the study: real estate agents and the digitized map of Izmir City. There are a total of 360 observations for multi-family residential units in the whole area, 187 of them from Bornova District (Nothern Terminal) and 173 observations were collected from Ucyol district (Southern District). Since there is not reliable transaction prices from the tax records, asking prices by the realtors are used dependent variable in Hedonic Price Model. Also, the asking prices are converted to the U.S. dollars to make a general comparisons with previous studies. In data processing process for four months (December 2003 – March 2004), 1,350,670 Turkish liras for one US dollars as the daily average exchange rate was estimated. According to this estimation, the mean price is $ 43,122 for the Bornova Districts, $ 31,652 for the Ucyol District, and $ 37,610 for the whole area.

In order to understand characteristics of data, descriptive statistic are shown in table 1. Descriptive statistic include Ucyol district (West axis), Bornova Districts (East axis), and whole data set. For whole data set, on average properties were sold $ 37610. Distance as one of the focus variables ranges from minimum 20 meters to maximum 1610 meters. On average, properties locate within 535 meters from nearest station.. When comparing with total vehicle time by subway (tvtmetro) and total vehicle time by bus (tvtbus), tvtmetro is less than tvtbus. The distance from Ucyol to Bornova takes about 17 minutes by subway, but it takes about 47 minutes by bus in terms of in-vehicle times. Average prices in Bornova districts are higher than Ucyol. Distance to subway station in Ucyol district on average is lower than Bornova District.

IV. Modeling Methodology:

In literature, there are 12 traditional methods analyzing these impacts. According to Transit Cooperative Research Program (TCRP) Report 35 (Cambridge Systematics Inc., 1998), these analyses can be predictive and evaluative. In addition, the economic impacts are divided into three groups: generative impacts, redistributive impacts, and transfer impacts. The traditional methods are multiple regression and econometric models, regional transportation and land use models, benefit-cost analysis, input-output models, economic forecasting and simulation models, statistical and non-statistical comparisons, case comparisons, interviews/focus groups/surveys, physical condition analysis, real estate market analysis, fiscal impact analysis, and development support analysis. Hedonic price model used in this study is a part of multiple regression and econometric models (Cambridge Systematics Inc., 1998).

The hedonic price model developed by Rosen (1974) provides an important econometric analysis for urban housing markets. Within the theoretical framework of Rosen's model, "*goods are valued for their utility bearing attributes or characteristics. Hedonic prices are defined as the implicit prices of attributes and are revealed to economic agents from observed prices of differentiated products and the specific amounts of characteristics associated with them*" (Rosen, 1974; p. 34). Rosen's theory of implicit markets assumes that a diffentiated good is determined as a bundle of individual attributes, so housing unit is accepted as a heterogeneous good. It can be diffentiated into a bundle of attributes (Rosen, 1974; Can, 1992). The formulation of a Z heterogeneous good is written as $Z = (Z_1, Z_2, \ldots\ldots\ldots Z_n)$. the price of the property is formulated as a function of its attributes. $P(Z) = Z(Z_1, Z_2, \ldots\ldots, Z_n)$. In the case of housing, housing is treated as the sum of three main attributes: the physical attributes, neighborhood attributes; and locational or accessibility attributes. Its price function is formulated as below:

$$P = (S, N, L, \beta, \varepsilon)$$

Where P is a vector of housing prices; S is the vector of structural attributes; N and L are vectors of neighborhood and locational attributes; β is the vector of estimated parameters; and ε is the random error term.

By differentiating the price of property P(Z) with respect to ith attribute, it gives an implicit price in P(Z). In hedonic price model, there is a lack of theoretical basis associated with the choice of the functional form. In the literature, many functional forms have been used: **linear, semi-log (log-linear), the inverse semi-log, the double log (log-log), the exponential, the quadratic and Box-Cox transformation**. The most accurate functional form must be chosen according to reliability of regression estimation. In the present study, we prefer to use two traditional forms: linear, log-linear functional forms. In empirical studies, many authors have used these forms (Hennebery, 1998; Al Mosaind et. al., 1993).

The dependent variable of the model is asking price which are available precisely in Turkey. The attributes affecting house prices entered into the models as independent variables including structural and locational characteristics. The continues variables are the size of the apartment (**size**) in square meters, the age of the multi-family units (**age**), the number of the apartments in buildings (**resnmbr**), the number of apartments in a floor (**aptnmbr**), the number of floor located in the buildings (**floor**), the number of bedrooms (**bednmbr**), the height of the apartment building as story number (**fltnmbr**), distance from nearest subway station (**subdist**), distance from nearest bus stop (**busdist**). The subdist and busdist are locational variables, they were measured as linear distance. Total vehicle time in bus (**Tvtbus**) and total vehicle time in subway (**tvtmetro**) were measured as minutes. Total vehicle time was found by summing in vehicle time and out of vehicle time in minutes. The dummy variables are coded 1 representing the presence of the relative attributes in the apartment buildings and 0 representing absent. There are 6 dummy variables: apartment building is a corner building in the block (**corner**), presence of a garage (**op**), type of heating system: central heating or other (**heating**), presence of doorkeeper in the buildings (**dkeeper**), location: main street or street (**locate**), type of ground (**ground**). Type of ground is one of the variables presenting the quality of the apartments. Before the model calibration, we expects that locational variables are negatively correlated with price while other variables except for age, are positively correlated with price.

V. Results:

In order to analyze the effect of proximity to subway stations on house price, linear and log-linear functional forms are estimated for three zones: Ucyol station (West Axis of Izmir city), Bornova district (East Axis), and both districts (for the whole area). The model results are presented in Table 2, 3 and 4. As mentioned third chapter, distance variable presents linear distance to the nearest subway station and bus stop from house units, and for the models it is the focus variable of our study. Fistly, it should be noted that the signs of the coefficient confirm our expectations. Especially, subdist variable is a negative relationship with price as expected, also significant at the % 5 level for all the models. The literal interpretation indicates that the housing price decreases when its distance to a light rail station increases. In this case, housing prices goes up with proximity to the station. This results confirm the literature. Also, the must of the estimated parameters are significant at 95 % confidence interval.

For Ucyol district; the model results are presented in Table 2. **Size**, **resnmbr**, **aptnmbr**, **floor**, **subdist**, **busdist**, **corner**, **heating**, **locate**, and **ground** are significant in both forms. It is known that buildings deteriorate over time. Therefore, the age of the apartment buildings has a negative influence on its price, but not significant. The sign of age variable is also negative for all the districts. Presence of heating system (**heating**), location (**locate**), and type of ground (**ground**) as desirable attributes are positively correlated with price as expected for both models. The apartments in high-rise buildings and the number of floor located in apartment buildings are positively correlated with price. Also, corner location (**corner**) is significant determinant of house prices. An interesting point in the model results is that presence of parking lot (op) is negative in contrast to our expectations. One possible explanations for this result is that nuisance and air pollution are not desired for residents or house-buyers. On the other hand, the data obtained from real estate agents in Ucyol district can not represent correctly presence of parking lot in the apartment buildings. According to our observations, an empty parcel or a street is used for parking lot, so that this can be accepted as parking lot (op) variable for real estate agents.

The main finding of the study is that distance from subway station is negatively correlated with price. Since ucyol station is underground, negative externalities such as noise are not obvious. Subway system provides a higher level of accessibility for housing units located within Ucyol district.

For Bornova district, table 3 represents the results of the models. **Size**, **floor**, **subdist**, **busdist**, **heating**, and **ground** are significant at the 5 % level and their signs are expected. Like Ucyol district, in Bornova, house prices go up with house size. Increase in age of the house units will result in a decrease in price. In contrast to Ucyol, number of bedrooms (**bednmbr**) is negative. It means that increase in number of bedrooms will decrease price since increase in number of bedrooms may cause to decrease size of the apartments. Presence of parking lot (op) is positively correlated with price. Air pollution, congestion, and nuisance effects due to main arters in Bornova district may have a negative effect on price. Therefore, the apartments located around main arters is not desired for house buyers. Table 4 represents the results for the whole area. In both model, **size**, **age**, **fltnmbr**, **subdist**, **corner**, **heating**, **locate**, and **ground** are significant level statistically. The signs of the variables are as expected. Presence of heating system and doorkeeper increase house prices in general. The result of the models for whole data set confirms the hypothesis that proximity to LRT stations is a key determinant of price. Focus variable, subdist, is negative and significant for both models. It can be said that house buyers are willing to pay premium paid for the properties located within the buffer zones.

For Ucyol District, elasticity coefficient in subdist variable is – 0, 00536 in log linear model, impying that a 1 per cent increase in distance leads to a 0, 19 per cent decrease in price. According to the linear model, a 1 % increase in distance leads to a 0,18 decrease in price. For Bornova district, distance as a proxy of transportation facilities plays an important role on price. Linear model suggests that a 1 % increase in distance leads to a 0, 06 per cent decrease in price. In log-linear model, this coefficient is -0, 000104, implying that it will decrease about 0, 07 per cent. It means that a unit change will result in a 0, 07 % decrease in price. For the whole area, in linear model, a 1 % increase in subdist leads to 0, 067 decrease in price. Log-linear model suggests that a 1 per cent change in subdist leads to a 0, 066 decrease in price.

Fifteen independent variables in total entered into the models. Three variables were initially tested in the models using stepwise and backward regression. The correlation matrix of the variables provided guidance for eliminating multicollinearity problem. The goodness of fit statistics, R square lies between 0, 71 and 0, 80. White heteroscedasticity test was conducted at the α = 0, 05 level. According to this, there is no heteroscedasticity problem in the models. Some studies such as Bajic (1983) and Dewees (1976) used travel times instead of distance factor since travel time is one of key determinants of transportation costs. People may be willing to pay more for centrally located residential areas or for locating near transportation facilities in order to minimize transportation costs.

VI. Conclusion:

The overall result of this study confirms that proximity to light rail transit stations cause higher property values one more time in densely populated residential units of a developing country in a short time period after 4 years the subway was opened. In addition, positive effects of accessibility are stronger than negative effects. Distance from nearest light rail transit station and size of apartment buildings are the most influential factors in determining house prices in the impact zone. In general, the models provided high levels of explanation.

Measuring economic valuation of public investments is important for determining tax policies in decision-making process and individuals' marginal willingness to pay for environmental amenities, so that in the cities of developing countries, urban rents from many investments are provided to return into public. If we had recorded data, before and after analysis would have been made. This analysis may have provided detailed information, but this is an important issue for developing countries. Since the rail transit investments are new, measuring of long term impacts in terms of changes in employment, population, land use, and density will be important in the next. Because of this, this study may provide information for next studies.

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Table 1: Descriptive Statistics of the Variables used in the Hedonic Price Model

	N	Mean	St Dev	Min	Max
Whole Area					
Ask. Price($)	360	37610,3101	14439,0440	8096,15	69921,32
Size	360	112,3472	23,4599	65,00	186,00
Resnmbr	360	15,7167	8,5518	3,00	45,00
Aptnmbr	360	2,5194	,9900	1,00	6,00
Age	360	16,9722	7,2462	2,00	35,00
Bednmbr	360	2,7417	,5034	2,00	4,00
Fltnmbr	360	6,0833	1,5581	3,00	11,00
Floor	360	3,3083	2,0199	1,00	8,00
Subdist	360	535,2083	323,9923	20,00	1610,00
Busdist	360	208,5250	119,8660	15,00	736,00
Tvtbus	360	328,6814	1,5414	326,19	335,46
Tvtmetro	360	84,8822	4,1662	78,26	98,70
Bornova District					
Ask. Price($)	187	43121,7553	12391,4039	22080,42	69921,32
Size	187	119,1230	23,0243	70,00	180,00
Resnmbr	187	19,0909	9,1044	4,00	45,00
Aptnmbr	187	2,9251	1,0948	1,00	6,00
Age	187	13,7380	5,0397	2,00	34,00
Bednmbr	187	2,8235	,4705	2,00	4,00
Fltnmbr	187	6,4064	1,4163	3,00	10,00
Floor	187	3,3636	1,9828	1,00	8,00
Subdist	187	696,7807	323,9242	119,00	1610,00
Busdist	187	238,7968	119,2814	40,00	736,00
Tvtbus	187	296,0707	1,5338	293,51	302,46
Tvtmetro	187	80,9599	4,1653	73,53	92,70
Ucyol District					
Ask. Price($)	173	31652,8519	14155,7851	8096,15	69921,32
Size	173	105,0231	21,7162	65,00	186,00
Resnmbr	173	12,0694	6,1034	3,00	36,00
Aptnmbr	173	2,0809	,6141	1,00	4,00
Age	173	20,4682	7,6461	2,00	35,00
Bednmbr	173	2,6532	,5238	2,00	4,00
Fltnmbr	173	5,7341	1,6314	3,00	11,00
Floor	173	3,2486	2,0634	1,00	8,00
Subdist	173	360,5607	215,7952	20,00	824,00
Busdist	173	175,8035	111,9346	15,00	586,00
Tvtbus	173	328,2607	1,4394	326,19	333,54
Tvtmetro	173	82,6364	2,7749	78,26	88,60

Table 2. The Results of the Models for Ucyol Station (West Axis)

Variables	Model 1 Linear	Model 2 Log Linear
Constant (C)	-1138366612 (-0,13)	23,373 (113.89)*
Size	265909696 (5,25)*	0,00551 (4.58)*
resnmbr	-920642140 (-1,97)**	-0.022842 (-2.05)*
aptnmbr	5183281082 (1,74)**	0.128777 (1.82)**
age	-89066922 (-0,84)	-0.002527 (-1.00)
bednmbr	2837205633 (1,35)	0.116176 (2.32)*
fltnmbr	1761857491 (1,52)	0.034534 (1.25)
floor	869982844 (2,15)*	0.021602 (2.24)*
subdist	-22,512,590 (-5,88)*	-0.000536 (-5.89)*
busdist	-15,176,833 (-2,15)*	-0.000510 (-3.04)*
corner	2496767483 (1,67)**	0.075842 (2.14)*
op	-3216884169 (-1,18)	-0.059221 (-0.91)
heating	4010957636 (2,05)*	0.098985 (2.13)*
dkeeper	6651710552 (2,19)*	0.096931 (1.34)
locate	5114111690 (2,51)*	0.120127 (2.48)*
ground	8682101711 (5,07)*	0.202925 (4.99)*
R^2	0,80	0,79
Adj R^2	0,781	0,77
N	173	173
White Test	0,247	0,937

* Significant at 5 % level   ** Significant at 10 % level.

Table 3. The Results of the Models for Bornova Districts (East Axis)

Variables	Model 1 Linear	Model 2 Log Linear
C	2.34E+10 (2,25)*	24.05717 (139,07)*
size	3.96E+08 (7,78)*	0.006911 (8,13)*
resnmbr	1.93E+08 (0,40)	0.004165 (0,529)
aptnmbr	-2.84E+09 (-0,89)	-0.047834 (-0,89)
age	-1.33E+08 (-0,88)	-0.001012 (-0,40)
bednmbr	-1.74E+09 (-0,84)	-0.011678 (-0,33)
fltnmbr	5.00E+08 (0,40)	0.006850 (0,328)
floor	-1.17E+09 (-3,23)*	-0.019630 (-3,25)*
subdist	-5,011,073 (-2,23)*	-0.000104 (-2,76)*
busdist	-17,950,810 (-2,74)*	-0.000247 (-2,25)*
corner	3.80E+09 (2,28)*	0.051759 (1,86)**
op	1.00E+09 (0,622)	0.003728 (0,13)
heating	6.29E+09 (3,89)*	0.104068 (3,85)*
dkeeper	-2.83E+09 (-1,51)	-0.036310 (-1,16)
locate	-1.14E+09 (-0,74)	-0.023804 (-0,93)
ground	7.17E+09 (4,22)*	0.142555 (5,03)*
R^2	0,75	0,77
Adj R^2	0,72	0,74
N	187	187
White Test	0,155	0,161

* Significant at 5 % level   ** Significant at 10 % level.

Table 4. The Results of the Models for the Whole Area (West and East Axis)

Variables	Model 1 Linear	Model 2 Log Linear
C	-7.87E+09 (-1,05)	23.27336 (142,37)*
size	3.74E+08 (9,47)*	0.006887 (7,95)*
resnmbr	-4.03E+08 (-1,08)	-0.009202 (-1,12)
aptnmbr	2.53E+09 (1,02)	0.072546 (1,33)
age	-2.54E+08 (-2,80)*	-0.006215 (-3,11)*
bednmbr	-1.21E+08 (-0,07)	0.049634 (1,38)
fltnmbr	2.42E+09 (2,53)*	0.047748 (2,277)*
floor	-3.79E+08 (-1,25)	-0.003493 (-0,52)
subdist	-6,462,674 (-3,15)*	-0.000124 (-2,76)*
busdist	-737,642.9 (-0,14)	-9.12E-06 (-0,07)
corner	4.23E+09 (3,35)*	0.094660 (3,42)*
op	1.62E+08 (0,10)	-0.008673 (-0,25)
heating	5.24E+09 (3,67)*	0.086074 (2,75)*
dkeeper	1.59E+09 (0,88)	0.040275 (1,02)
locate	4.70E+09 (3,57)*	0.117306 (4,06)*
ground	9.25E+09 (6,80)*	0.196631 (6,59)*
R^2	0,73	0,71
Adj R^2	0,72	0,70
N	360	360
White Test	0,054	0,317

* Significant at 5 % level ** Significant at 10 % level.

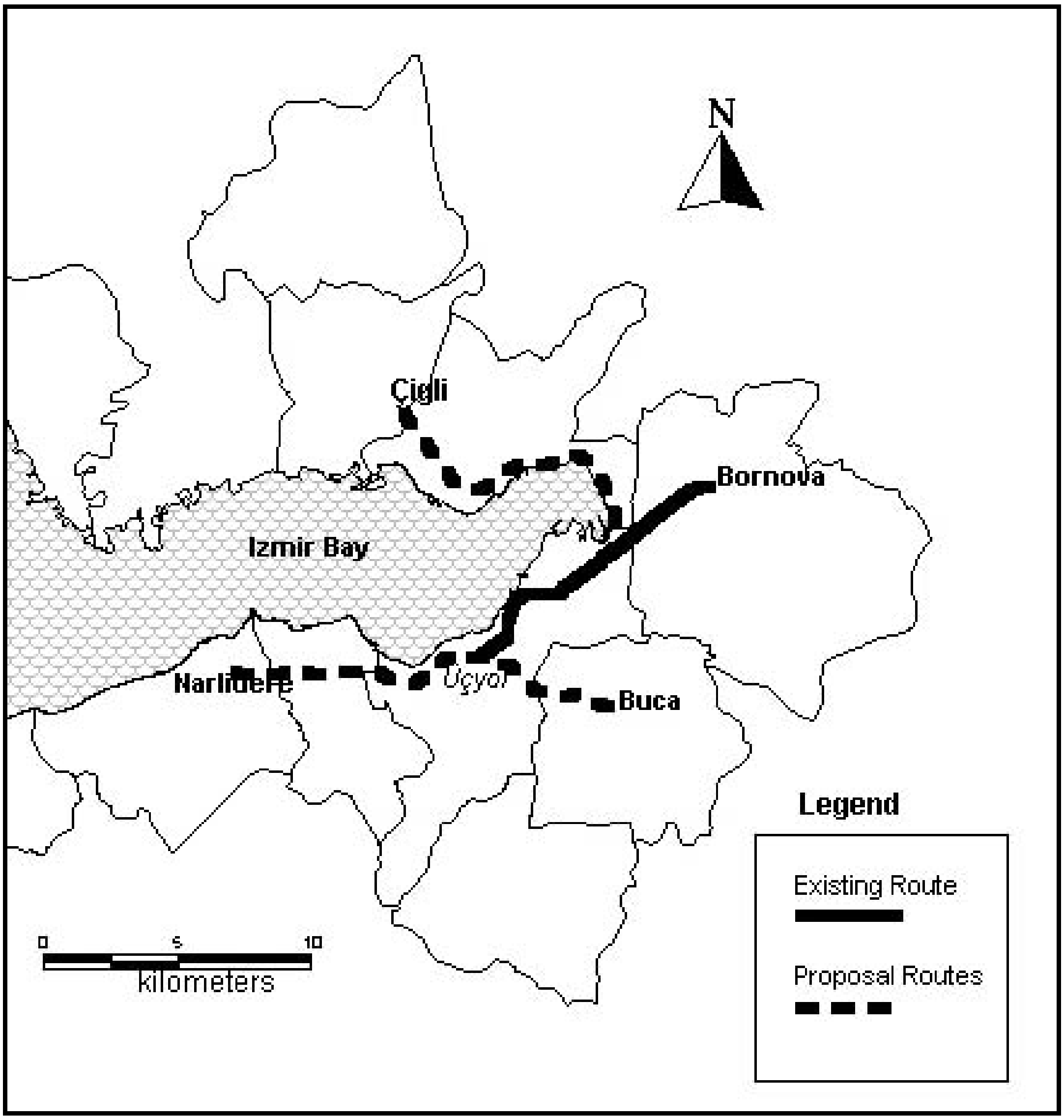

Figure 1. Existing and Proposed Lines for the Izmir Subway

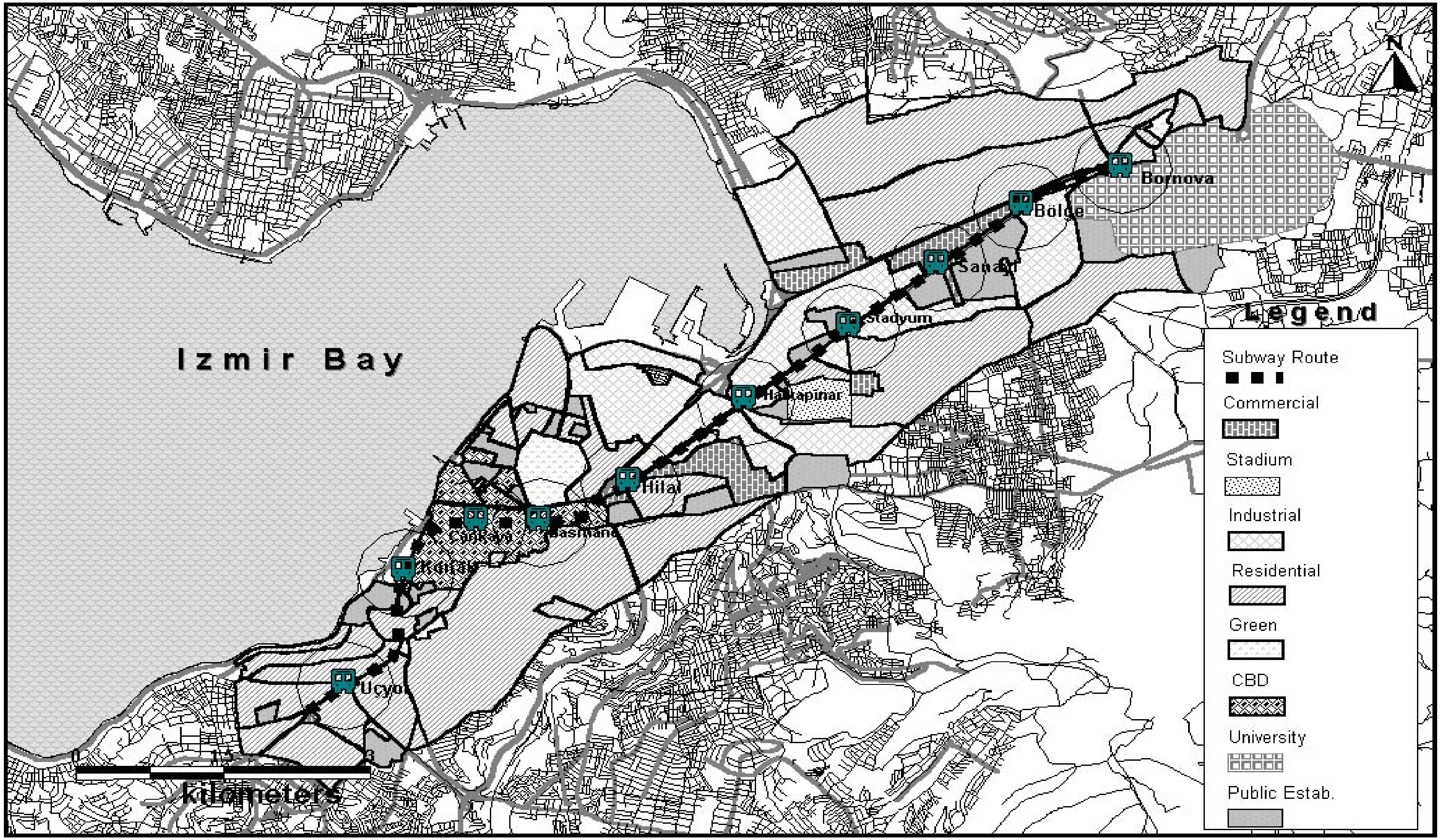

Figure 2. Land Use around Existing Subway Line