HOUSE PRICE DYNAMICS IN IZMIR'S NEIGHBORHOODS: A COMPREHENSIVE APPROACH

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İZMİR

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ABSTRACT

HOUSE PRICE DYNAMICS IN IZMIR'S NEIGHBORHOODS: A COMPREHENSIVE APPROACH

The determinants of housing prices have a large place in empirical studies in the literature on housing markets. In the hedonic price modeling studies, structural and location-specific characteristics are considered as determinants under a cross-sectional study framework. Under another category, an approach is applied in which the effects of macroeconomic variables on housing prices are examined.

The aim of this study is to examine the housing prices with a dynamic panel data set in Izmir through macroeconomic, neighborhood-specific and housing structural variables, to expand the scope of the related literature and to determine the effect level of these variables. Since spatial autocorrelation has been determined, the study has been extended within the scope of spatial models.

The study area consists of 212 neighborhoods located in different districts of Izmir. The average housing sales data of these neighborhoods for 30 months in the 05.2017-10.2019 period were examined with 4 macroeconomic, 11 neighborhood-specific, and 9 housing structural characteristic variables, with descriptive analyses, panel linear regression, spatial autocorrelation tests, spatial panel regression, and geographically weighted regression (GWR).

The results of the variables in the macroeconomic and the housing structural characteristics categories are consistent with the expectations formed as a result of the empirical literature review. The results of the neighborhood-specific variables raise new research questions. As a result of the spatial methods, a high level of spatial dependence and positive spatial spillover effects were determined. This study proves the validity of the use of spatial models in housing price research in Izmir.

Keywords: *Housing Market, Housing Price Determinants, Spatial Panel Regression, Moran's I Statistics.*

ÖZET

İZMİR MAHALLELERİNİN KONUT FİYAT DİNAMİKLERİ: KAPSAMLI BİR YAKLAŞIM

Konut piyasalarına ilişkin literatürde, konut fiyatlarının belirleyicileri ampirik çalışmalar içerisinde geniş bir yer tutmaktadır. Konut fiyatlarının belirleyicilerine dair yapılan araştırmalar iki ana başlık altında incelenebilmektedir. Hedonik fiyat modellemeleri çalışmalarına belirleyiciler olarak dahil edilen yapısal ve lokasyona özgü özellikler bulunmaktadır. Bu başlık altındaki araştırmalar genellikle yatay-kesit çalışma çerçevesi altında yürütülür. İkinci başlık altında ise makroekonomik değişkenlerin konut fiyatlarına etkisinin incelendiği bir yaklaşım uygulanmaktadır.

Bu çalışmada, mahalle bazında, İzmir ilinde ortalama konut satış fiyatlarının belirleyicileri mekânsal olmayan ve mekânsal olan yöntemler ile dinamik bir panel veri seti kullanılarak araştırılmıştır. Çalışmanın amacı, İzmir'de konut fiyatlarını makroekonomik, mahalleye özgü ve konut yapısal değişkenleri aracılığı ile irdeleyip literatürdeki kapsamı genişletmek ve bu değişkenlerin etki düzeyini tespit etmektir. Konut fiyatlarında ve konut fiyatlarının yıllık yüzde değişimlerinde mekânsal otokorelasyon tespit edildiği için çalışma mekânsal modeller kapsamında genişletilmiştir.

Çalışma alanı İzmir'in farklı ilçelerinde bulunan 212 mahalledir. 05.2017-10.2019 periyodunda 30 ay boyunca bu mahallelerin ortalama konut satış verileri 4 makroekonomik değişken, 11 mahalleye özgü değişken ve 9 konut yapısal karakteristiği değişkeni ile betimleyici analizler, panel lineer regresyon, mekânsal otokorelasyon testleri, mekânsal panel regresyon ve coğrafi ağırlıklı regresyon ile incelenmiştir.

Makroekonomik ve konut yapısal özellikleri kategorilerindeki değişkenlerin sonuçları ampirik literatür taraması sonucu oluşan beklentiler ile uyumlu iken mahalleye özgü değişkenlerin sonuçları yeni araştırma sorularını ortaya çıkarmaktadır. Mekânsal yöntemler sonucunda ise yüksek seviyede bir mekânsal bağımlılık ile olumlu mekânsal yayılma etkileri tespit edilmiştir. Çalışma, İzmir'de konut fiyatı araştırmalarında mekânsal modellerin kullanımının geçerliliğini kanıtlamaktadır.

Anahtar Kelimeler: *Konut Piyasası, Konut Fiyatı Belirleyicileri, Mekânsal Panel Regresyon, Moran's I İstatistiği.*

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CHAPTER 1

INTRODUCTION

The housing sector, which is one of the sectors that are the main drivers of the Turkish economy, is a part of the construction sector by addressing many sub-sectors. The housing sector is the subject of three main sectors (agriculture, industry, service) and is an output of all production factors (Özkurt, 2007; Akpolat, 2020). Housing has features that make it different from other outputs. First, the housing stock is heterogeneous, and they differ in their features and location. Secondly, the housing is durable and may change over time depending on the consumer's decisions. Third, since relocating is costly, consumers do not immediately adapt their housing consumption when their income or housing preferences change. Instead, they wait until the difference between their ideal housing and their current housing is significant enough to justify the high cost of relocation (O'Sullivan, 2011). There are two main features that distinguish the housing market from other real estate markets. Residential markets are highly heterogeneous, split by location, and stratified by different categories of consumers. Second, demographics and ability to afford, as well as customer and supplier expectations, all play a role (Mourouzi-Sivitanidou and Sivitanides, 2020).

Discussions on the determinants of housing prices occupy a wide area in the literature on housing markets. The way these determinants are examined can be divided into two categories. The first category is the studies carried out within the framework of the cross-sectional research, which examines the structural characteristics of the houses and the location characteristics as variables. The second category is the studies that examine the effects of macroeconomic variables on housing prices. In the category of macroeconomic variables, exchange rate, industrial production index, consumer price index, producer price index etc. are used to identify the effects.. In the category of variables related to housing structural characteristics, housing size, number of rooms, building age, etc. are used mostly. Variables regarding location characteristics may vary according to the spatial unit studied. The spatial unit can be a country, a city, a district, a neighborhood or even a street. Socio-economic characteristics of this unit, accessibility to various urban facilities, etc. variables can be examined in this category. To our

knowledge, there is no empirical study examining the effects of these three different categories of independent variables on housing prices together.

Here from, the aim of this study is to expand the scope of the literature by examining the independent variables in three categories in combination. The investigation was conducted using a panel data set. According to Baltagi (2021), the following are some of the benefits of using panel data: controlling for individual heterogeneity, more informative data, more variability, and less collinearity among the variables (Baltagi, 2021). Since this study will employ both a-spatial and spatial methods to analyze the effect of three independent variable categories on housing prices using a panel data set, it will extend the scope of the literature and will be the most comprehensive housing price research to be conducted.

The research questions of this study are as follows:

1. What are the main determinants of housing prices in Izmir's neighborhoods?
2. What is the sign of effect and level of effect of these determinants in the neighborhoods?
3. Is there a spatial dependence in the determinants of housing sales prices in the neighborhoods of Izmir?
4. Is there a spatial spillover in housing sales prices in the neighborhoods of Izmir?
5. What are the local effects of these determinants in the neighborhoods?

The study area is 212 neighborhoods in the province of Izmir. These neighborhoods are located in different districts with industrial, agricultural, or tourism characteristics and they were chosen based on data availability of average housing sale prices. The time dimension of the panel data set consists of 30 months covering the period between May 2017 and October 2019. While the average house sales price represents the dependent variable, a total of 24 variables from 3 different categories represent the independent variables. The average housing sales prices of the neighborhoods were obtained from the real estate websites (Endeksa and Sahibinden) monthly. Dollar exchange rate, consumer price index, producer price index, industrial production index, and housing loan interest rates, which are in the macroeconomic variables category, were obtained monthly from the electronic data delivery system of the Central Bank of the Republic of Turkey. The variables of total population, children population rate, active population rate, elderly population rate, higher education rate, and existence of commercial function used to describe the socio-economic characteristics of the

neighborhood, which is the spatial unit of the study, were obtained monthly from the Turkish Statistical Institute. The variables of accessibility to preschools, accessibility to primary schools, accessibility to mid schools, accessibility to high schools, and accessibility to health care center, which are in the same category and illustrate the accessibility levels of the neighborhood to various social facilities, were produced by the author. The distance to the central business district, which is the last variable in this category, indicates the distance of the neighborhoods to the Adalet Neighborhood (in Bayraklı), which is called the new city center of Izmir and this variable constant in time. Variables of size, number of rooms, age of the building, number of floors, balcony, number of bathrooms, site, natural gas, and geothermal, which are in the category of housing structural characteristics, were obtained from real estate websites and these variables are constant in time.

The part that makes up the empirical analyzes of the study can be divided into two categories: a-spatial analysis and spatial analysis. First, the dependent variable was introduced in the study area by making descriptive analyzes using ArcGIS software of the first month, last month of the period, and annual percentage changes in housing prices. The data set was prepared for analysis with the correlation matrix using R software and the panel unit root test using EViews software before using the panel data set. In the next step, the panel linear regression using R software was used and the effect signs and effect levels of the independent variables on the housing sales prices were determined (see Croissant and Millo, 2008). For the spatial research, a 212x212 dimensional inverse distance-based spatial weight matrix was created and the Global Moran's I Test was used to investigate the presence of spatial autocorrelation using R software (see Bivand and Wong, 2018). Anselin Local Moran's I test using GeoDa software was used to examine the characteristics of the spatial autocorrelation determined as a result of the test in the study area. As a result of the test, spatial clusters and spatial outliers were observed in the study area. The Global Moran's I test does not reveal the origin of the spatial specification. For this purpose, the existence of spatial autocorrelation in the spatial panel set was investigated by applying the LM test using R software to 4 different specifications. The Spatial Error Model (SEM) and the Spatial Lag Model (SAR) results from R software were presented comparatively (see Millo and Piras, 2012). The empirical analysis was completed by interpreting the effects of the variables at the local through GWR using ArcGIS software.

The rest of the thesis is organized as follows: In Chapter 2, the theoretical framework is explained; in Chapter 3, empirical literature based on housing price determinants is surveyed; in Chapter 4, study area and panel data set are presented; in Chapter 5, methodology and empirical results are presented and in Chapter 6, the thesis is concluded.

CHAPTER 2

THEORETICAL FRAMEWORK

The housing market, which is unique in many respects, complies with the basic principles of supply and demand as well as this uniqueness. To understand how the housing market is shaped, it is necessary to examine the supply and demand framework. Due to this necessity, this section will provide the basic principles of supply and demand and its relationship with the housing market.

2.1. Housing Demand

In the traditional economic approach, the definition of demand differs between various concepts. These concepts can be listed as effective, ex-ante, ex-post, pent-up. The concept of effective market demand is related to purchasing power. Ex-ante (or desired) represents the state of the investor or user before interacting with the market. Ex-post (or realized) points out the state of the investor or user after interacting with the market, which may be different from ex-ante. Lastly pent-up displays demand that has not yet been realized (Mourouzi-Sivitanidou and Sivitanides, 2020, p.20).

Demand in the housing market can be defined as the number of units desired to be owned by the investor or user at different price levels. It would be more accurate to think of the demand as a schedule rather than a single quantity (Mourouzi-Sivitanidou and Sivitanides, 2020, p.20). The reason for this is demand is affected by price changes. This effect is in the opposite direction, when the price increases, the demand decreases and is called the fundamental law of demand (Figure 1).

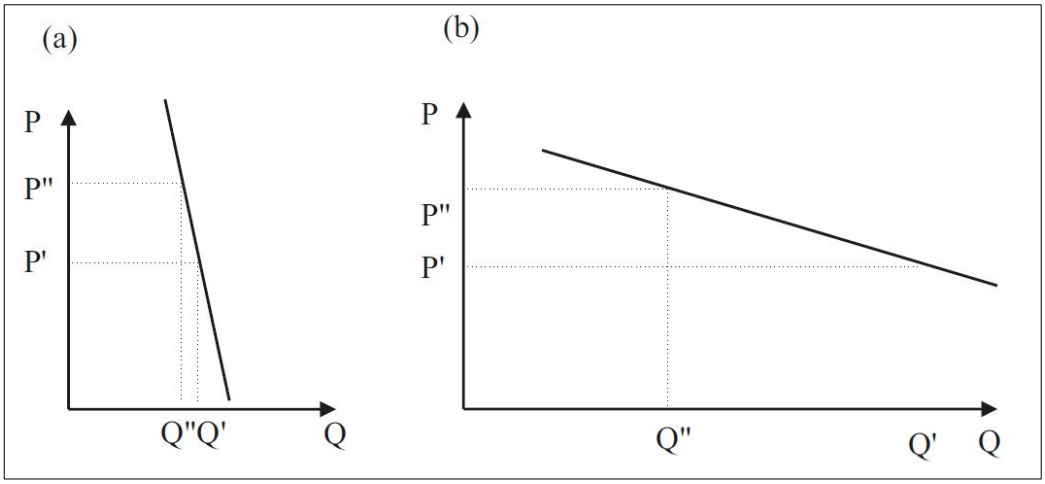

Figure 1. Fundamental Law of Demand
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.21)

Price elasticity of demand, which is an important property of the demand curve and mathematically denoted in the form of εD, represents the sensitivity of demand to price changes. It is measured by dividing the amount of demand by the percentage change in price, thus revealing how much a 1% increase in price creates a change in demand. The price elasticity of demand is interpreted in three ways. If the price elasticity is less than 1, the demand curve is considered inelastic. When the curve is inelastic, demand is insensitive to price changes, or a large increase in price produces a small decrease in demand. If the price elasticity is equal to 1, the demand curve is considered unit elastic. When the curve is unit elastic, the percentage increase in price is equal to the percentage decrease in demand. If price elasticity is greater than 1, it is considered to be elastic. When the curve is elastic, a small increase in price produces a large decrease in demand (DiPasquale and Wheaton, 1995, p.218; Mourouzi-Sivitanidou and Sivitanides, 2020, p.21).

It has been observed that the fundamental law of demand does not apply, i.e., when property prices rise, so does demand. Rises in demand are caused in this scenario not by actual price rises, but by expectation of future price increases. As a result, the effect of increasing price expectations represents a shift in (rather than a movement along) the demand curve (Figure 2). Expected price changes are exogenous demand determinants in this way (Mourouzi-Sivitanidou and Sivitanides, 2020, p.23).

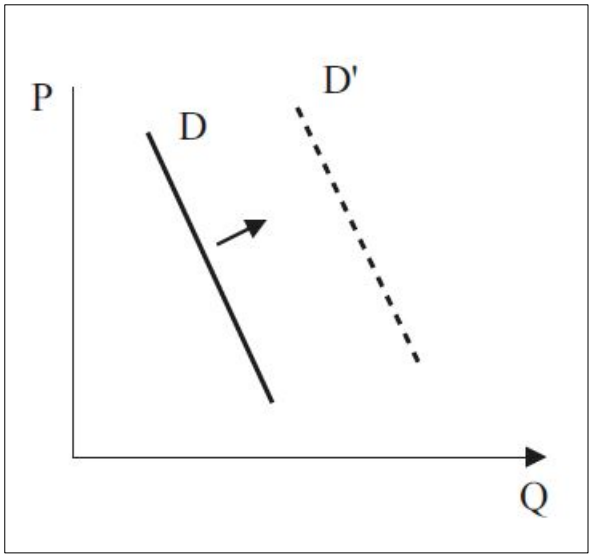

Figure 2. Demand Shift
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.23)

The following categories can be used to classify the exogenous drivers of real estate demand in the investor or user market: market size (population, employment), income or wealth, prices of substitutes, expectations, interest rates, and availability of credit (Mourouzi-Sivitanidou and Sivitanides, 2020, p.23).

2.2. Housing Supply

The quantity of housing units available at varying costs is referred to as housing supply. The supply curve is shown as an upward sloping curve, illustrating the fundamental law of supply, which asserts that more quantities are delivered at greater prices. Long-run aggregate supply, short-run aggregate supply, and new construction are three broad supply ideas that should be distinguished in housing supply (Mourouzi-Sivitanidou and Sivitanides, 2020, p.26).

The relationship between long-run prices and total number of units supplied over time is represented by the long-run aggregate supply. A long-term supply curve shows that the supply of real estate is not limited by topographical, financial, or time restrictions in the long run (Figure 3) (Mourouzi-Sivitanidou and Sivitanides, 2020, p.26).

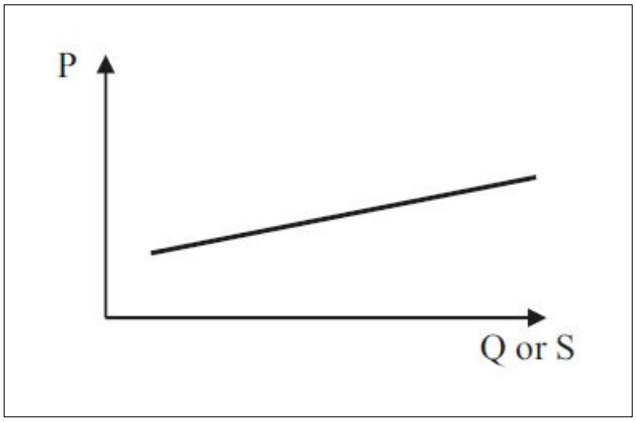

Figure 3. The Long-Run Aggregate Supply
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.27)

The total stock of a market at a given point in time is referred to as short-run aggregate supply. The short-term aggregate supply curve is shown by a vertical line since the real estate stock is fixed in the short run. The lengthy process of making a building available for purchase ensures that the housing stock remains in fixity in the immediate term. This concept is critical for understanding short-term housing market adjustments in response to demand shocks (Figure 4) (Mourouzi-Sivitanidou and Sivitanides, 2020, p.27).

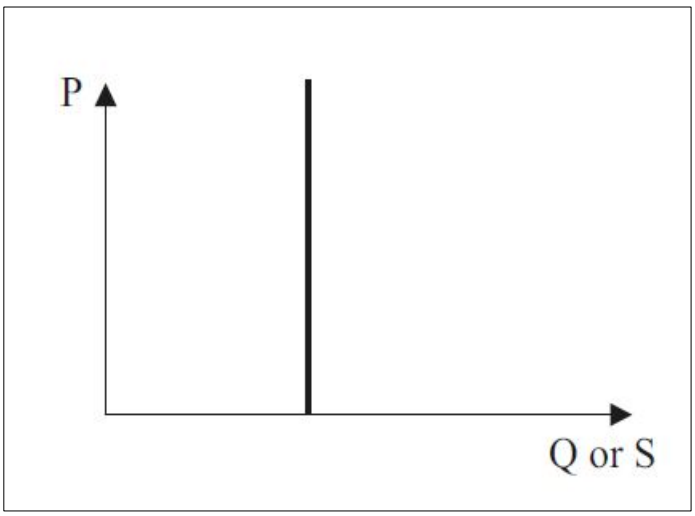

Figure 4. The Short-Run Aggregate Supply
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.27)

New construction is by far the most relevant supply concept, due to the lengthy life of housing assets. The concept of new construction is referred to as completions, which refers to the total square footage of all new structures that received a certificate of occupancy or passed their final inspection during the analysis period. The fundamental

law of supply governs new construction. If all other factors are equal, the higher the property values, the newer space is available on the market. This means that the concept is triggered by high prices. The new construction schedule is featured by a minimum price level, *Pmin*, which is the minimum price threshold required to cover costs and earn a conceivable profit. The high prices that trigger the concept are above this minimum value (Figure 5) (Mourouzi-Sivitanidou and Sivitanides, 2020, p.28).

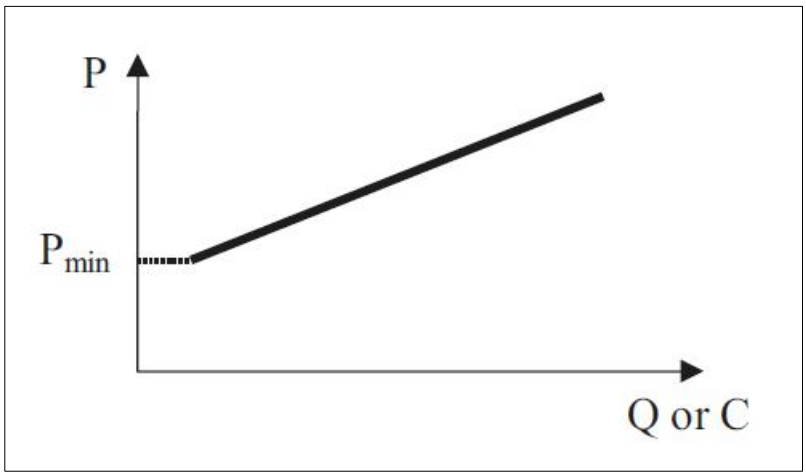

Figure 5. New Construction
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.29)

Profit is the primary motivator for new construction. The types of housing assets with the highest profitability are built by developers. Several factors influence a project's profitability: availability and cost of production, expectations, and perceived market risk. Increases in any of these factors result in less space at the same price level, causing construction schedule adjustments. The status of the new construction schedule is determined by these exogenous factors (Figure 6) (DiPasquale and Wheaton, 1995, p.235; Mourouzi-Sivitanidou and Sivitanides, 2020, p.28).

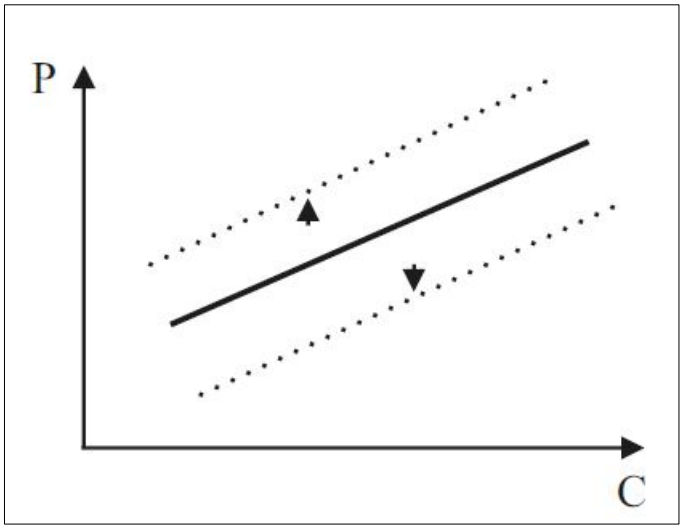

Figure 6. Effects of Exogenous Shifters on New Construction
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.33)

2.3. Price Determination Mechanism

Housing prices are based on the relationship between supply and demand. The intersection point (*P**) in this relationship represents the number of buyers equal to the number of sellers (*QD*=*QS*) (Figure 7).

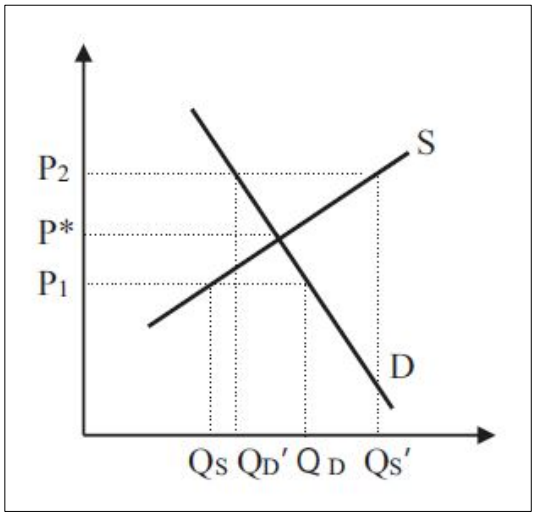

Figure 7. Price Determination Mechanism
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.34)

This price level should prevail as the equilibrium market price. Because if the market price is at the *P1* level, that is, lower than the value of *P**, *QD*, which represents housing demand, will be greater than *QS*, which represents housing supply. While this

circumstance will drive some buyers to leave the market, it will allow sellers to enter the market with highly motivated housing prices, or vice versa (Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.34).

In the short run, the demand shift caused by rising home prices will be distinct from the long-term effect. In instance, short-term housing price rises will be higher than long-term rises. Because of the time it will take to develop new housing, the present housing stock is fixed in the short run, as represented by the vertical line. In the long run, however, developers will have enough time to develop new housing units in response to the increased demand and early price increases. Thus, the housing stock will climb to the level determined by the intersection of the demand curve, *D′*, and the long-term housing supply curve, *S*, in the long run (Figure 8) (Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.35).

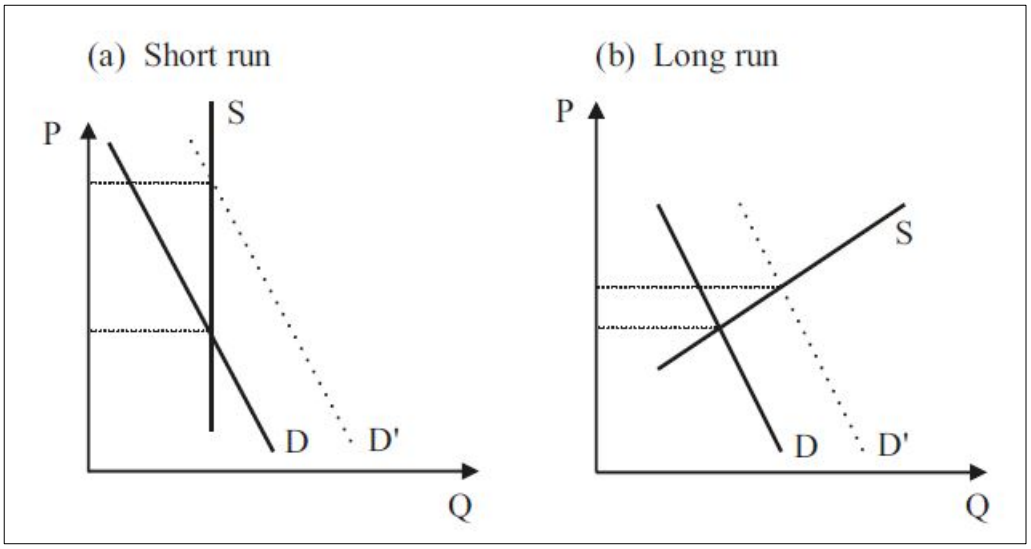

Figure 8. Short-Run versus Long-Run Price Changes
(Source: Mourouzi-Sivitanidou and Sivitanides, 2020, p.35)

CHAPTER 3

LITERATURE REVIEW BASED ON HOUSING PRICES DETERMINANTS

The determinants of house prices hold a large place in empirical studies in the literature on housing economics. In this topic, there are two main research streams. On the one hand, in hedonic pricing modeling research, structural and locational aspects of properties are incorporated as determinants. This type of study is usually conducted in a cross-sectional manner. A macroeconomic approach to house prices, on the other hand, is used to examine the effects of aggregate variables (such as interest rates, inflation, etc.) on house prices. In this section, empirical studies conducted in this context in Turkey and abroad will be reviewed and an evaluation will be made regarding this literature review.

In Turkey, studies on the determinants of housing prices became more prevalent in the literature after the 2000s. The scope of work has expanded since the Central Bank of the Republic of Turkey published monthly data on the housing sector in 2010, and data collecting has become easier and faster because to the widespread usage of real estate websites.

According to the Turkish literature, knowledge on the determinants of macroeconomic variables on housing prices include a broad variety of topics. Effects of macroeconomic variables on housing prices has been investigated numerous times, using various approaches and timeframes (see Sarı et al., 2007; Badurlar Öner, 2008; Hepşen and Baş, 2009; Gök and Keçeli, 2015; Dilber and Sertkaya, 2016; Afşar, 2018; Kolcu and Yamak, 2018; Bayır et al., 2019; Canbay and Mercan, 2020; Sağlam and Abdioğlu, 2020; Tunç, 2020; Varlık, 2020; Çetin, 2021). The variables considered in the related studies, as well as the conclusions of their impacts on housing prices, are summarized in Table 1.

Table 1. The Effects of Macroeconomic Variables in the Turkish Studies

Variables	**Impacts**
Housing loan interest rate	+/-
Production	+
Money supply	+/-
Employment	+
Exchange rate	+
GDP	+
Industrial Production Index	+/-
Loan volume	+
Gross Value Added	+
Inflation	+/-
Income	+/-
Economic growth	+/-
Consumer Price Index	+/-
Construction Price Index	+

In the examined literature, the effect of housing structural characteristics on the housing prices covers a wider area compared to the international literature. In addition, there are more variables in the category mentioned in the national literature. While the research investigated in abroad is generally limited to the house's structural characteristics, the literature examined in national includes the house's facilities as variables in addition to these characteristics (see Üçdoğruk, 2001; Yankaya and Çelik, 2005; Keskin, 2008; Mutluer, 2008; Abayhan, 2009; Özsoy and Şahin, 2009; Selim, 2009; Çetintahra and Çubukçu, 2011; Çağlayan and Arıkan, 2011; Koramaz and Dökmeci, 2012; Kördiş et al., 2014; Yayar and Gül, 2014; Yayar and Karaca, 2014; Bulut et al., 2015; Işık, 2015; Çalmaşur, 2016; Afşar et al., 2017; Ellibeş and Görmüş, 2018; Akçay, 2019; Çalmaşur and Aysin, 2019; Çelik and Turgut, 2019; Güler et al., 2019; Güzel et al., 2020; Moralı and Yılmaz, 2020; Uyar and Keten, 2020; Özsoy and Şahin, 2021).

Table 2. The Effects of Structural Characteristics in International & National Literature

INTERNATIONAL		NATIONAL	
Variables	Impacts	Variables	Impacts
Number of rooms	+/-	Size	+
Size	+	Number of rooms	+
Age of building	-	Age of building	+/-
Number of floors	-	Number of bathrooms	+
Repaired situation	+	Central heating	+/-
		Geothermal	+
		Air conditioning	+
		Cable TV	+
		Number of floors	+/-
		Floor number of flat	+
		Security	+
		Swimming pool	+
		Being in a site	+
		Garage	+
		Carpark	+
		Elevator	+
		Garden	+
		Balcony	+

In the literature reviewed, it is possible to examine the category of location-specific variables in addition to these two variable categories. At this point, the "location" may differ according to the study area of the research. This location can be a country, a region, a city, a district, a neighborhood, or even a street. These variables represent the characteristics of the location and the facilities that the location offers to the residents. Studies on the basis of city or district (Üçdoğruk, 2001; Yankaya and Çelik, 2005; Abayhan, 2009; Çetintahra and Çubukçu, 2011; Koramaz and Dökmeci, 2012; Kördiş et al., 2014; Yayar and Gül, 2014; Bulut et al. , 2015; Işık, 2015; Uyar and Yayla, 2016; Çelik and Turgut, 2019; Güler et al., 2019; Güzel et al., 2020; Moralı and Yılmaz, 2020;

Uyar and Keten, 2020; Özsoy and Şahin, 2021) are more numerous than the studies conducted on the basis of neighborhoods (Keskin, 2008; Akçay, 2019). In the examined national literature, these variables can be classified as distance to public transportation, distance to educational institutions (public or private), distance to center, distance to sea, distance to shopping centers, and environmental quality of the location. Although these variables are also found in the international literature examined, the variables related to various facilities were examined with the "accessibility" criterion, not the "distance" criterion. By determining the number or density of amenities within a certain walking distance, variables based on accessibility criteria were included in empirical studies (Wu et al., 2016; Xiao et al., 2017; Hu et al., 2019; Li et al., 2019). In addition to these variables, the popularity of various recreational areas was included in the research of housing price determinants by using data obtained from social media channels through "web scraping", "data mining" and "machine learning" methods, which are increasingly used in international literature (Li et al., 2019).

Table 3. The Effects of Location-Specific Variables in International & National Literature (Cont. to Page 16)

INTERNATIONAL		NATIONAL	
Variables	Impacts	Variables	Impacts
Population density	-	Distance to metro stations	-
Accessibility to metro stations	+	Distance to bus stations	-
Accessibility to bus stations	+	Distance to center	-
Accessibility to bike-sharing stations	+	Distance to sea	-
Distance to park	-	Distance to shopping mall	-
Distance to university	-	Distance bazaar	+
Distance to sea	+/-	Proximity to public places	+
Number of educational institutions	+.	Earthquake risk	-
Number of hospitals	+	View	+
Number of banks	+	Environment	+
Job opportunities	+	Income level of neighborhood	+
Commercial activities	+		

Popularity of entertainment places	+		
Sky view	+		
Green area view	+		
Air quality reducing factors	-		
Noise	-		

In the related literature, the variables affecting the housing price are only considered as macroeconomic, only structural, only location features, or binary combinations. In addition to the variables that are the subject of the studies, the presence of 'space' emphasis in these studies is another subject examined. According to our knowledge, in the national literature, the emphasis on space on housing studies was first made in 2012 by Koramaz and Dökmeci. In subsequent studies, the relationship between housing prices and its determinants with space was examined through the spatial models, the spatial quantile regression, and the geographically weighted regression (see Uyar and Yayla, 2016; Çelik and Turgut, 2019; Moralı and Yılmaz, 2020; Uyar and Keten, 2020). In the literature international, it is seen that the relationship with the space has begun to be examined earlier compared to Turkey, and it has a more intense place in the related literature compared to Turkey.

In the empirical literature, which determines Izmir as the study area, only structural or structural and location-specific variables have been examined together. Panel data were not used in studies conducted in only one district or neighborhoods determined according to the availability of data (Üçdoğruk, 2001; Yankaya and Çelik, 2005; Abayhan, 2009; Çetintahra and Çubukçu, 2011; Akçay, 2019; Özsoy and Şahin, 2021).

Table 4 summarizes the empirical studies examined international while Table 5 summarizes the empirical studies examined in national.

Table 4. Empirical Studies in International (Cont. to Page 22)

Authors and Year	Study Area	Aim	Time Period	Data Frequency	Method	Findings
Apergis and Rezitis, 2003	Greece	Examining the dynamic effects of macroeconomic variables on the housing prices	1981-1999	Quarterly	•Error Correction Vector Autoregressive Model	•Interest rate: **POSITIVE** •Consumer price index: **POSITIVE** •Employment rate: **POSITIVE** •Money supply: **POSITIVE**
Yiu and Wong, 2005	Hong Kong	Examining the effects of a new tunnel before its completion on housing prices	May 1991-March 2001	Special classification (based on construction period of the project)	•Index Construction Analysis •Price Gradient Analysis	•**POSITIVE**
Holly et al., 2010	USA	Examining macroeconomic variables that affect housing prices	1975-2003	Annual	•OLS •Spatial Autoregressive (SAR) Error Model	•Net borrowing cost: **NEGATIVE** •Population growth: **POSITIVE**
Mallick and Mahalik, 2012	China	Examining the dynamic effects of macroeconomic variables on the housing prices	1999:Q2-2009:Q3	Quarterly	•Vector Autoregressive Model	•Income: **NEGATIVE** •Volume of loans: **NEGATIVE** •Interest rate: **POSITIVE**

Table 4. (Cont.)

Mallick and Mahalik, 2015	15 Cities of China	Examining the determinants of the housing market price behavior	2010:Q1-2013:Q4	Quarterly	•Panel Regression Model	•FDI: **POSITIVE** •Non-food bank credit: **POSITIVE** •Share Price Index: **POSITIVE** •Speculation: **POSITIVE**
Wu et al., 2016	Shenzhen city of China	Examining the factors affecting house prices from a big data perspective	July 2014-June 2015	Survey data from real estate agents' web sites and social media	•OLS •Geographically Weighted Regression	•Cluster of commercial-business functions: **POSITIVE** •Cluster of greean areas: **POSITIVE** •Proximity to CBD: **POSITIVE**
Yao and Fotheringham ,2016	Fife region of Scotland	Analyzing spatial-temporal variations of the relationships between house prices and their determinants.	2003–2012	Annual	•OLS •Geographically Weighted Regression	•Population density: **NEGATIVE** •Number of rooms: **POSITIVE** •Household ownership: **POSITIVE** •Distance to university: **NEGATIVE** •Distance to coast: **POSITIVE**

Table 4. (Cont.)

Chen and Wang, 2017	USA and China	Examining the macroeconomic fundamentals of the two countries ' housing market in a comparative way	2000:Q1-2014:Q4	Quarterly	•FAVAR (Factor analysis with VAR)	Dynamics of house prices across cities driven by; •In China: **LOCAL** •In USA: **NATIONAL**
Xiao et al., 2017	Beijing city of China	Using open access datasets to analyze determinants of house prices	2015:Q3-2015:Q4	Survey data from real estate agents' web sites and social media	•OLS •Eigenvector Spatial Filtering	•Size: **POSITIVE** •Number of rooms: **POSITIVE** •Age of building: **NEGATIVE** •Accessibility to bus stops: **NEGATIVE** •Accessibility to supermarkets: **NEGATIVE** •Smog pollution: **NEGATIVE**
Nistor and Reianu, 2018	Ontario city of Canada	Investigating the magnitude of the impact of immigrants on house prices	2001-2011	Annual	•Panel Data Regression Model	•Immigrant group population: **POSITIVE** •Income: **POSITIVE** •Unemployment rate: **NEGATIVE** •Interest rate: **NEGATIVE**

Table 4. (Cont.)

Fotheringham and Park, 2018	Seoul city of South Korea	Evaluating housing price determinants in the context of spatial dependence and spatial heterogeneity	2006-2015	Annual	•OLS •Geographically Weighted Regression	•Age of building: **NEGATIVE** •Size: **POSITIVE** •Distance to nearest comercial district: **NEGATIVE** •Distance to nearest subway station: **NEGATIVE** •Distance to nearest major road: **NEGATIVE** •Population density: **NEGATIVE** •Income tax: **POSITIVE**
McCord et al., 2018	Belfast city of UK	Examining the relation between air quality and housing prices	2013	Annual	•OLS •Geographically Weighted Regression •Spatial Lag Model	•Air quality pollutants: **NEGATIVE** •Roads noise: **NEGATIVE** •Rail noise: **NEGATIVE** •Airport noise: **NEGATIVE** •Industry noise: **NEGATIVE**
Aliyev et al. 2019	Baku city of Azerbaijan Republic	Exploring the dynamics of housing prices	April 2018	Survey data from real estate agents' web sites	•OLS	•Number of rooms: **POSITIVE** •Number of floors: **NEGATIVE** •Size: **POSITIVE** •Area of land: **POSITIVE** •Repaired situation: **POSITIVE**

Table 4. (Cont.)

Cuestas and Kukk, 2019	Spain	Examining macroeconomic variables that affect housing prices	2001Q1-2017Q4	Quarterly	•Engle-Granger and Gregory-Hansen Cointegration Tests •Bai and Perron Method •DOLS	•Capital income: **POSITIVE** •Compensation of employees: **POS./NEG.** •Interest rate: **NEGATIVE** •Number of dwellings: **NEGATIVE**
Fu et al., 2019	Shangai and Beijing cities of China	Examining the effect of the scene perception component of the houses on the housing prices	March 2015-October 2015	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Sky perception: **POSITIVE** •Greenery perception: **POSITIVE**
Hu et al., 2019	Shenzhen city of China	Determining the determinants of housing prices and to sort them in order of importance	October 2017-February 2018	Survey data from real estate agents' web sites	Machine learning algorithms under the guidance of hedonic price method	•Job opportunities: **POSITIVE** •Health care facilities: **POSITIVE** •Commercial facilities: **POSITIVE** •Education facilities: **POSITIVE** •Public transportation: **POSITIVE** •Natural amenities: **POSITIVE**

Table 4. (Cont.)

Li et al., 2019	Shangai city of China	Examining the spatial patterns and determinants of the housing market in an open data-based manner	2016-2017	Survey data from real estate agents' web sites and social media	•OLS •Spatial Lag Model •Multi-level Regression	•Size: **POSITIVE** •Number of rooms: **NEGATIVE** •Age of building: **NEGATIVE** •Accessibility to metro stations: **POSITIVE** •Accessibility to bus stops: **POSITIVE** •Accessibility to sharing bikes: **POSITIVE** •Distance to park: **NEGATIVE** •Number of public schools: **POSITIVE** •Number of public banks: **POSITIVE** •Number of hospitals: **POSITIVE** •Popularity of entertainment facilities: **POSITIVE** •Popularity of shopping facilities: **NEGATIVE** •Popularity of domestic service facilities: **POSITIVE**

Table 5. Empirical Studies in National (Cont. to Page 35)

Authors and Year	Study Area	Aim	Time Period	Data Frequency	Method	Findings
Üçdoğruk, 2001	İzmir	Exploring the dynamics of housing prices	May 2001-	Survey data from real estate agents	•OLS	•Central heating: **POSITIVE** •Geothermal: **POSITIVE** •Being on boulevard: **POSITIVE** •Cable TV: **POSITIVE** •Size: **POSITIVE** •Number of rooms: **POSITIVE**
Yankaya and Çelik, 2005	Bornova district and Üçyol neighborhood in İzmir	Examining the impact of Izmir metro on housing prices	December 2003-March 2004	Survey data from real estate agents	•Multiple Regression Analysis	•Distance to the nearest metro station: **NEGATIVE** •Distance to the nearest bus station: **NEGATIVE** •Size: **POSITIVE** •Age of building: **NEGATIVE** •Number of floors: **POSTIVE** •Location in the corner of block: **POSITIVE** •Central heating: **POSITIVE** •Quality: **POSITIVE**
Sarı et al., 2007	Turkey	Examining the relation between housing starts and macroeconomic variables	1961-2000	Annual	•Unit Root Test •Cointegration Test •Variance Decompositions	•Interest rate: **POSITIVE** •Output: **POSITIVE** •Money stock: **POSITIVE** •Employment: **POSITIVE**

Table 5. (Cont.)

Badurlar Öner, 2008	Turkey	Examining the dynamic effects of macroeconomic variables on the housing prices	1990-2006	Quarterly	•Johansen Cointegration Test •Vector Error Correction Model	•GDP: **POSITIVE** •Exchange rate: **POSITIVE** •Money supply: **NEGATIVE** •Interest rate: **NEGATIVE**
Keskin, 2008	946 neigh. in 32 districts of Istanbul	Exploring the factors that affect housing prices	April 2006-November 2006	Survey data from real estate agents' web sites and Istanbul Metropolitan Municipality	•Multiple Regression Analysis	•Size: **POSITIVE** •Being a low stoney building: **POSITIVE** •Being in a secured site: **POSITIVE** •Age of building: **POSITIVE** •Living period in Istanbul: **POSITIVE** •Average income of household: **POSITIVE** •Neighborhood Satisfaction: **POSITIVE** •Earthquake risk of the area: **NEGATIVE**
Mutluer, 2008	39 neigh. n Çankaya district of Ankara	Examining the effects of housing characteristics on housing prices	June 2007-July 2007	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Size: **POSITIVE** •Age of building: **NEGATIVE** •Number of floors of building: **POSITIVE** •Floor number of flat: **POSITIVE** •Number of rooms: **POSITIVE** •Number of bathrooms: **POSITIVE**

Table 5. (Cont.)

Abayhan, 2009	Buca district in İzmir	Examining the effect of urban green areas on housing prices	2000-2008	Survey	•Multiple Regression Analysis	•Existence of view: **POSITIVE** •Size: **POSITIVE** •Age of building: **POSITIVE** •Distance to sub-center: **NEGATIVE**
Hepşen and Kalfa, 2009	Turkey	Determining the variables that have a dynamic causality relationship with housing market activity	2002-2007	Monthly	•Granger Causality Tests •Impulse Response Functions •Variance Decomposition Model	•Industrial production index: **POSITIVE** •Volume of loans: **POSITIVE** •Interest rate: **POSITIVE**
Özsoy and Şahin, 2009	İstanbul	Analyzing the major factors affecting housing sales prices	June 2007	Survey data from real estate agents' web sites	•Classification and Regression Tree Model	•Size: **POSITIVE** •Elevator: **POSITIVE** •Existence of security: **POSITIVE** •Existence of central heating unit: **POSITIVE** •Existence of view: **POSITIVE**

Table 5. (Cont.)

Selim, 2009	Turkey	Exploring the determinants of housing prices	2004	2004 Household Budget Survey Data	•Multiple Regression Analysis •Artificial Neural Network	•Locational characteristics: **POSITIVE** •Type of house: **NEGATIVE** •Age of building: **NEGATIVE** •Type of building: **NEGATIVE** •Saloon floor: **NEGATIVE** •Living room floor: **NEGATIVE** •Bathroom floor: **POSITIVE** •Heating system: **POSITIVE** •Number of rooms: **POSITIVE** •Size: **POSITIVE** •Other structural characteristics: **POSITIVE**
Çetintahra and Çubukçu, 2011	Karşıyaka district in İzmir	Examining the effect of environmental aesthetics on housing prices	2009	Survey data from real estate agents	•Multiple Regression Analysis	•Being in a site: **POSITIVE** •Complex environment: **NEGATIVE** •Well maintained environment: **POSITIVE**

Table 5. (Cont.)

Çağlayan and Arıkan, 2011	İstanbul	Examining the effects of housing characteristics on housing prices	October 2007-December 2007	Survey data from real estate agents	•Quantile Regression Analysis	•Age of bulding: **POSITIVE** •Cable TV: **POSITIVE** •Security: **POSITIVE** •Heating system: **POSITIVE** •Garage: **POSITIVE** •Kitchen area: **POSITIVE** •Number of rooms and bathrooms: **POSITIVE**
Koramaz and Dökmeci, 2012	İstanbul	Examining the effect of spatial characteristics on housing prices and developing a method for predicting housing prices	May 2009-July 2009	Survey data from real estate supplement of national newspaper	•Multiple Regression Analysis •Kriging Method	•Size: **POSITIVE** •Centrality: **NEGATIVE** •Accessibility: **NEGATIVE** •Neighbourhood density: **NEGATIVE**
Kördiş et al., 2014	Antalya	Exploring the determinants of housing prices	March 2013-April 2013	Survey data from real estate agents' web sites	•OLS	•Size: **POSITIVE** •Income level of neighbourhood: **POSITIVE** •Scenery: **POSITIVE** •Parking area: **POSITIVE** •Distance to sea: **NEGATIVE** •Heating system: **POSITIVE** •Elevator: **POSITIVE** •Age of building: **NEGATIVE** •Number of bathroom: **POSITIVE** •Swimming pool: **POSITIVE** •Security: **POSITIVE**

Table 5. (Cont.)

Yayar and Gül, 2014	Mersin	Exploring the determinants of housing prices	November 2011-February 2012	Survey data from real estate agents	•OLS	•Size: **POSITVE** •Distance to bazaar: **POSITIVE** •Number of bathrooms: **POSITIVE** •Garage: **POSITIVE** •Central satellite system: **POSITIVE** •Security: **POSITIVE** •Elevator: **POSITIVE** •Garden: **NEGATIVE** •Being in a site: **NEGATIVE** •Distance to public transport: **NEGATIVE** •Age of building: **NEGATIVE**
Yayar and Karaca, 2014	TR83 Region (Tokat, Samsun, Çorum, Amasya)	Exploring the determinants of housing prices	May 2012-September 2012	Survey data from real estate agents	•Multiple Regression Analysis	•Number of bathrooms: **POSITIVE** •Number of elevators: **POSITIVE** •Being on boulevard: **POSITIVE** •Central heating: **POSITIVE** •Being in first floor: **NEGATIVE** •Fuel oil heating system: **NEGATIVE**
Bulut et al., 2015	Samsun	Exploring the determinants of housing prices	2012	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Size: **POSITIVE** •Elevator: **POSITIVE** •Number of bathrooms: **POSITIVE** •Central heating: **POSITIVE** •Sea scenery: **POSITIVE** •Age of building: **NEGATIVE** •Being in first floor: **NEGATIVE** •Distance to public transport: **NEGATIVE**

Table 5. (Cont.)

Gök and Keçeli, 2015	Turkey and its 26 regions	Exploring the determinants of housing prices	2014-2015	Annual	•OLS •Stepwise Regression Model	•GVA per capita: **POSITIVE** •Net domestic migration: **POSITIVE**
Işık, 2015	Erzurum	Exploring the determinants of housing prices	2015	Survey	•Multiple Regression Analysis	•Number of room: **POSITIVE** •Number of bathroom: **POSITIVE** •Size: **POSITIVE** •Heating system: **POSITIVE** •Elevator: **POSITIVE** •Being in a site: **POSITIVE** •Proximity to public spaces: **POSITIVE** •Age of building: **NEGATIVE** •Number of floors: **NEGATIVE** •Distance to center: **NEGATIVE**
Çalmaşur, 2016	Turkey	Determining the factors that affect housing prices	January 2016	Survey data from real estate agents' web sites	•OLS	•Size: **POSITIVE** •Number of floor: **POSITIVE** •Garden: **POSITIVE** •Balcony: **POSITIVE** •Air conditioning: **POSITIVE** •Sea view: **POSITIVE**

Table 5. (Cont.)

Dilber and Sertkaya, 2016	Turkey	Examining macroeconomic variables that affect housing prices after the 2008 financial crisis	2008-2014	Quarterly	•Unit Root Test •Cointegration Test •VAR Model •Variance Decompositions	•Interest rate: **POSITIVE** •Inflation: **POSITIVE** •Exchange rate: **POSITIVE**
Uyar and Yayla, 2016	İstanbul	Exploring the dynamics of housing prices within spatial dependence	October 2013-December 2013	Survey	•OLS •Spatial Durbin Model	•Bosphorus view: **POSITIVE** •Quality of life index: **POSITIVE** •Being in basement: **NEGATIVE**
Afşar et al., 2017	Odunpazarı and Tepebaşı districts in Eskişehir	Exploring the determinants of housing prices	November 2016-December 2016	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Size: **POSITIVE** •Number of rooms: **POSITIVE** •Number of bathrooms: **POSITIVE** •Parking area: **POSITIVE** •Elevator: **POSITIVE** •Central heating: **NEGATIVE** •Being in first floor: **NEGATIVE**

Table 5. (Cont.)

Afşar, 2018	Turkey	Examining macroeconomic variables that affect housing prices	January 2010-November 2017	Monthly	•Autoregressive Distributed Lag Model	•Income: **NEGATIVE** •Volume of loans: **POSITIVE** •Interest rate: **NEGATIVE**
Ellibeş and Görmüş, 2018	Kocaeli	Exploring the determinants of housing prices	October 2017-November 2017	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Number of bathroom: **POSITIVE** •Price of land: **POSITIVE** •Swimming pool: **POSITIVE** •Size: **POSITIVE** •Being in a site: **POSITIVE**
Kolcu and Yamak, 2018	Turkey	Examining the short- and long-term effects of income and housing loan interest rates on housing prices.	January 2010-September 2017	Monthly	•Autoregressive Distributed Lag Model	•Income: **POSITIVE** •Interest rate: **NEGATIVE**
Akçay, 2019	2 neighborhood in Bayraklı district of İzmir	Exploring the dynamics of housing prices	November 2018-March 2019	Survey data from real estate agents' web sites	•Multiple Regression Analysis	•Size: **POSITIVE** •Number of rooms: **POSITIVE** •Age of building: **NEGATIVE** •Autopark: **POSITIVE** •Swimming pool: **POSITIVE** •Distance to CBD: **NEGATIVE** •Distance to rail: **NEGATIVE** •Distance to sea: **POSITIVE**

Table 5. (Cont.)

Bayır et al., 2019	Turkey	Examining macroeconomic variables that affect housing prices	2011-2018	Quarterly	•Autoregressive Distributed Lag Model	•Economic growth: **POSITIVE** •Money supply: **POSITIVE** •Exchange rate: **POSITIVE** •Inflatıon: **NEGATIVE**
Bayır, 2019	Turkey	Examining the effects of monetary policy on housing prices.	January 2011-December 2017	Monthly	•Structural VAR Analysis	•No significant effect on housing prices
Çalmaşur and Aysin, 2019	TRA1 Region (Erzurum, Erzincan, Bayburt)	Examining the effects of structural variables on housing prices.	October 2017-November 2017	Survey data from real estate agents' web sites	•OLS	•Number of room: **POSITIVE** •Size: **POSITIVE** •Autopark: **POSITIVE** •Floor number of flat: **POSITIVE** •Number of bathroom: **POSITIVE** •Age of building: **NEGATIVE**
Çelik and Turgut, 2019	Antalya	Exploring the determinants of housing prices	May 2018-June 2018	Survey data from real estate agents' web sites	•OLS •Spatial Error Model	•Number of rooms: **POSITIVE** •Size: **POSITIVE** •Number of floor: **POSITIVE** •Number of bathroom: **POSITIVE** •Being in a site: **POSITIVE** •Increasing of district population: **NEGATIVE** •Lack of balcony: **NEGATIVE** •Distance to sea: **NEGATIVE** •Distance to shopping mall: **NEGATIVE**

Table 5. (Cont.)

Güler et al., 2019	Rize	Exploring the determinants of housing prices	2016	Survey	•OLS	•Size: **POSITIVE** •Heating system: **POSITIVE** •Socioeconomic level of neighborhood: **POSITIVE** •Sea view: **POSITIVE** •Age of building: **NEGATIVE**
Canbay and Mercan, 2020	Turkey	Examining the effects of monetary policy on housing prices.	2010Q1-2019Q2	Quarterly	•VAR/VECM	•Volume of loans: **POSITIVE** •Interest rate: **NEGATIVE** •Economic growth: **NEGATIVE**
Güzel et al., 2020	Ordu	Examining the effects of structural and environmental factors on housing prices.	December 2019-February 2020	Survey data from real estate agents	•Multiple Regression Analysis	•Size: **POSITIVE** •Heating system: **POSITIVE** •Proximity to sea: **POSITIVE** •Park view: **POSITIVE** •Age of building: **NEGATIVE**
Moralı and Yılmaz, 2020	İstanbul	Examining spatial heterogeneity in housing market	October 2017	Survey data from real estate agents' web sites	•GWR	•Age of building: **POSITIVE** •Size: **POSITIVE** •Number of bathroom: **POSITIVE** •Distance to public education: **POSITIVE** •Distance to private education: **NEGATIVE** •Distance to university: **NEGATIVE** •Distance to transportation: **NEGATIVE**

Table 5. (Cont.)

Sağlam and Abdioğlu, 2020	26 regions of Turkey	Examining the effects of consumer prices on housing prices.	2010Q1-2018Q2	Quarterly	•Unit Root Test •Panel Cointegration Test	•CPI: **POSITIVE**
Tunç, 2020	26 regions of Turkey	Examining the effects of exogenous credit supply shocks on housing prices.	2010-2017	Annual	•OLS	•Housing credits: **POSITIVE**
Uyar and Keten, 2020	Denizli	Exploring the dynamics of housing prices within spatial dependence	May 2019-June 2019	Survey data from real estate agents' web sites	•OLS •Spatial Quantile Regression Analysis	•Size: **POSITIVE** •Age of building: **NEGATIVE** •Smart system: **POSITIVE** •Number of bathroom: **POSITIVE** •Balcony: **POSITIVE** •Autopark: **POSITIVE** •Distance to shopping mall: **NEGATIVE**

Table 5. (Cont.)

Varlık, 2020	Turkey	Examining the effects of economic growth on housing prices.	January 2010-April 2019	Monthly	•Nonlinear Autoregressive Distributed Lag	•Industrial production index: **POSITIVE**
Çetin, 2021	Turkey	Exploring the determinants of housing prices	December 2012-August 2020	Monthly	•Autoregressive Distributed Lag Band Cointegration Test	•Industrial production index: **NEGATIVE** •Consumer price index: **NEGATIVE** •Interest rate: **POSITIVE** •Construction price index: **POSITIVE**
Özsoy and Şahin, 2021	İzmir	Exploring the determinants of housing prices	June 2018	Survey data from real estate agents' web sites	•OLS •Quantile Regression Analysis	•Size: **POSITIVE** •Elevator: **POSITIVE** •Security: **POSITIVE** •Distance to shopping mall: **NEGATIVE**

CHAPTER 4

STUDY AREA AND PANEL DATA SET

The general introduction to the study area, the distribution of the neighborhoods included in the study, and the data will all be discussed in this section.

4.1. Study Area

Izmir, one of Turkey's national central cities with highly competitive ability in various sectors, has a population of 4,394,694 people by 2020, 30 districts, and 1296 neighborhoods (TURKSTAT, 2021). In the 2014-2023 Izmir Regional Plan prepared by the Izmir Development Agency, a classification based on the identities of the districts was made. According to this classification, the province of Izmir is categorized in the following way: Center of the metropolitan area (Balçova, Bayraklı, Bornova, Buca, Çiğli, Gaziemir, Güzelbahçe, Karabağlar, Karşıyaka, Konak, Narlıdere), the focus of industrial growth (Aliağa), the focus of regional growth (Torbalı, Urla, Kemalpaşa), tourism focus (Çeşme, Selçuk, Bergama), secondary tourism focus (Foça, Seferihisar, Karaburun, Dikili), the focus of agriculture (Tire, Bayındır, Ödemiş, Menemen, Menderes) and secondary agricultural focus (Kınık, Kiraz, Beydağ) (Izmir Development Agency, 2015).

There are 212 neighborhoods in total that are the subject of the study. As seen in Figure 9, the districts where these neighborhoods are concentrated on the districts that are the center of the metropolitan area. These districts are followed by tourism focus and industrial growth focus. While it is seen that the districts with agriculture focus are included in the study with a few neighborhoods, it is seen that no neighborhood in the districts defined as the secondary agriculture focus could be included in the study. The study's neighborhoods were chosen based on data availability. On a district-by-district basis, Figure 9 and Table 6 show the distribution of the number of neighborhoods in which the average housing sales price data is balanced over time.

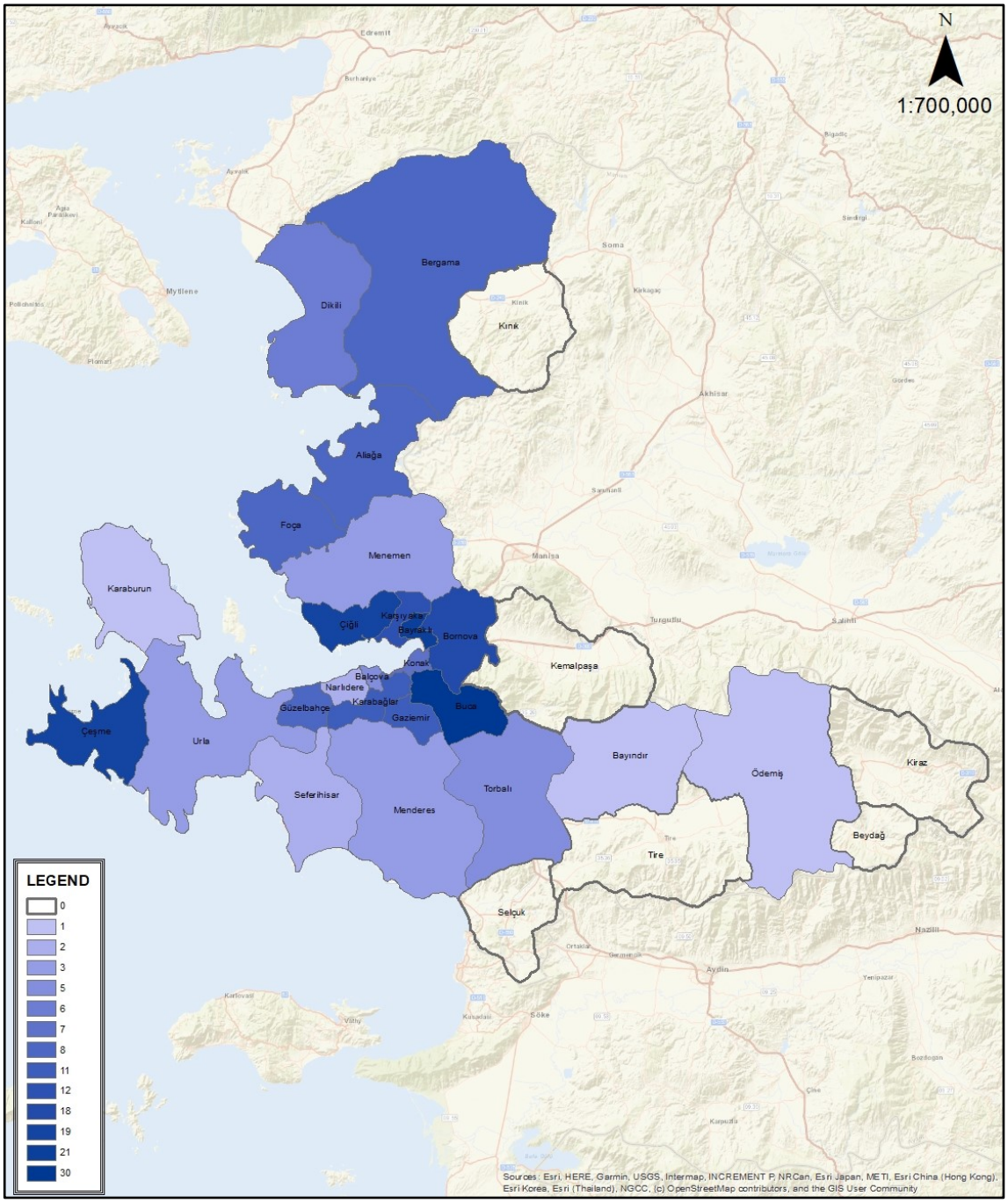

Figure 9. Number of Neighborhoods in Study on Izmir Map

Table 6. Number of Neighborhoods in Study by the Districts

DISTRICTS	TOTAL NUMBER OF NEIGHBORHOODS IN DISTRICT	NUMBER OF NEIGHBORHOODS IN STUDY
Aliağa	30	8
Balçova	8	5
Bayındır	59	1
Bayraklı	24	21
Bergama	137	8
Beydağ	25	0
Bornova	45	18
Buca	48	30
Çeşme	25	19
Çiğli	26	19
Dikili	30	6
Foça	16	8
Gaziemir	16	11
Güzelbahçe	12	8
Karabağlar	58	11
Karaburun	16	1
Karşıyaka	27	12
Kemalpaşa	49	0
Kınık	37	0
Kiraz	56	0
Konak	113	7
Menderes	44	3
Menemen	65	3
Narlıdere	11	2
Ödemiş	99	1
Seferihisar	21	2
Selçuk	14	0
Tire	88	0
Torbalı	60	5
Urla	37	3
TOTAL	1296	212

4.2. Data Collection Process

The period of the study consists of a total of 30 months, between May 2017 and October 2019. The dependent variable is the average housing sales price. There are 26 independent variables in 3 categories in total.

The 3 categories that include the independent variables are classified as macroeconomic variables, location-specific variables, and housing structural characteristics. In the study, since the spatial unit in the neighborhood, the characteristics of the neighborhoods and the facilities offered to the users in the neighborhood will be examined within the location-specific variables. There are 5 variables in the macroeconomic variables category, 12 variables in the neighborhood-specific variables category, and 9 variables in the housing structural characteristics category. Table 7 shows the names of the independent variables, the period, their representation, data sources, the period of the dependent variable, and its data sources.

Table 7. All Variables (Continuing to Page 40)

INDEPENDENT VARIABLES			
MACROECONOMIC VARIABLES	**PERIOD**	**REPRESENTATION**	**DATA SOURCE**
USD	05.2017-10.2019	Dollar Exchange Rate	TCMB
CPI	05.2017-10.2019	Consumer Price Index	TCMB
PPI	05.2017-10.2019	Producer Price Index	TCMB
IPI	05.2017-10.2019	Industrial Production Index	TCMB
IRFHL	05.2017-10.2019	Housing Loan Interest Rate	TCMB
NEIGHBORHOOD-SPESIFIC VARIABLES	**PERIOD**	**REPRESENTATION**	**DATA SOURCE**
Population	05.2017-10.2019	Total Population of Neighborhood	TURKSTAT
0-14 Age Population Ratio	05.2017-10.2019	Children Population Ratio of Neighborhood	TURKSTAT
15-64 Age Population Ratio	05.2017-10.2019	Active Population Ratio of Neighborhood	TURKSTAT
64+ Age Population Ratio	05.2017-10.2019	Elderly Population Ratio of Neighborhood	TURKSTAT
BSc, MSc, and PhD Degree Population Ratio	05.2017-10.2019	Higher Education Rate of the Neighborhood	TURKSTAT
Existence of Commercial Function	05.2017-10.2019	Commercial Function/Residential	TURKSTAT

Accessibility to Preschools	05.2017-10.2019	Walking Area of Preschools/Population	Produced by Author
Accessibility to Primary Schools	05.2017-10.2019	Walking Area of Primary Schools/Population	Produced by Author
Accessibility to Mid Schools	05.2017-10.2019	Walking Area of Mid Schools/Population	Produced by Author
Accessibility to High Schools	05.2017-10.2019	Walking Area of High Schools/Population	Produced by Author
Accessibility to Family Health Center	05.2017-10.2019	Walking Area of Family Health Centers/Population	Produced by Author
Distance to CBD	Constant in Time	Distance to CBD of Neighborhood	Produced by Author
HOUSING STRUCTURAL VARIABLES	**PERIOD**	**REPRESENTATION**	**DATA SOURCE**
Size	Constant in Time	Size of Flat	Endeksa
Number of Rooms	Constant in Time	Number of Rooms	Sahibinden.com
Age of Building	Constant in Time	Age of Building	Sahibinden.com
Number of Floors	Constant in Time	Number of Floors	Sahibinden.com
Balcony	Constant in Time	1: if there is a balcony; 0: if there is no balcony	Sahibinden.com
Number of Bathroom	Constant in Time	Number of Bathroom	Sahibinden.com
Site	Constant in Time	1: if flat gated in site; 0: otherwise	Sahibinden.com
Natural Gas	Constant in Time	1: if there is a natural gas boiler in flat; 0: otherwise	Sahibinden.com
Geothermal	Constant in Time	1: if there is a geothermal in flat; 0: otherwise	Sahibinden.com
DEPENDENT VARIABLE			
	PERIOD	**REPRESENTATION**	**DATA SOURCE**
Average Housing Sales Price of Neighborhood	05.2017-10.2019		Endeksa Sahibinden.com

In the "neighborhood-specific" category, the list of pre-schools, primary schools, mid-schools, and high schools and their location information were obtained from the Izmir Provincial Directorate of National Education, the list of family health centers and their location information were obtained from the website of the Izmir Provincial Health Directorate and processed on Google Maps. It was then integrated with the neighborhoods included in the workspace in the ArcGIS environment. According to the Code on Construction of Spatial Plans, walking distances are specified as 500 meters for pre-schools, primary school, and family health centers, 1000 meters for mid-school, and 2500 meters for high schools. While using the *buffer* tool in the ArcGIS environment in the

calculation of these service domains of the institutions; the *intersect* tool was used to calculate the total service impact areas within the neighborhoods. Afterward, the results were divided by the total population, and the data of the per-capita square footage of the service domains of different equipment in the neighborhoods were obtained. For the distance to central business district variable, first of all, the centers of gravity of the neighborhoods were determined with the *centroid of polygon* tool in the ArcGIS environment and converted into point data. Then, the distances of the neighborhoods to the new city center were calculated with the *point distance* tool. Here, the neighborhood that represents the new city center of İzmir is the Adalet neighborhood of the Bayraklı district.

The results of the variables in the category of "housing structural characteristics" were determined by taking the mode of the structural features in the existing advertisements as a result of scanning all the housing ads for sale in the neighborhoods. Since the past ads could not be accessed, they were kept as constant variables in time.

4.2.1. Preparing Final Data Set

The final data set to be used in the analysis should be generated after collecting the panel data set in the previous section. This was accomplished through the employment of two ways. The panel unit root analysis is the first way, while the correlation matrix is the second.

First, the panel unit root analysis was performed using the Augmented Dickey-Fuller Test to understand the properties of the variables over time. The results of the test for macroeconomic variables are shown in Table 8. According to the results, all macroeconomic variables, except for the industrial production index, are not stationary at the level, which is not statistically significant. At the first difference level, it is seen that the variables are statistically significant. The industrial production index, on the other hand, is statistically significantly stationary. Hence, the series has been made stationary by using the first difference level in all macroeconomic variables.

Table 8. ADF, Unit Root Tests for Macroeconomic Variables, Scwartz () Criterion Used, Max.Lag=4 Months

	ADF Test Statistic-Levels	**ADF Test Statistic-First Difference**	**Result**
USD	-0.764800	-4,88973***	I(1) - Non stationary
CPI	0.063829	-5,032733***	I(1) - Non stationary
PPI	-0.833194	-4,23491***	I(1) - Non stationary
IPI	-5,771864***	-6,652017***	I(0) - stationary
IRFHL	-1,922643	-3,67942***	I(1) - Non stationary
Test critical values:	1% level: -3,639407	5% level: -2,951125	10% level: -2,6143

The test result applied to other variables except macroeconomic variables can be seen in Table 9. The results show that all variables are stationary, while the elderly population ratio and the existence of commercial function variables are not statistically insignificantly stationary. Hence, the mentioned variables are used as levels.

Table 9. Panel Unit Root Tests for Other Variables, Scwartz () Criterion Used, Max.Lag=4 Months (Continuing to Page 43)

	Levin, Lin & Chu t*	Im, Pesaran and Shin W-stat	ADF - Fisher Chi-square	PP - Fisher Chi-square	Result
Housing Price	-20,0694***	-10,0424***	1224,22***	1074,52***	I(0)-Stationary
Population	-12,2198***	-3,01891***	781,102**	985,56***	I(0)-Stationary
0-14 Age Population Ratio	-6,03345***	-0,89253	728,446	927,45***	I(0)-Stationary
15-64 Age Population Ratio	-12,1279***	-4,42876***	841,261***	1076,54***	I(0)-Stationary
64+ Age Population Ratio	-10,996***	1,513	560,922	604,583	I(1)-Nonstationary
BSc, MSc, and PhD Degree Population Ratio	-15,9412***	-2,82709***	719,223	902,657***	I(0)-Stationary
Existence of Commercial Function	1,948	8,366	466,829	679,407	I(1)-Nonstationary
Accessibility to Preschools	-8,53689***	-1,85233**	371,771	460,912***	I(0)-Stationary
Accessibility to Primary Schools	-12,4978***	-3,57914***	779,509***	1003,01***	I(0)-Stationary
Accessibility to Mid Schools	-12,1778***	-3,18235***	746,957**	938,466***	I(0)-Stationary
Accessibility to High Schools	-12,3777***	-3,53586***	785,04***	1008,18***	I(0)-Stationary

Accessibility to Family Health Center	-12,0339***	-3,35065***	698,765**	889,184***	I(0)-Stationary

Second, to determine the associations between the variables, a correlation matrix was created. The need for this matrix arises from the necessity to determine whether or not there is a multicollinearity issue. Multicollinearity is defined as a strong positive or negative link between two or more variables. If this problem is not identified and addressed, it will have an impact on the analysis that will be conducted in later stages of the research. In this study, variables having correlation coefficients of <-0.7 and 0.7> were excluded from the matrix. Figure 10 depicts the results of the correlation matrix.

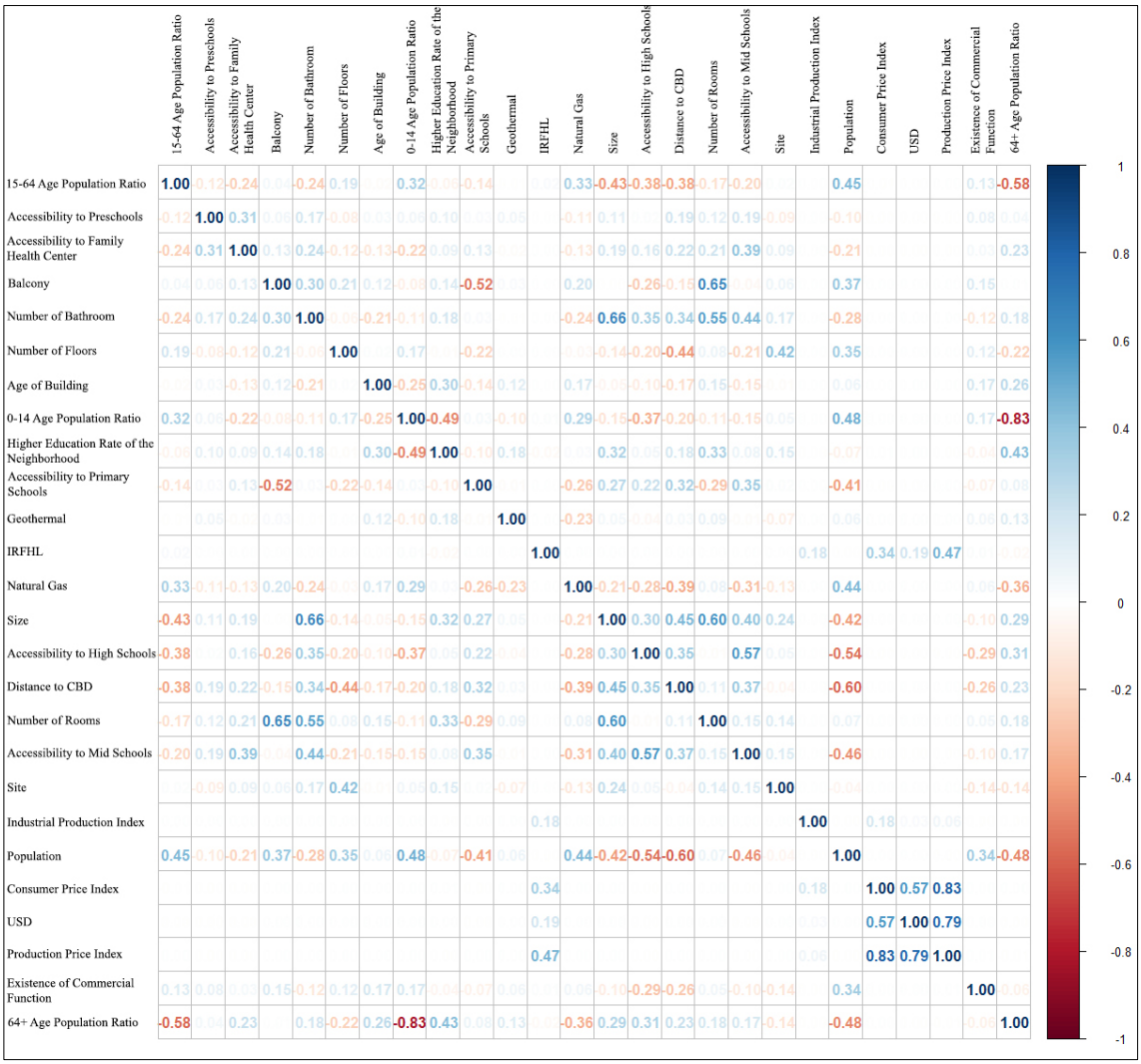

Figure 10. The Correlation Matrix of the Variables

There were 3 cases that exceeded the critical limit determined according to the correlation matrix. The first situation is that the coefficient between the children

population ratio and the elderly population is -0.83. The second situation is that the coefficient between the consumer price index and the production price index is 0.79. The third and last case is that the coefficient between USD and production price index is 0.79. For these reasons, the production price index variable, which is in 2 of the 3 cases, and the elderly population ratio variable, whose interaction with other variables is close to the limit, were excluded from the study.

As a result, the following is the final dataset: During 30 months in 212 neighborhoods, the study examines the dynamics of housing prices using a total of 24 independent variables (4 of which are macroeconomic, 11 of which are neighborhood-specific, 9 of which are housing structural characteristics).

CHAPTER 5

METHODOLOGY AND EMPIRICAL RESULTS

As a first step of the research, descriptive analysis and descriptive statistics of housing prices and changes in housing prices were conducted in the study area as part of the research. Then, using the panel linear regression, the a-spatial analysis of the determinants of housing prices was conducted, and the results were evaluated using the Hausman Test. Following this, the Global Moran's I test was used to examine the spatial autocorrelation using housing prices and changes in housing prices. Since the spatial autocorrelation has been found, Cluster and Outlier Analysis (Anselin Local Moran's I) has been used to investigate the features of spatial clusters. The Baltagi, Song, and Koh marginal or conditional LM test for spatial error correlation or random effects in the spatial panel models were performed. After this test, the Spatial Error Model and the Spatial Lag Model were compared by using GM estimation of the spatial panel data models, and the effects of local variables were examined by performing the GWR with the variables found to be significant for both models. In this section, this method scheme will be explained.

5.1. Descriptive Analyses

The first month (May 2017) and last month (October 2019) of housing sales price data gathered for 30 months in 212 neighborhoods were used for descriptive statistics. The annual % change in housing sales price calculated using this two months' data is also included in the statistical table. Maximum value, minimum value, mean value, median, standard deviation and SD/Mean are given in Table 10.

Table 10. Descriptive Statistics

	Max.	Min.	Mean	Median	SD	SD/Mean
2017/5 Housing Prices	1513593	133510	343041	259824	228569.4	0.6663044
2019/10 Housing Prices	2372692	155266	465434	340304	348662.53	0.7491133
Annual % Change of Housing Prices	57.4861181	-3.726319315	13.06164	11.519959	8.1508647	0.6240307

The maximum value in May 2017 data belongs to Ardıç neighborhood (Çeşme district), while the minimum value belongs to Atatürk neighborhood (Bergama district). While the Ardıç neighborhood has the maximum value in the data from October 2019 again, the Atatürk neighborhood (Buca district) has the lowest value. Binbaşı Reşatbey neighborhood (Gaziemir district) has the maximum price change at 57.48 percent, while Tuna neighborhood (Bornova district) has the lowest price change rate. Since this value is negative, the change must be accounted for by a decrease in the price.

May 2017 housing sales prices, October 2019 housing sales prices, and annual percentage changes in housing prices are displayed in the following three figures (Figure 11, Figure 12, Figure 13). While the standard deviation was used to determine the range of housing prices, the changes were determined with natural breaks.

In Figure 11, the neighborhoods with the highest average housing prices in May 2017 are mostly located in Çeşme and Güzelbahçe districts. While housing prices gradually decrease in the neighborhoods (secondary agriculture sub-region) on the east axis from the central districts, this decrease is not observed from the central districts to the north. In the neighborhoods located in the central districts, it has been determined that the housing prices are mostly in the range of 0.50-1.5 standard deviations.

In Figure 12, the neighborhoods with the highest housing prices in October 2019 are mostly located in Çeşme, Güzelbahçe, Urla, and Karşıyaka districts. While housing prices gradually decrease in the neighborhoods (secondary agriculture sub-region) on the axis from the central districts to the east, this decrease is not observed from the central districts to the north, but on the contrary, an increase is observed. In the neighborhoods located in the central districts, it has been determined that the housing prices are mostly in the range of 0.50-1.5 standard deviations.

Figure 13 shows the annual percentage change rates. There are three neighborhoods with negative change rate values. The highest percentage change rates are mostly observed in the neighborhoods of Çeşme, Urla, Güzelbahçe, Gaziemir, Aliağa, Foça and Dikili.

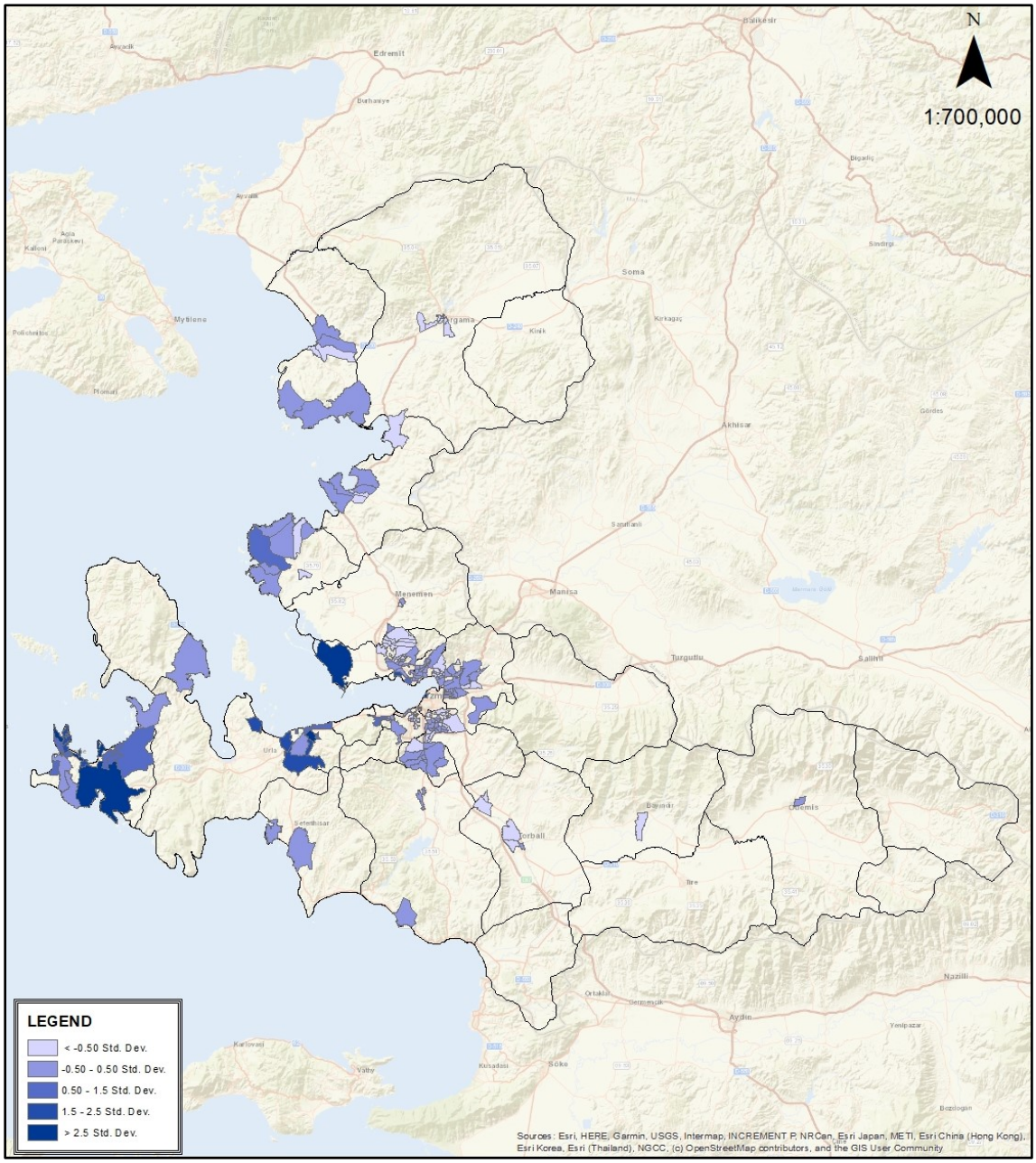

Figure 11. May 2017 Average Housing Sales Prices

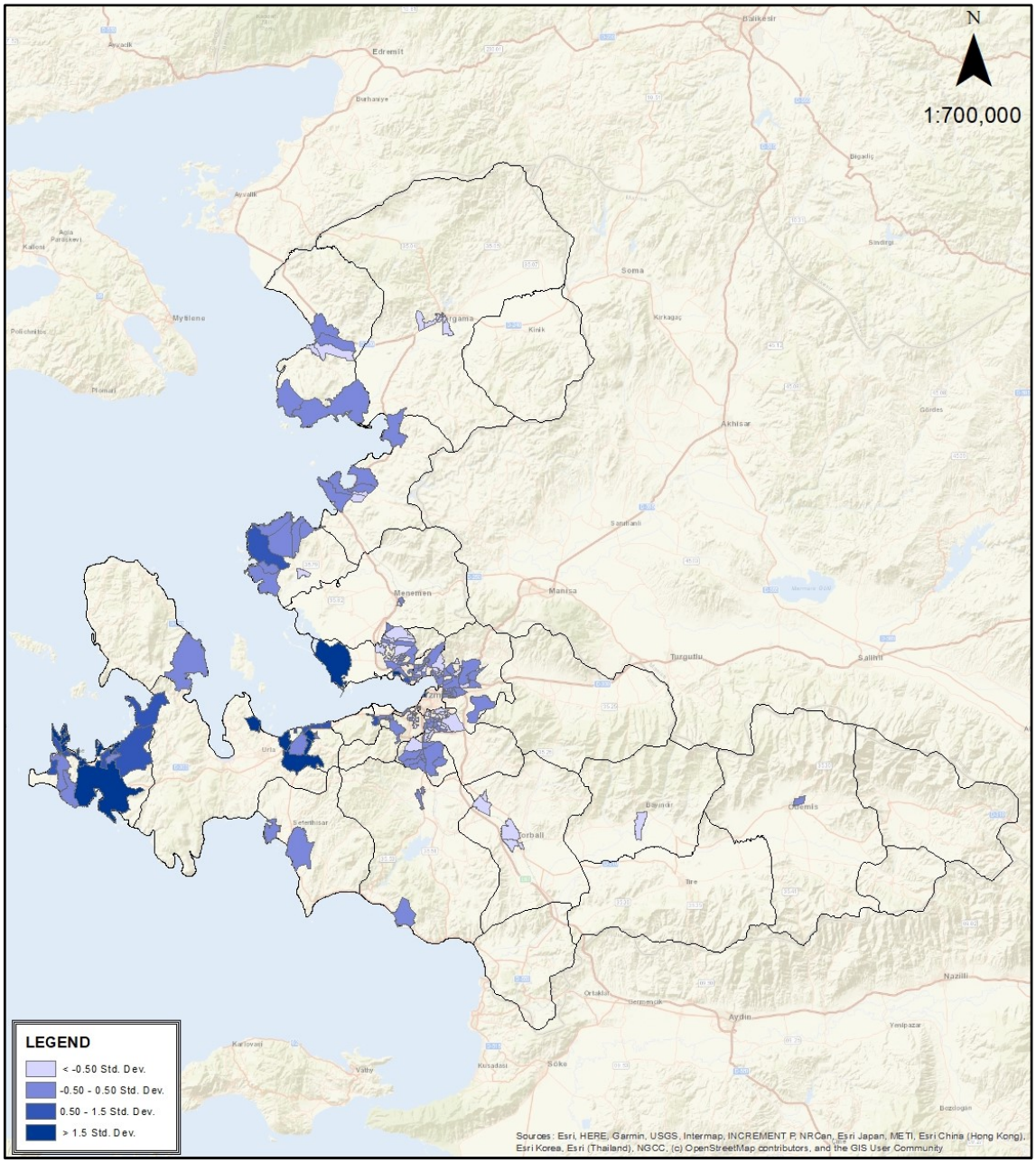

Figure 12. October 2019 Average Housing Sales Prices

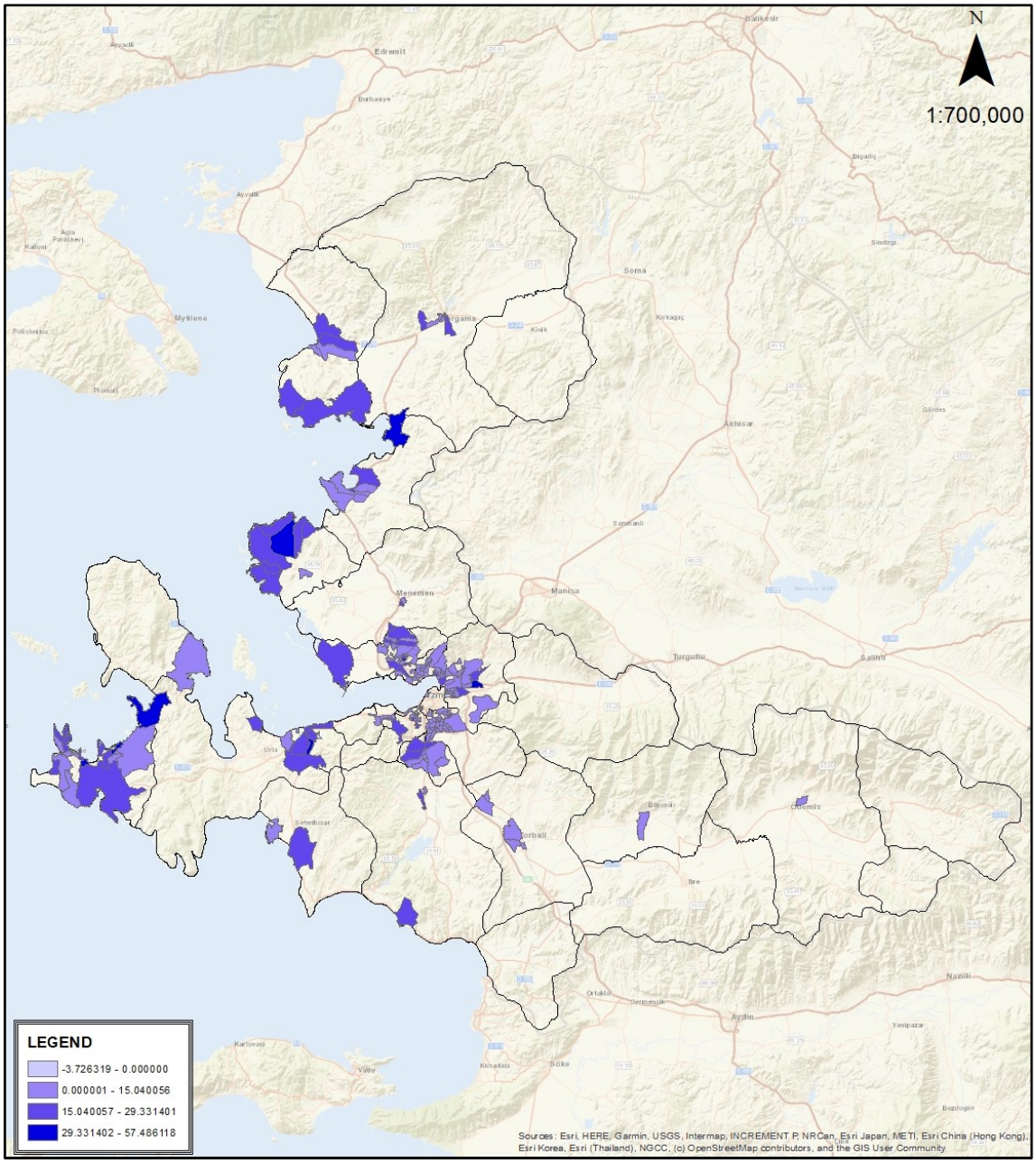

Figure 13. Annual Percentage Change Rate

5.2. Panel Linear Regression

The panel linear regression was performed to determine how and how much the independent variables affect the dependent variable. The dependent variable used in the study is the average house sales price. Independent variables, on the other hand, were examined with 4 different specifications. The first specification contains all variables. The second specification includes the neighborhood-specific variables. The third specification contains only the independent variables of the housing structural characteristics. The fourth and last specification includes the neighborhood-specific variables and the independent variables of the housing structural characteristics. In the formulas of these specifications, β represents the coefficient of variables, ∂ represents constant and ϵ represents error term.

The first specification of panel linear regression equation is expressed below:

$Price_{it} = \partial + \beta 1usd_{it} + \beta 2cpi_{it} + \beta 3ipi_{it} + \beta 4irfhl_{it} + \beta 5population_{it} + \beta 6children_{it} + \beta 7active_{it} + \beta 8education_{it} + \beta 9commercial_{it} + \beta 10preschool_{it} + \beta 11primaryschool_{it} + \beta 12midschool_{it} + \beta 13highschool_{it} + \beta 14healthcenter_{it} + \beta 15distancecbd_{it} + \beta 16size_{it} + \beta 17rooms_{it} + \beta 18age_{it} + \beta 19floors_{it} + \beta 20balcony_{it} + \beta 21bathroom_{it} + \beta 22site_{it} + \beta 23naturalgas_{it} + \beta 24geothermal_{it} + \epsilon_t$ i= neighborhoods, 1…212, t=time, 30 months

(1)

The second specification of panel linear regression equation is expressed below:

$Price_{it} = \partial + \beta 1population_{it} + \beta 2children_{it} + \beta 3active_{it} + \beta 4education_{it} + \beta 5commercial_{it} + \beta 6preschool_{it} + \beta 7primaryschool_{it} + \beta 8midschool_{it} + \beta 9highschool_{it} + \beta 10healthcenter_{it} + \beta 11distancecbd_{it} + \epsilon_t$ i= neighborhoods, 1…212, t=time, 30 months

(2)

The third specification of panel linear regression equation is expressed below:

$Price_{it} = \partial + \beta 1size_{it} + \beta 2rooms_{it} + \beta 3age_{it} + \beta 4floors_{it} + \beta 5balcony_{it} + \beta 6bathroom_{it} + \beta 7site_{it} + \beta 8naturalgas_{it} + \beta 9geothermal_{it} + \epsilon_t$ i= neighborhoods, 1…212, t=time, 30 months

(3)

The fourth specification of panel linear regression equation is expressed below:

$Price_{it} = \partial + \beta 1population_{it} + \beta 2children_{it} + \beta 3active_{it} + \beta 4education_{it} + \beta 5commercial_{it} + \beta 6preschool_{it} + \beta 7primaryschool_{it} + \beta 8midschool_{it} + \beta 9highschool_{it} + \beta 10healthcenter_{it} + \beta 11distancecbd_{it} + \beta 12size_{it} + \beta 13rooms_{it} + \beta 14age_{it} + \beta 15floors_{it} + \beta 16balcony_{it} +$

$\beta 17 bathroom_{it} + \beta 18 site_{it} + \beta 19 naturalgas_{it} + \beta 20 geothermal_{it} + \epsilon_t$ i= neighborhoods, 1…212, t=time, 30 months

(4)

The fixed effect and the random effect models were used to investigate the panel linear regression. Individual-specific effect (unobserved heterogeneity) is not included in the Fixed Effect regression, whereas individual-specific effect (unobserved heterogeneity) is included as an error term in the Random Effect regression. The Fixed Effect removes variables from the regression that are constant over time. This demonstrates that the Fixed Effect cannot account for the independent variables of housing structural characteristics and distance to the central business district. As an outcome, the Fixed Effect was used to investigate at specification 1. The results are shown in Table 11.

According to the results in Table 11, the effect of all macroeconomic variables on housing prices is highly significant. While the dollar exchange rate, the consumer price index and the industrial production index affect the housing prices positively, the housing loan interest rates affect negatively. While the effect of child population ratio and the active population ratio among neighborhood-specific variables are statistically significant, it is observed that their effects on housing prices are negative. The effect of the existence of the commercial function is highly significant and its effect on the housing prices is positive. While the effect of accessibility to preschools is statistically significant, its effect on housing prices is observed to be negative. The significance levels of other variables are very low or insignificant. While the ratio of this specification to explain the housing prices is 52%, its statistical significance level is high.

Table 11. Panel Linear Regression Results (Fixed Effect Model) (Cont. to Page 52)

Balanced Panel: n = 212, T = 30, N = 6360			
	Estimate	Std. Error	Pr(>|t|)
USD	1.0384	0.16371	2.409e-10 ***
CPI	13.593	0.60104	< 2.2e-16 ***
IPI	0.38853	0.024431	< 2.2e-16 ***
IRFHL	-0.5958	0.024842	< 2.2e-16 ***
Population	0.021912	0.059906	0.7145392
0-14 Age Population Ratio	-0.12698	0.032088	7.662e-05 ***
15-64 Age Population Ratio	-0.86366	0.13241	7.455e-11 ***
BSc, MSc, and PhD Degree Population Ratio	0.04286	0.032929	0.1931064

Existence of Commercial Function	0.027981	0.0076728	0.0002678 ***
Accessibility to Preschools	-0.0028995	0.0007722	0.0001749 ***
Accessibility to Primary Schools	0.00082193	0.0003767	0.0291575 *
Accessibility to Mid Schools	-0.0001953	0.0001441	0.175417
Accessibility to High Schools	-4.021E-05	2.226E-05	0.0708881 .
Accessibility to Family Health Center	-0.0003563	0.0004745	0.4527764
Signif. codes:	0 '***' 0.05 '.'	0.001 '**' 0.1 ' '	0.01 '*' 1
R-Squared:	0.54482		
Adj. R-Squared:	0.5262		
p-value:	< 2.22e-16		

The Random Effect was used to investigate all specifications. The results of specification 1 are shown in Table 12.

According to the results in Table 12, the effect of all macroeconomic variables on the housing prices is statistically significant. While the dollar exchange rate, the consumer price index and the industrial production index affect the housing prices positively, the housing loan interest rates affect negatively. While the effect of child population ratio and the active population ratio among neighborhood-specific variables is statistically significant, it is observed that their effects on the housing prices are negative. The effect of the higher education rate on the housing prices is highly significant and it is observed that this effect is positive. The result of this variable is different from the Fixed Effect model. The effect of the existence of the commercial function is significant and its effect on the housing prices is positive. The effects of the accessibility to preschools and the accessibility to family health center are significant, their effects on the housing prices are observed to be negative. The effect of the distance to central business district is significant, its effect on housing prices is observed to be negative. The effects of the variables of the size and number of bathrooms in the category of housing structural characteristics are significant, their effects on the housing prices are positive. The effect of the natural gas variable is statistically significant, its effect on the housing prices is negative. The effect of the balcony variable is significant, its effect on the housing prices is positive. The significance levels of other variables are very low or not significant. The ratio of this specification to explain the housing prices is 55%, and its statistical significance level is very high.

Table 12. Panel Linear Regression Results (Random Effect Model)

Balanced Panel: n = 212, T = 30, N = 6360			
	Estimate	Std. Error	Pr(>|z|)
(Intercept)	7.0019	0.77539	< 2.2e-16 ***
USD	1.0098	0.16448	8.283e-10 ***
CPI	13.037	0.59128	< 2.2e-16 ***
IPI	0.37045	0.024227	< 2.2e-16 ***
IRFHL	-0.56905	0.024243	< 2.2e-16 ***
Population	-0.026269	0.024751	0.2885458
0-14 Age Population Ratio	-0.1638	0.029892	4.257e-08 ***
15-64 Age Population Ratio	-0.92035	0.12072	2.457e-14 ***
BSc, MSc, and PhD Degree Population Ratio	0.16782	0.025111	2.340e-11 ***
Existence of Commercial Function	0.029865	0.007178	3.174e-05 ***
Accessibility to Preschools	-0.001088	0.000398	0.0062462 **
Accessibility to Primary Schools	0.0002957	0.0001841	0.1083033
Accessibility to Mid Schools	6.692E-05	7.073E-05	0.3440333
Accessibility to High Schools	-1.63E-05	1.568E-05	0.2993657
Accessibility to Family Health Center	-0.000722	0.0002661	0.0066554 **
Distance to CBD	-0.061626	0.020324	0.0024275 **
Size	1.2109	0.13649	< 2.2e-16 ***
Number of Rooms	-0.061161	0.040682	0.1327347
Age of Building	-0.003022	0.0018689	0.1058724
Number of Floors	-0.009919	0.0072533	0.1714686
Balcony	0.58139	0.26234	0.0266812 *
Number of Bathroom	0.15418	0.043541	0.0003986 ***
Site	0.004185	0.060715	0.9450463
Natural Gas	-0.22812	0.045028	4.058e-07 ***
Geothermal	-0.038925	0.10551	0.7121938
Signif. codes:	0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1		
R-Squared:	0.55354		
Adj. R-Squared:	0.55008		
p-value:	< 2.22e-16		

The following 3 tables (Table 13, Table 14, and Table 15) show the results of other specifications within the Random Effect model. According to these results, while the effect signs of the variables on the housing prices do not change, the amount of the effect and the statistical significance of the effect change.

Table 13. Panel Linear Regression Results of Specification 2 (Random Effect Model)

Balanced Panel: n = 212, T = 30, N = 6360			
	Estimate	Std. Error	Pr(>|z|)
(Intercept)	7.03	0.78	< 2.2e-16 ***
Population	-0.03	0.02	0.2885458
0-14 Age Population Ratio	-0.16	0.03	4.257e-08 ***
15-64 Age Population Ratio	-0.92	0.12	2.457e-14 ***
BSc, MSc, and PhD Degree Population Ratio	0.17	0.03	2.340e-11 ***
Existence of Commercial Function	0.03	0.01	3.174e-05 ***
Accessibility to Preschools	-0.0011	0.0004	0.0062462 **
Accessibility to Primary Schools	0.0003	0.0002	0.1083033
Accessibility to Mid Schools	0.0001	0.0001	0.3440333
Accessibility to High Schools	-0.00002	0.00002	0.2993657
Accessibility to Family Health Center	-0.0007	0.0003	0.0066554 **
Distance to CBD	-0.06	0.02	0.0024275 **
Size	1.21	0.14	< 2.2e-16 ***
Number of Rooms	-0.06	0.04	0.1327347
Age of Building	0.00	0.00	0.1058724
Number of Floors	-0.01	0.01	0.1714686
Balcony	0.58	0.26	0.0266812 *
Number of Bathroom	0.15	0.04	0.0003986 ***
Site	0.00	0.06	0.9450463
Natural Gas	-0.23	0.05	4.058e-07 ***
Geothermal	-0.04	0.11	0.7121938
Signif. codes:	0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1		
R-Squared:	0.55354		
Adj. R-Squared:	0.55008		
p-value:	< 2.22e-16		

Table 14. Panel Linear Regression Results of Specification 3 (Random Effect Model)
(Cont. to Page 55)

Balanced Panel: n = 212, T = 30, N = 6360			
	Estimate	Std. Error	Pr(>|z|)
(Intercept)	5.3007809	0.8373683	2.447e-10 ***
Size	1.455752	0.1645375	< 2.2e-16 ***
Number of Rooms	-0.0885641	0.0508287	0.081438 .

Age of Building	0.002124	0.0022481	0.344747
Number of Floors	-0.0014627	0.0074656	0.844669
Balcony	0.5837231	0.3059597	0.056412 .
Number of Bathroom	0.1280281	0.0544104	0.018622 *
Site	-0.0030591	0.0747942	0.967375
Natural Gas	-0.2551838	0.0516836	7.916e-07 ***
Geothermal	-0.0068556	0.1310468	0.958278
Signif. codes:	0 '***' 0.05 '.'	0.001 '**' 0.1 ' '	0.01 '*' 1
R-Squared:	0.53965		
Adj. R-Squared:	0.53688		
p-value:	< 2.22e-16		

Table 15. Panel Linear Regression Results of Specification 4 (Random Effect Model)
(Cont. to Page 56)

Balanced Panel: n = 212, T = 30, N = 6360			
	Estimate	Std. Error	Pr(>|z|)
Population	-0.03	0.02	0.2885458
0-14 Age Population Ratio	-0.16	0.03	4.257e-08 ***
15-64 Age Population Ratio	-0.92	0.12	2.457e-14 ***
BSc, MSc, and PhD Degree Population Ratio	0.17	0.03	2.340e-11 ***
Existence of Commercial Function	0.03	0.01	3.174e-05 ***
Accessibility to Preschools	-0.00109	0.00040	0.0062462 **
Accessibility to Primary Schools	0.00030	0.00018	0.1083033
Accessibility to Mid Schools	0.00007	0.00007	0.3440333
Accessibility to High Schools	-0.00002	0.00002	0.2993657
Accessibility to Family Health Center	-0.00072	0.00027	0.0066554 **
Distance to CBD	-0.06	0.02	0.0024275 **
Size	1.21	0.14	< 2.2e-16 ***
Number of Rooms	-0.06	0.04	0.1327347
Age of Building	-0.00302	0.00187	0.1058724
Number of Floors	-0.01	0.01	0.1714686
Balcony	0.58	0.26	0.0266812 *
Number of Bathroom	0.15	0.04	0.0003986 ***
Site	0.00419	0.06	0.9450463
Natural Gas	-0.23	0.05	4.058e-07 ***
Geothermal	-0.04	0.11	0.7121938
Signif. codes:	0 '***' 0.05 '.'	0.001 '**' 0.1 ' '	0.01 '*' 1

R-Squared:	0.55354
Adj. R-Squared:	0.55008
p-value:	< 2.22e-16

All regressions are statistically highly significant, and the rate of explanation of the dependent variable by the independent variables is at least 52%. In addition, to examine the changes in the housing prices for 30 months, the prices were examined with the Random Effect model within the 4th specification. Therefore, Table 15 and Table 16 form a whole. Table 16 shows only the result of the time portion of this regression. According to the results, price changes in all months except June 2017 are statistically very significant, and a decrease is observed in the level of increase in housing prices only in January 2018 and January and February 2019.

Table 16. Panel Linear Regression Time Portion Results of Specification 4 (Random Effect Model) (Cont. to Page 57)

	Estimate	Std. Error	Pr(>|z|)
factor(Time)2017-06	0.00142	0.00764	0.8524605
factor(Time)2017-07	0.02280	0.00764	0.0028335 **
factor(Time)2017-08	0.03501	0.00764	4.593e-06 ***
factor(Time)2017-09	0.04778	0.00764	3.989e-10 ***
factor(Time)2017-10	0.06491	0.00764	< 2.2e-16 ***
factor(Time)2017-11	0.08186	0.00764	< 2.2e-16 ***
factor(Time)2017-12	0.09820	0.00764	< 2.2e-16 ***
factor(Time)2018-01	0.08972	0.00783	< 2.2e-16 ***
factor(Time)2018-02	0.11441	0.00783	< 2.2e-16 ***
factor(Time)2018-03	0.13040	0.00783	< 2.2e-16 ***
factor(Time)2018-04	0.14290	0.00783	< 2.2e-16 ***
factor(Time)2018-05	0.15780	0.00783	< 2.2e-16 ***
factor(Time)2018-06	0.16706	0.00783	< 2.2e-16 ***
factor(Time)2018-07	0.17582	0.00783	< 2.2e-16 ***
factor(Time)2018-08	0.18622	0.00783	< 2.2e-16 ***
factor(Time)2018-09	0.19292	0.00783	< 2.2e-16 ***
factor(Time)2018-10	0.19785	0.00783	< 2.2e-16 ***
factor(Time)2018-11	0.20128	0.00783	< 2.2e-16 ***
factor(Time)2018-12	0.20678	0.00783	< 2.2e-16 ***
factor(Time)2019-01	0.20118	0.00818	< 2.2e-16 ***
factor(Time)2019-02	0.20086	0.00818	< 2.2e-16 ***
factor(Time)2019-03	0.20446	0.00818	< 2.2e-16 ***

factor(Time)2019-04	0.20868	0.00818	< 2.2e-16 ***
factor(Time)2019-05	0.21269	0.00818	< 2.2e-16 ***
factor(Time)2019-06	0.21559	0.00818	< 2.2e-16 ***
factor(Time)2019-07	0.21997	0.00818	< 2.2e-16 ***
factor(Time)2019-08	0.22611	0.00818	< 2.2e-16 ***
factor(Time)2019-09	0.23197	0.00818	< 2.2e-16 ***
factor(Time)2019-10	0.24505	0.00818	< 2.2e-16 ***

The Hausman Test determines which of the two models is appropriate. In the Hausman Test alternative hypothesis is Fixed Effect model. The alternative hypothesis assumes that individual heterogeneity, which is considered as an error term in the Random Effect, is related to the regressors. Table 17 shows the result of the Hausman Test within specification 1. Since the significance level is less than 0.05, it is concluded that the Fixed Effect model is more appropriate to use. However, within the scope of this study, a methodological distinction was not made to examine the effect of the housing structural characteristics on the housing prices.

Table 17. Hausman Test Results

chisq = 81.388	df = 39	p-value = 8.121e-05
alternative hypothesis: one model is inconsistent		

5.3. Spatial Analyses

Evidence of the existence of spatial autocorrelation is required for spatial models to be applicable. If there is a spatial autocorrelation and this presence is statistically significant, the scope of the study can be expanded by using the spatial research methods. For this reason, first of all, the Global Moran's I test was applied to the housing prices and annual percentage changes in housing prices. A spatial weight matrix is used to apply this test. The matrix can be created according to the contiguity or distance-based weights. Weights by distance are determined according to the length of the common boundary between spatial units or the distance between them. As the distance between observations increases, the spatial autocorrelation between them decreases (Anselin, 1988).

In this study, since the spatial unit is a neighborhood and there are 212 neighborhoods in the study area, the spatial weight matrix (W) is 212x212 dimensional. Due to the spatial units are determined according to the availability of the average house

sales price data, there is no border situation. Therefore, the spatial weight matrix is constructed based on an inverse distance method.

Table 18 shows the results of the Global Moran's I test applied to the average housing sales prices of May 2017. Since the Moran's I statistic result is higher than the expected value, there is a spatial autocorrelation, and this correlation is statistically very significant. In Figure 14, the visualization of the test is observed. In May 2017, there has been spatial autocorrelation in the houses in a price range of 200000-400000 TL, as shown in Figure 14.

Table 18. Global Moran's I Test Results (2017/5 Housing Sales Prices)

Moran I Statistic Standard Deviate	p-value	Moran I statistic	Expectation	Variance
26.759	< 2.2e-16	0.282302695	-0.004739336	0.000115064

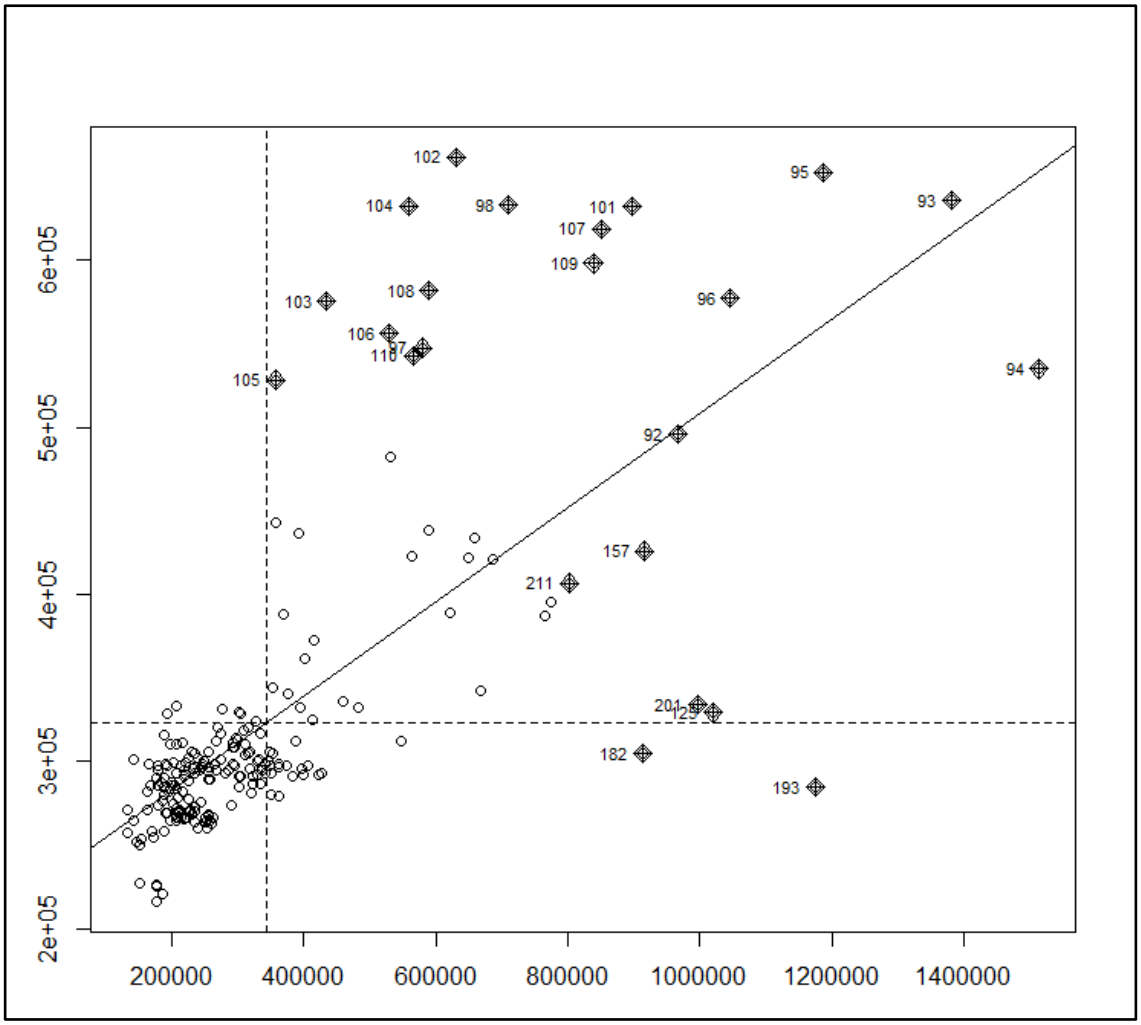

Figure 14. Global Moran's I Test Results (2017/5 Housing Sales Prices)

Table 19 shows the results of the Global Moran's I test applied to the average housing sales prices of October 2019. Since the Moran's I statistic result is higher than the expected value, there is a spatial autocorrelation, and this correlation is statistically very significant. In Figure 15, the visualization of the test is observed. In October 2019, there has been spatial autocorrelation in the houses in a price of 450000 TL, as shown in Figure 15.

Table 19. Global Moran's I Test Results (2019/10 Housing Sales Prices)

Moran I Statistic Standard Deviate	p-value	Moran I statistic	Expectation	Variance
27.527	< 2.2e-16	0.290541079	-0.004739336	0.000115064

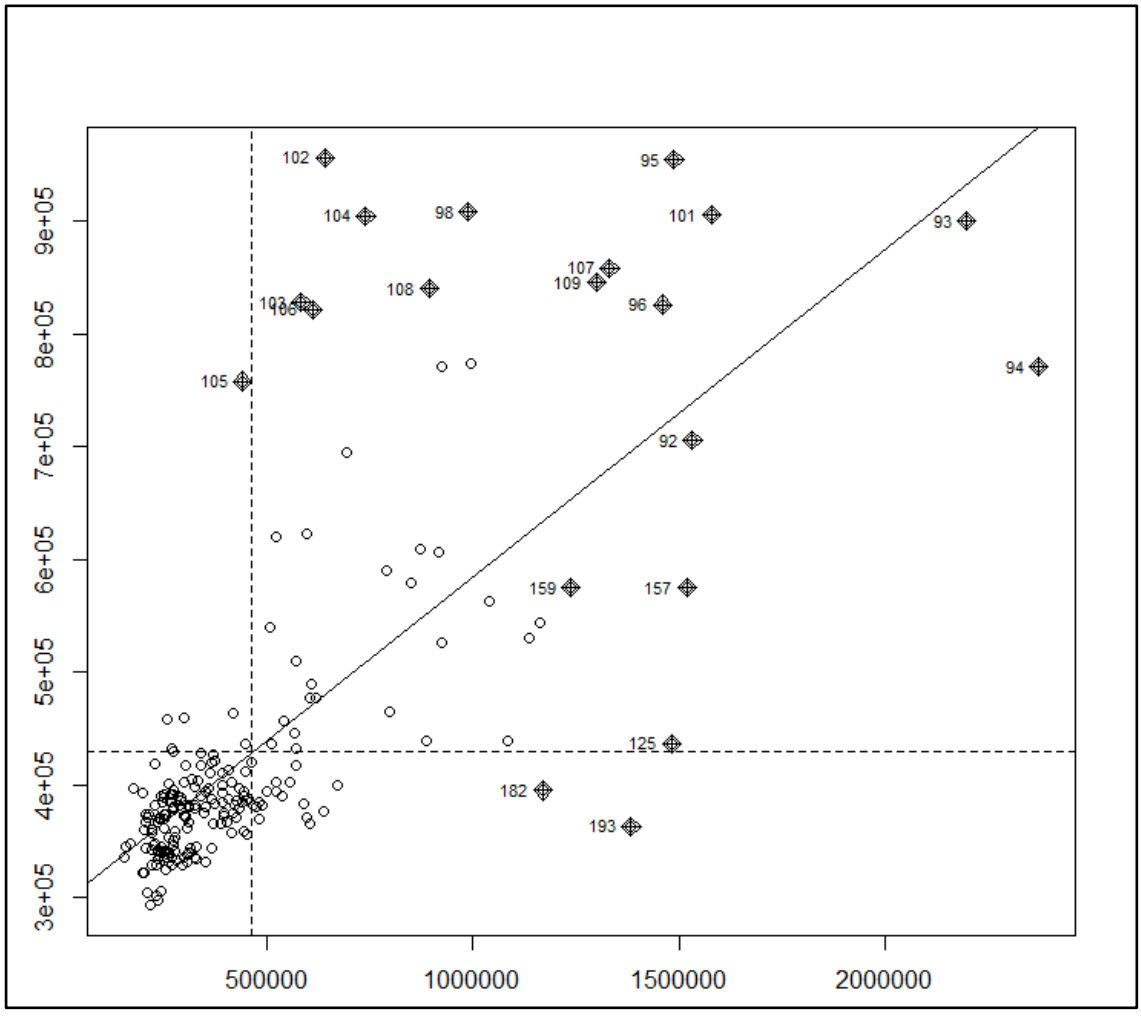

Figure 15. Global Moran's I Test Results (2019/10 Housing Sales Prices)

Table 20 shows the results of the Global Moran's I test applied to the annual percentage change of housing prices. Since the Moran's I statistic result is higher than the expected value, there is a spatial autocorrelation, and this correlation is statistically very significant. In Figure 16, the visualization of the test is observed. There is spatial autocorrelation for annual percentage changes of around 5% -12%, as shown in Figure 16.

Table 20. Global Moran's I Test Results (Annual % Change)

Moran I Statistic Standard Deviate	p-value	Moran I statistic	Expectation	Variance
8.308	< 2.2e-16	0.084378497	-0.004739336	0.000115064

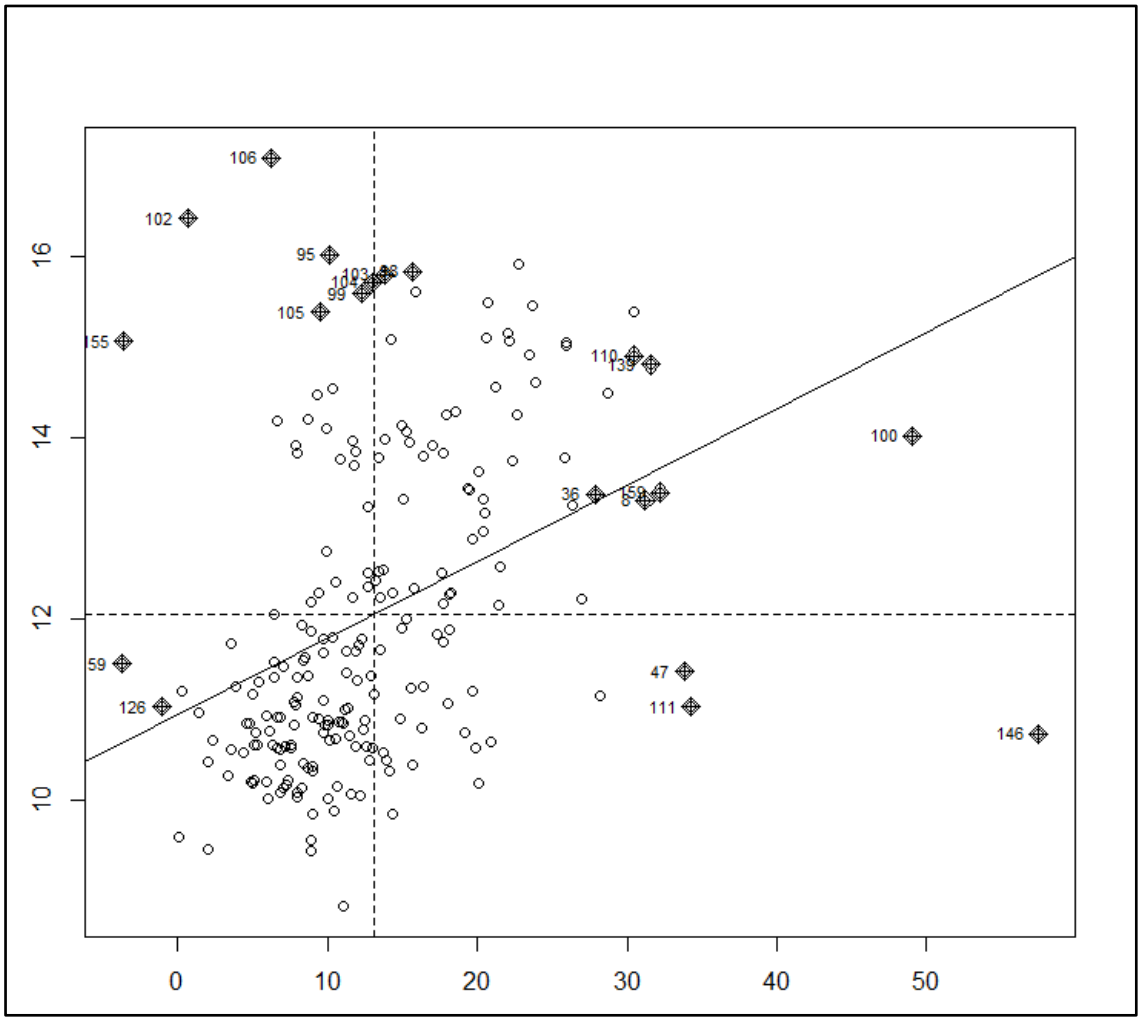

Figure 16. Global Moran's I Test Results (Annual % Change)

Cluster and Outlier Analysis (Anselin Local Moran's I) was applied to indicate statistically significant clusters and outliers generated by the values. Figure 17 shows the analysis in May 2017. According to Figure 17, spatial clusters with high housing prices are found in the neighborhoods of Çeşme, Urla, Gaziemir, Çiğli districts, and spatial clusters with low housing prices are found in the neighborhoods of Buca, Torbalı, Karabağlar, Bayraklı, Bornova, and Bergama districts. Besides, low priced houses are found in the neighborhoods of Bayraklı and Çiğli districts around the high-priced houses (high-low outliers), high priced houses around the low-priced houses (low-high outliers) are found in the neighborhoods of Gaziemir, Buca, and Çiğli districts.

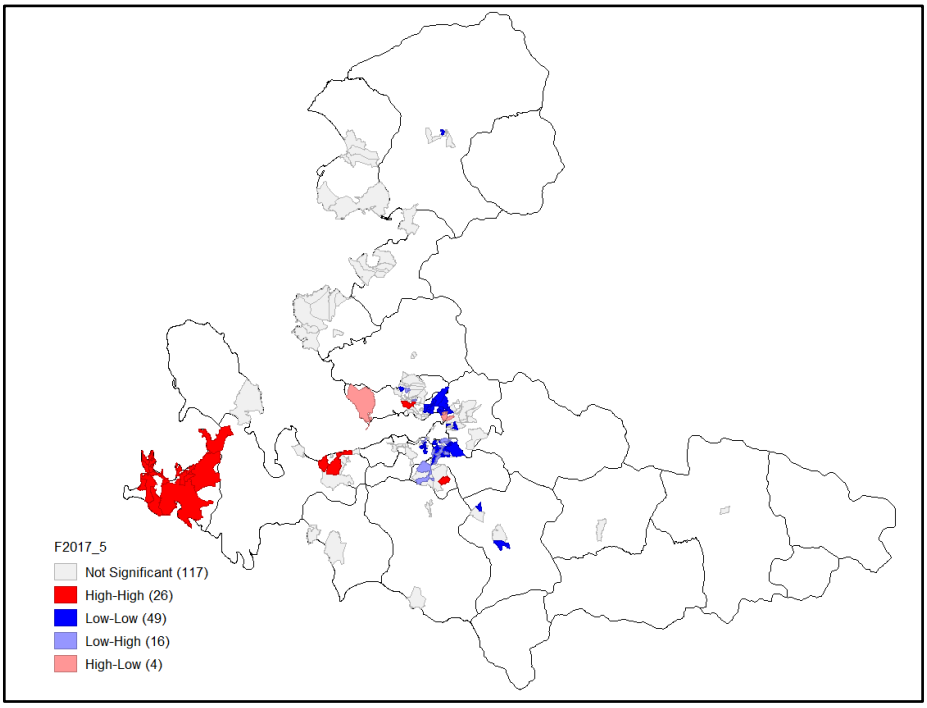

Figure 17. Anselin Local Moran's I (2017/5 Housing Sales Prices)

Figure 18 shows the analysis for October 2019. According to Figure 18, spatial clusters with high housing prices are found in the neighborhoods of Çeşme, Urla, Güzelbahçe, Gaziemir, Çiğli districts, and spatial clusters with low housing prices are found in the neighborhoods of Buca, Torbalı, Karabağlar, Bayraklı, and Bornova districts. It is also clear that low priced houses are found in the neighborhoods of Bayraklı and Çiğli districts around the high-priced houses (high-low outliers), high priced houses around the low-priced houses (low-high outliers) are found in the neighborhoods of Gaziemir, Buca, Çiğli, and Çeşme districts.

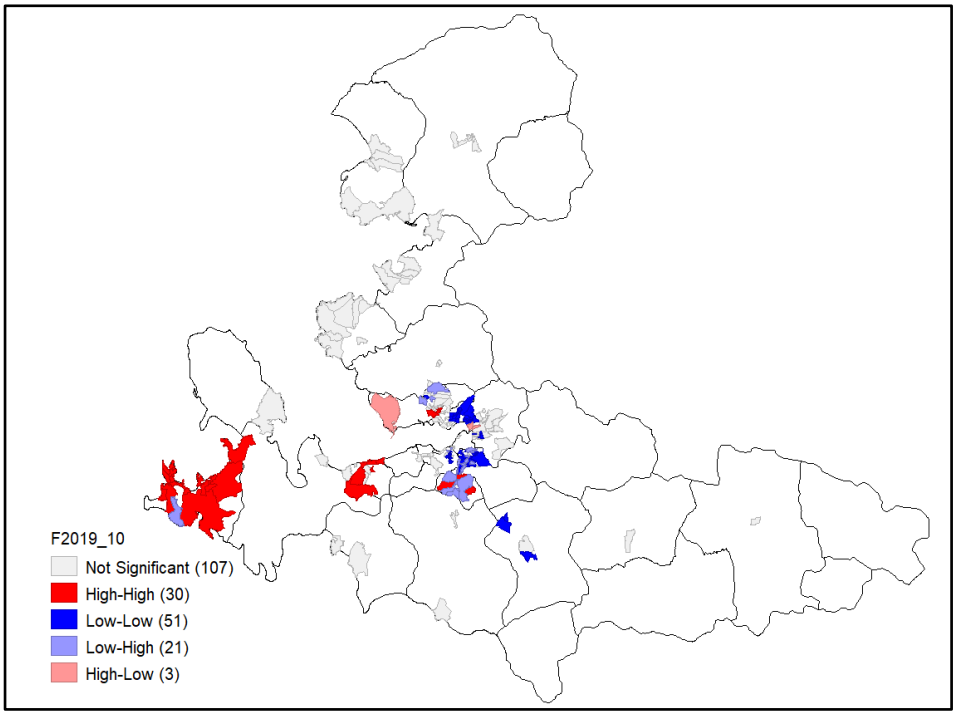

Figure 18. Anselin Local Moran's I (2019/10 Housing Sales Prices)

Figure 19 shows the analysis in annual percentage change of housing sales prices. According to Figure 19, spatial clusters with high change are found in the neighborhoods of Çeşme, Urla, Güzelbahçe, Gaziemir, Çiğli, Foça, Dikili districts, and spatial clusters with low change found in the neighborhoods of Buca, Bornova, and Bayraklı districts. Low changes are found in the neighborhoods of Karabağlar, Buca, Bayraklı, and Bergama districts around the high changes (high-low outliers), high changes around the low changes (low-high outliers) are found in the neighborhoods of Çeşme, Gaziemir and Foça districts.

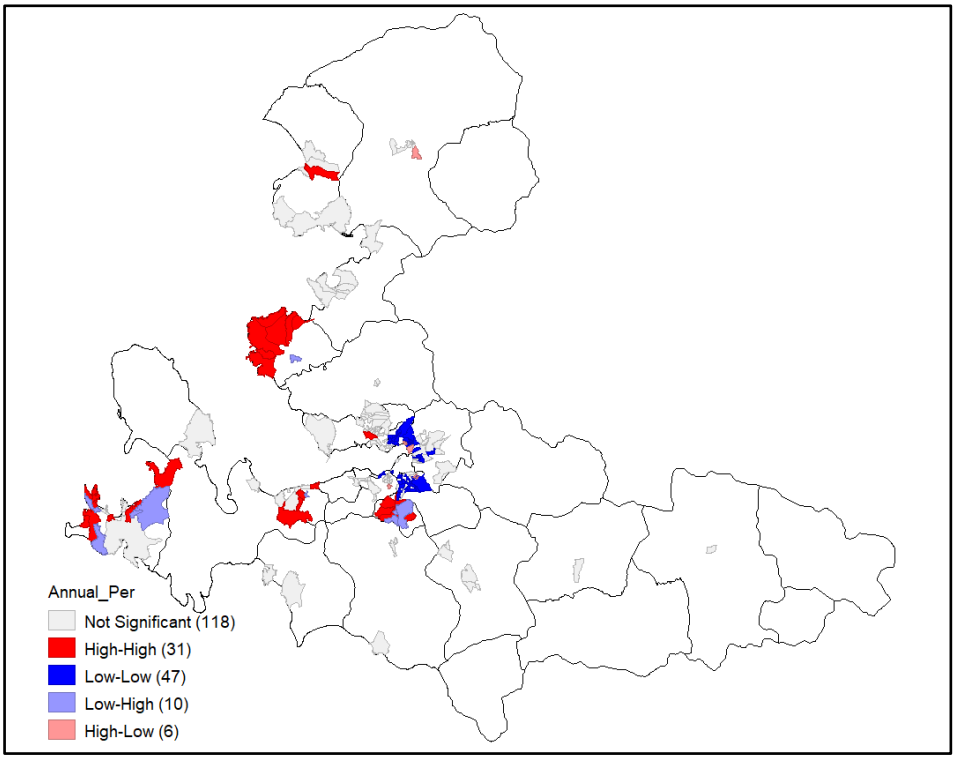

Figure 19. Anselin Local Moran's I (Annual % Change of Housing Prices)

The Global Moran's I test, which proves the existence of the spatial autocorrelation, does not explain source of this autocorrelation. Therefore, the ML (Maximum Likelihood) or the GM (Generalized Moment) estimators are used to determine the source of spatial dependence. The spatial autocorrelations for panel regression should be tested before using these estimators. For this purpose, the Baltagi, Song, and Koh marginal or conditional LM test was used. This test investigates spatial correlation on the error term. Table 21 gives the results of the LM test for all specifications.

Table 21. LM Test Results of All Specifications (Cont. to Page 64)

Baltagi, Song and Koh LM*-lambda conditional LM test (assuming sigma^2_mu >= 0)	
SPECIFICATION 1 (ALL VARIABLES)	
LM*-lambda = 84.844	p-value < 2.2e-16
alternative hypothesis: Spatial autocorrelation	
SPECIFICATION 2 (NEIGHBORHOOD-SPESIFIC VARIABLES)	
LM*-lambda = 83.609	p-value < 2.2e-16
alternative hypothesis: Spatial autocorrelation	
SPECIFICATION 3 (STRUCTURAL VARIABLES)	
LM*-lambda = 218.5	p-value < 2.2e-16

alternative hypothesis: Spatial autocorrelation	
SPECIFICATION 4 (NEIGHBORHOOD + STRUCTURAL VARIABLES)	
LM*-lambda = 85.902	p-value < 2.2e-16
alternative hypothesis: Spatial autocorrelation	

The existence of spatial autocorrelation is found in the spatial panel regression because the LM*-lambda value reflecting the spatial autocorrelation coefficient is high and the test is statistically significant.

Spatial dependence refers to the dependence of an observation at position *i* on other observations at position *j*. Dependency resulting from measurement errors is seen in the error term of the regression. The model that takes this kind of dependency into account is called the Spatial Error Model (SEM). The model that considers the dependence that occurs as a result of the interaction between the positions is called the Spatial Lag Model or the Spatial Autoregressive Model (SAR). It is the ML (Maximum Likelihood) estimator which is suitable for the Spatial Error Model and the Spatial Lag Model and is frequently used in empirical studies. However, because it is difficult to calculate this estimator in large samples and in some cases to realize the assumption of normal distribution, another estimator that is considered appropriate is the Generalized Moment estimator (Zeren, 2010).

The Spatial Error Model and the Spatial Lag Model were tested with GM estimator simultaneously within the scope of the study. However, the findings of the LM test which are shown in Table 21, cannot discriminate whether one model is more appropriate than the other. Both the fixed and the random effects were included in both models because no methodological differentiation was made. The Spatial Error Model for the first specification is given in Table 22.

Table 22. Spatial Error Model (Specification 1) (Cont. to Page 65)

	FIXED EFFECT		RANDOM EFFECT	
	Estimate	Pr(>|t|)	Estimate	Pr(>|t|)
rho	0.835655			
(Intercept)			6.8474	< 2.2e-16 ***
USD	-0.11627	0.391639	-0.1736	0.56919
CPI	2.3789	5.914e-05 ***	3.2579	0.014240 *
IPI	0.01943	0.7167253	0.028742	0.811194
IRFHL	-0.24825	1.111e-06 ***	-0.3741	0.001055 **

Population	0.1247	0.0372858 *	0.0092678	0.674124
0-14 Age Population Ratio	-0.11558	0.0002147 ***	-0.12421	1.820e-05 ***
15-64 Age Population Ratio	-1.0109	8.158e-15 ***	-0.85232	5.766e-13 ***
BSc, MSc, and PhD Degree Population Ratio	0.14725	7.306e-06 ***	0.18896	2.583e-15 ***
Existence of Commercial Function	0.010754	0.1697841	0.013211	0.068073 .
Accessibility to Preschools	-0.002509	0.0007900 ***	-0.0009904	0.003291 **
Accessibility to Primary Schools	0.0018021	2.940e-06 ***	0.00039243	0.014411 *
Accessibility to Mid Schools	-0.00034	0.0191325 *	0.000019435	0.754068
Accessibility to High Schools	-2.89E-05	0.1978063	-6.3981E-06	0.655061
Accessibility to Family Health Center	4.923E-05	0.9159189	-0.00021816	0.355677
Distance to CBD			-0.041962	0.049756 *
Size			1.2384	< 2.2e-16 ***
Number of Rooms			-0.060536	0.072386 .
Age of Building			-0.0017832	0.261431
Number of Floors			-0.0015387	0.799529
Balcony			0.45141	0.038464 *
Number of Bathroom			0.048331	0.185395
Site			-0.026686	0.595779
Natural Gas			-0.17459	2.960e-05 ***
Geothermal			0.0092575	0.922983

Signif. codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' ' 1

Since this rho value in the Spatial Error Model tested with the fixed effect is positive and high, it has been concluded that the spatial dependency is high in this specification, as shown in Table 22. The children population rate, the active population rate, the higher education rate, and the preschool accessibility are variables with high statistical significance in both the fixed and the random effects. The housing prices were negatively affected in the neighborhoods with high children population rate, high active population rate, and high access to preschools. Housing prices were positively affected in neighborhoods with high education rates. In the category of the housing structural characteristics, which can only be examined within the scope of the random effect, the statistical significance levels of the size and natural gas variables are very high. The

housing prices were positively affected in the neighborhoods where the size of housing increased. In the neighborhoods where there are houses with natural gas, housing prices were negatively affected. The model was repeated with the other 3 specifications to examine whether these results were robust. The following 3 tables (Table 23, Table 24, Table 25) present the Spatial Error Model results of these specifications.

Table 23. Spatial Error Model (Specification 2)

	FIXED EFFECT		RANDOM EFFECT	
	Estimate	Pr(>|t|)	Estimate	Pr(>|t|)
rho	0.8375552			
(Intercept)			13.266	< 2.2e-16 ***
Population	0.13406	0.0253731 *	-0.038951	0.166839
0-14 Age Population Ratio	-0.12045	0.0001174 ***	-0.12719	3.530e-05 ***
15-64 Age Population Ratio	-1.0466	9.308e-16 ***	-0.96909	1.731e-14 ***
BSc, MSc, and PhD Degree Population Ratio	0.15517	2.338e-06 ***	0.23047	< 2.2e-16 ***
Existence of Commercial Function	0.01095	0.1629474	0.014377	0.063833 .
Accessibility to Preschools	-0.0025636	0.0006180 ***	-0.0011862	0.006155 **
Accessibility to Primary Schools	0.001798	3.239e-06 ***	0.0005318	0.004572 **
Accessibility to Mid Schools	-0.0003365	0.0206537 *	0.000071873	0.36774
Accessibility to High Schools	-2.937E-05	0.1908112	-0.000026543	0.122026
Accessibility to Family Health Center	8.2146E-05	0.8604042	-0.00023029	0.426324
Distance to CBD			0.0097543	0.696709

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 24. Spatial Error Model (Specification 3) (Cont. to Page 67)

	RANDOM EFFECT	
	Estimate	Pr(>|t|)
(Intercept)	5.7349354	2.01e-11 ***
Size	1.4677195	< 2.2e-16 ***
Number of Rooms	-0.0749151	0.0685102 .
Age of Building	0.0016844	0.3685231
Number of Floors	0.0038222	0.5482952

Balcony	0.4202174	0.0886216 .
Number of Bathroom	0.0208257	0.6406409
Site	-0.0123602	0.8383606
Natural Gas	-0.1830388	0.0002648 ***
Geothermal	0.0730925	0.5359549

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Table 25. Spatial Error Model (Specification 4) (Cont. to Page 68)

	RANDOM EFFECT	
	Estimate	Pr(>|t|)
(Intercept)	6.8834	< 2.2e-16 ***
Population	0.009958	0.651395
0-14 Age Population Ratio	-0.1251	1.580e-05 ***
15-64 Age Population Ratio	-0.85416	5.141e-13 ***
BSc, MSc, and PhD Degree Population Ratio	0.18901	2.558e-15 ***
Existence of Commercial Function	0.013658	0.059204 .
Accessibility to Preschools	-0.00099352	0.003183 **
Accessibility to Primary Schools	0.0003896	0.015115 *
Accessibility to Mid Schools	0.000018867	0.761005
Accessibility to High Schools	-0.0000063	0.659972
Accessibility to Family Health Center	-0.00021783	0.356344
Distance to CBD	-0.041684	0.051587 .
Size	1.2384	< 2.2e-16 ***
Number of Rooms	-0.060579	0.072104 .
Age of Building	-0.0017843	0.261044
Number of Floors	-0.0015115	0.802955

Balcony	0.44757	0.040090 *
Number of Bathroom	0.048108	0.187322
Site	-0.026272	0.601389
Natural Gas	-0.17414	3.123e-05 ***
Geothermal	0.0094727	0.92122

Signif. codes:	0 '***'	0.001 '**'	0.01 '*'	0.05 '.'	0.1 ' '	1

Table 23 shows that, similar to the first specification, the rho value in the fixed effect is positive and high. This finding demonstrates the robustness of the spatial dependence result. When the results of the models applied to all specifications are examined based on variables, the fact that the effect signs of the variables and the statistical significance level of this effects are the same in each model shows that the results for the variables are also robust.

The Spatial Lag Model was applied to all specifications after reviewing the Spatial Error Model with all specifications. The Spatial Lag Model for the first specification is given in Table 26.

Table 26. Spatial Lag Model (Specification 1) (Cont. to Page 69)

	FIXED EFFECT		RANDOM EFFECT	
	Estimate	Pr(>|t|)	Estimate	Pr(>|t|)
lambda	1.0239	< 2.2e-16 ***	0.97659	< 2.2e-16 ***
(Intercept)			-4.7215	0.00000000000003553 ***
USD	-0.0016469	0.94087	-0.00059232	0.9788612
CPI	-0.019854	0.84362	-0.010653	0.9160644
IPI	0.0035386	0.68648	0.0044457	0.6141615
IRFHL	-0.0021449	0.80542	0.0034955	0.6888878
Population	0.018878	0.74693	0.010978	0.5502558
0-14 Age Population Ratio	-0.080738	0.00994 **	-0.12233	0.00001167 ***
15-64 Age Population Ratio	-0.63489	0.0000009345 ***	-0.72586	0.0000000001101 ***
BSc, MSc, and PhD Degree Population Ratio	0.04189	0.18402	0.15363	0.000000000000665 ***
Existence of Commercial Function	0.01543	0.0372 *	0.019865	0.0026421 **
Accessibility to Preschools	-0.0019062	0.01195 *	-0.00087002	0.003977 **
Accessibility to Primary Schools	0.0014584	0.00007408 ***	0.00022098	0.1133408
Accessibility to Mid Schools	-0.0003074	0.0296 *	0.000042893	0.4217175

Accessibility to High Schools	-1.729E-05	0.42781	4.1594E-06	0.7446206
Accessibility to Family Health Center	-0.0004085	0.37953	-0.00022887	0.2677132
Distance to CBD			-0.078841	0.00000004317 ***
Size			1.1282	< 2.2e-16 ***
Number of Rooms			-0.05528	0.053495 .
Age of Building			-0.0011818	0.3762585
Number of Floors			-0.0025872	0.6129156
Balcony			0.33973	0.0684031 .
Number of Bathroom			0.064489	0.0355781 *
Site			-0.0010346	0.9808147
Natural Gas			-0.1186	0.0002343 ***
Geothermal			0.046323	0.5336935

The spatial units have a positive spillover impact on their neighbors, according to the results in Table 26, because the lambda coefficient is high and statistically significant. This means that if the average house sales price in one neighborhood rises, the average house sales price in nearby neighborhoods rises as well. The children population rate, and the active population rate are variables with high statistical significance in both the fixed and the random effects. In the neighborhoods where these two ratios increase, the housing prices are negatively affected. The distance to the central business district variable, which can only be examined within the random effect because it is constant in time, has a very high level of statistical significance. The housing prices are negatively affected in the neighborhoods with a high distance from the central business area. The size and natural gas variables in the housing structural characteristics category have a high level of statistical significance. While the housing prices are affected positively in the neighborhoods with high housing sizes, the housing prices are negatively affected in the neighborhoods with natural gas. The model was repeated with the other 3 specifications to examine whether these results were robust. The following table (Table 27) present the Spatial Lag Model results of specification 2.

Table 27. Spatial Lag Model (Specification 2) (Cont. to Page 70)

	FIXED EFFECT		RANDOM EFFECT	
	Estimate	Pr(>|t|)	Estimate	Pr(>|t|)
lambda	1.0222	< 2.2e-16 ***	0.97331	< 2.2e-16 ***
(Intercept)			0.96065	0.016162 .
Population	0.020242	0.729029	-0.063488	0.0065592 .
0-14 Age Population Ratio	-0.082016	0.008614 ***	-0.10972	0.0001505 ***

15-64 Age Population Ratio	-0.64218	0.0000006191 ***	-0.80074	0.0000000000104 ***
BSc, MSc, and PhD Degree Population Ratio	0.043261	0.169145	0.1877	0.000000000000001332 ***
Existence of Commercial Function	0.015144	0.040134 .	0.021675	0.0017693 **
Accessibility to Preschools	-0.0019074	0.011869 *	-0.00093987	0.0168956 *
Accessibility to Primary Schools	0.0014552	0.00007626 ***	0.00036098	0.0280746 *
Accessibility to Mid Schools	-0.0003056	0.030425 *	0.00012058	0.0835268 .
Accessibility to High Schools	-1.708E-05	0.433021	-0.000017091	0.2686548
Accessibility to Family Health Center	-0.0004059	0.382378	-0.00037691	0.1438879
Distance to CBD			-0.011019	0.4958697

Since the lambda coefficients in Table 26 and Table 27 were high and statistically significant, it was determined that the positive spillover impact finding was a robust result. When the results are analyzed based on variables, the variables with a very high statistical significance level in both the fixed effect and the random effect in the first specification are the same in the second specification too. It proves that the effect signs and statistical significance levels of these variables are robust. Because the results of specifications 3 and 4 are exactly the same, they are not tabulated in this section, demonstrating the results' robustness once again.

The Geographical Weighted Regression was applied as the last step of the empirical analysis. The Geographically Weighted Regression allows examining the effect of independent variables on the dependent variable at the local level. The analysis was made for the last month of the period, October 2019. It is planned to include statistically significant variables as a result of both the Spatial Error Model and Spatial Lag Model in this regression. These variables are listed as the children population rate, the active population rate, the higher education rate, the existence of commercial function, the accessibility to preschools, the accessibility to primary school, the size, the number of bathrooms, and the natural gas. However, due to the multicollinearity problem, the children population ratio, the size, the number of bathrooms, and the natural gas variables had to be removed. Analysis was performed with the remaining five variables.

Figure 20 shows the coefficients of the active population ratio. According to Figure 20, the neighborhoods where the active population ratio cause the highest decrease in housing prices are in Aliağa, Dikili, and Bergama districts. Neighborhoods, where the

active population ratio causes the least decrease in housing prices, are located in Çeşme, Urla, Güzelbahçe, Seferihisar, Menderes, Gaziemir, Torbalı, and Bayındır districts.

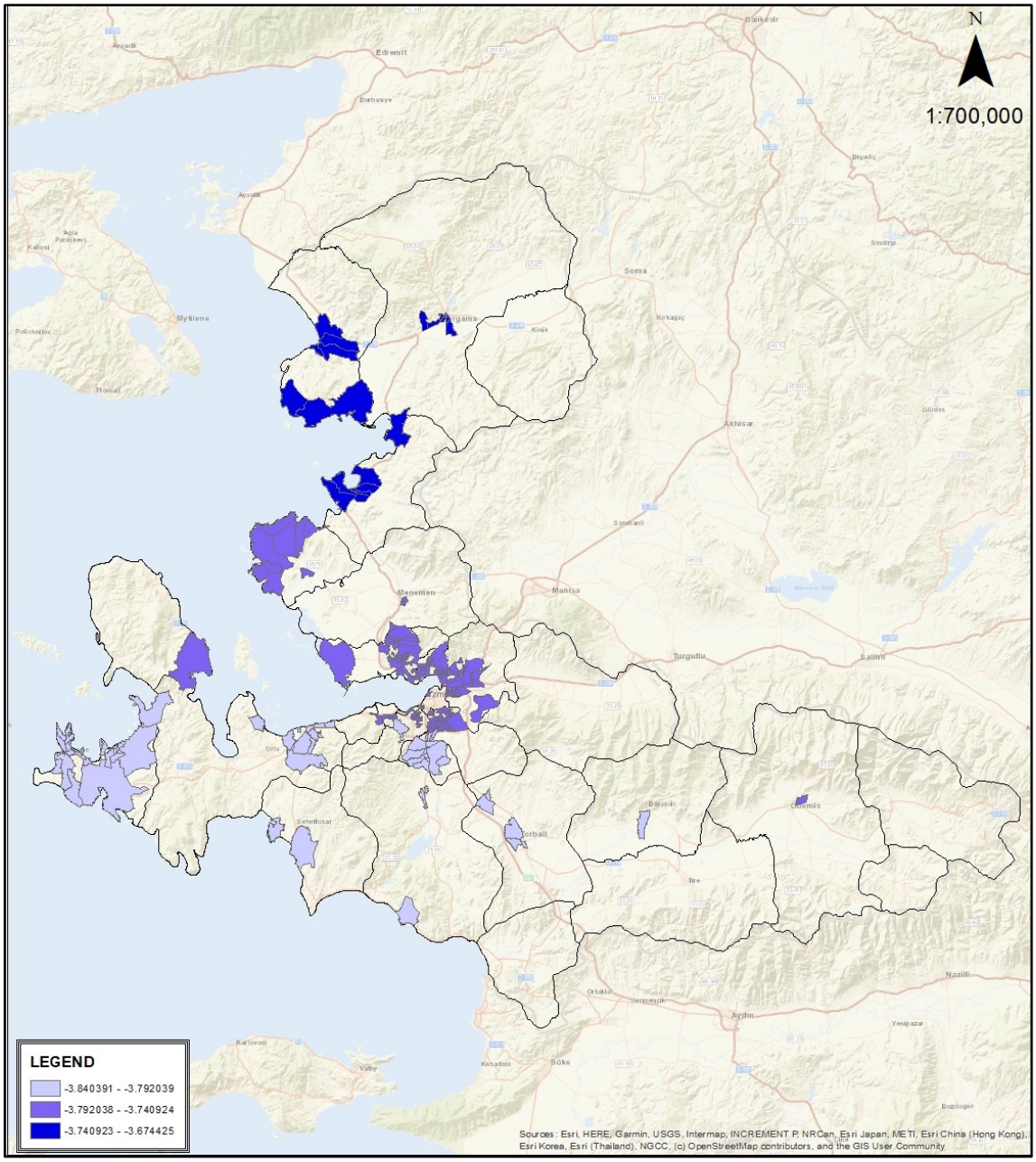

Figure 20. GWR Coefficients of Active Population Rate

Figure 21 shows the coefficients of the accessibility to preschools. According to Figure 21, in the neighborhoods in Çeşme, Urla, Karaburun, and Seferihisar districts the ease of access of preschools resulted in the highest decreases in housing prices. The neighborhoods in Bergama, Bayındır, and Ödemiş districts have the lowest decrease in housing prices as a result of preschool accessibility.

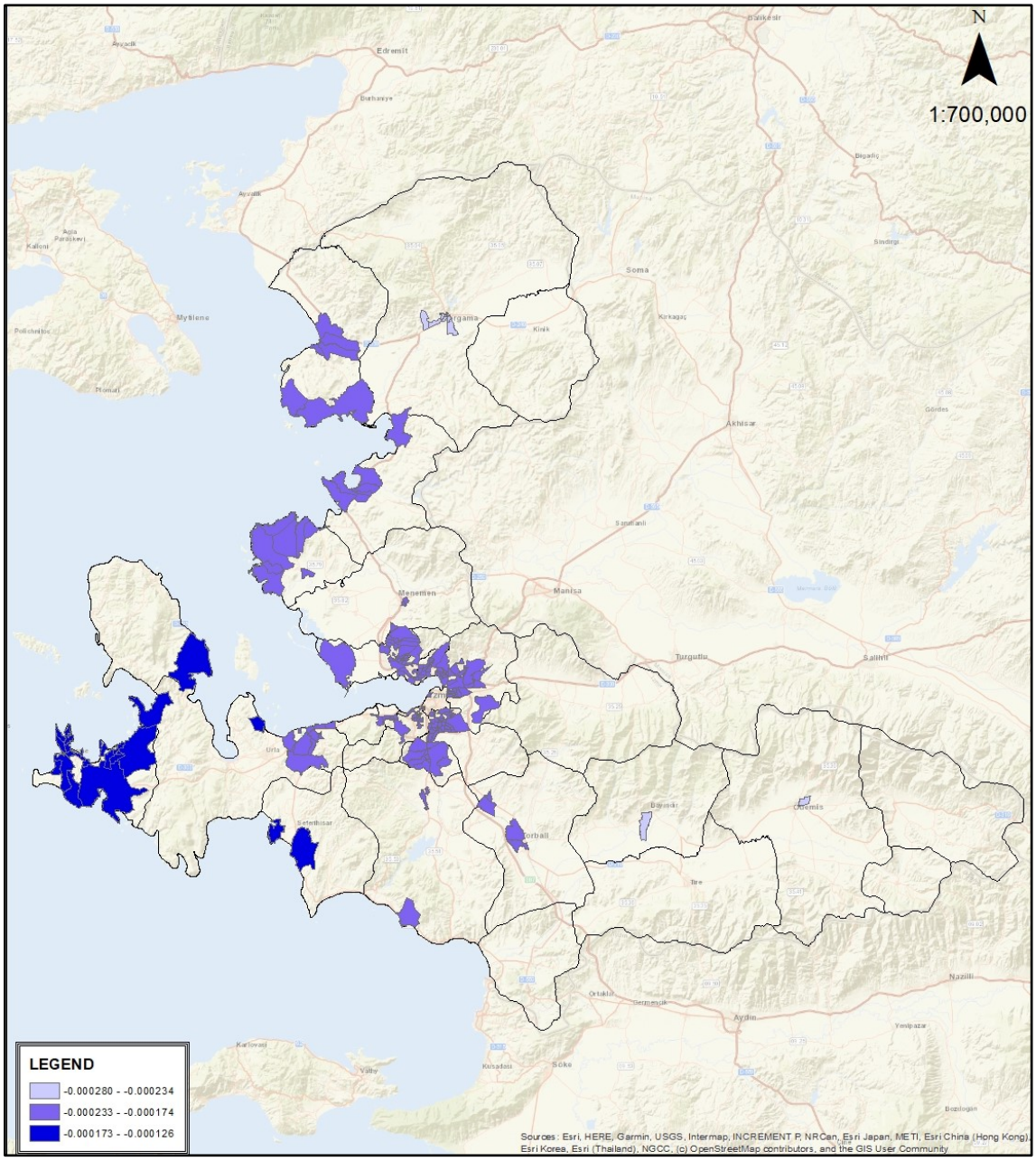

Figure 21. GWR Coefficients of Accessibility to Preschools

Figure 22 shows the coefficients of the higher education rate. According to the results in Figure 22, the neighborhoods where the higher education rate caused the highest increase in housing prices are in Çeşme, Urla, Karaburun, Foça, Aliağa, Dikili, and Bergama districts. Neighborhoods, where the higher education rate causes the least increase in housing prices, are located in Menderes, Torbalı, Bayındır, Ödemiş, and central districts of Izmir.

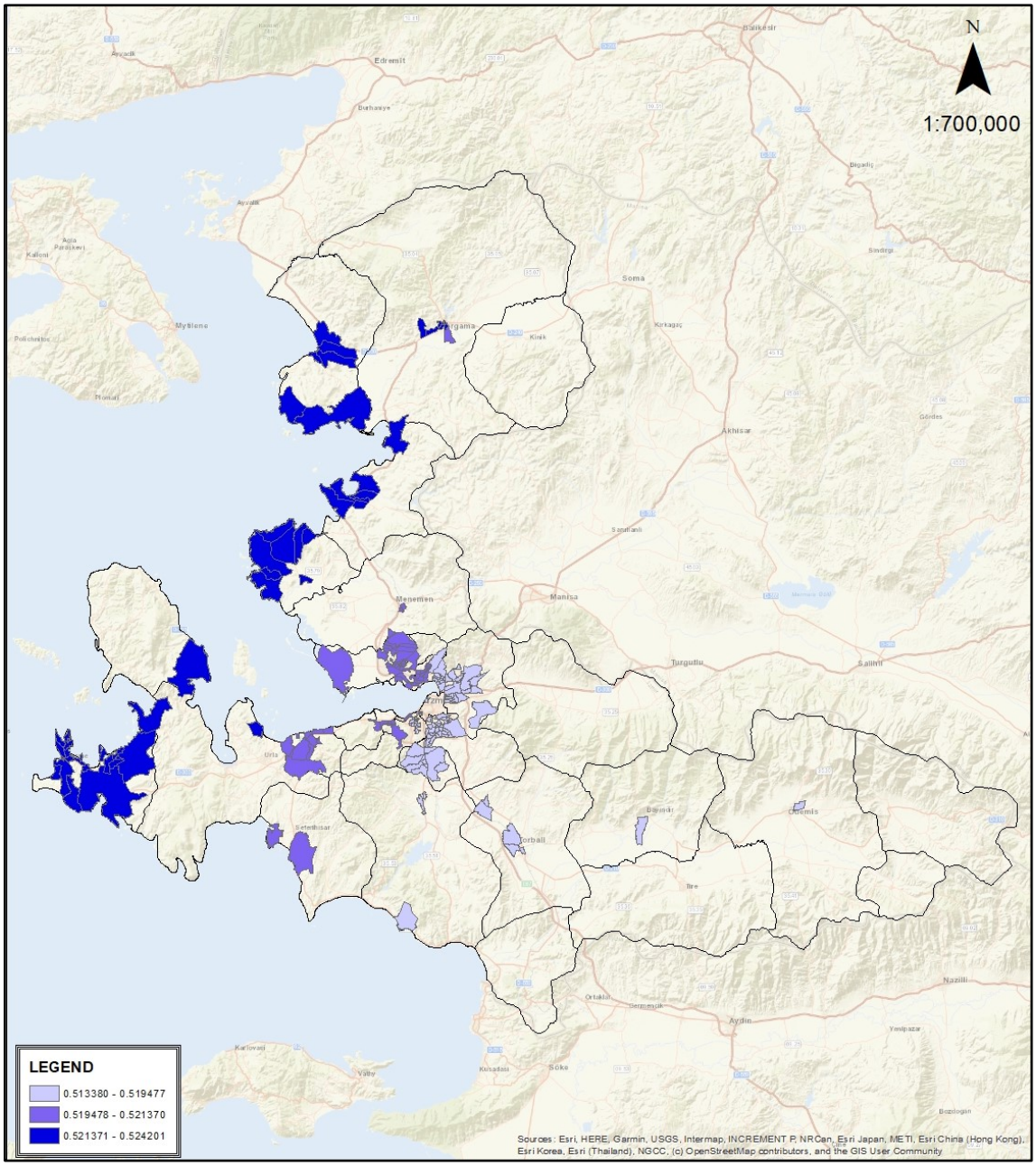

Figure 22. GWR Coefficients of Higher Education Rate

Figure 23 shows the coefficients of the accessibility to primary schools. According to the results in Figure 23, in the neighborhoods in Seferihisar, Menderes, Torbalı, Bayındır, Ödemiş, and central districts of Izmir the ease of access of primary schools resulted in the highest increases in housing prices. The neighborhoods in Aliağa, Foça, Dikili, and Bergama districts have the lowest increase in housing prices as a result of primary school accessibility.

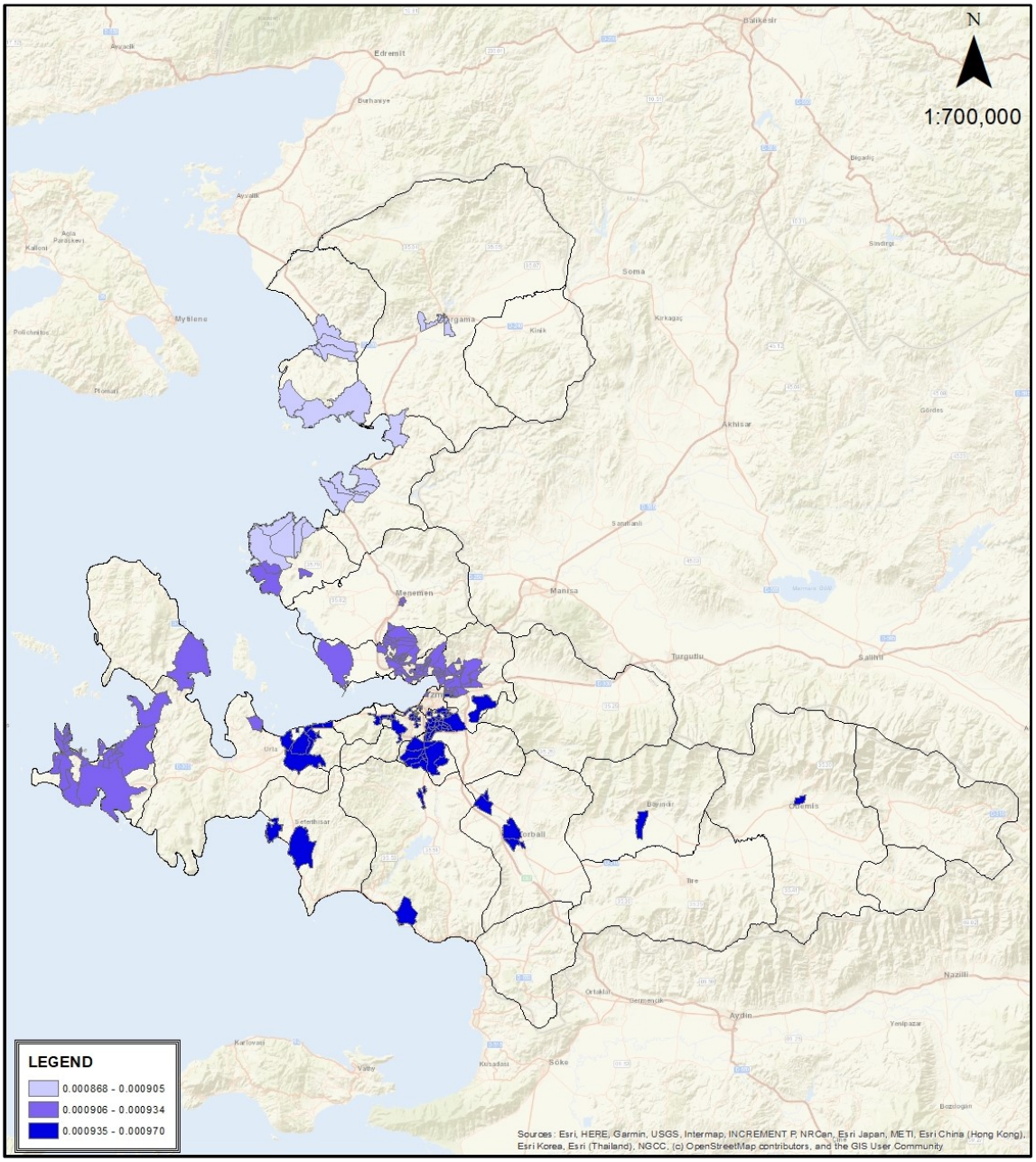

Figure 23. GWR Coefficients of Accessibility to Primary Schools

Figure 24 shows the coefficients of the existence of commercial function. According to the results in Figure 24, the neighborhoods where the existence of commercial function caused the highest increase in housing prices are in Menderes, Torbalı, Bayındır, Ödemiş, and central districts of Izmir. Neighborhoods, where the existence of commercial function causes the least increase in housing prices, are located in Çeşme and Karaburun districts.

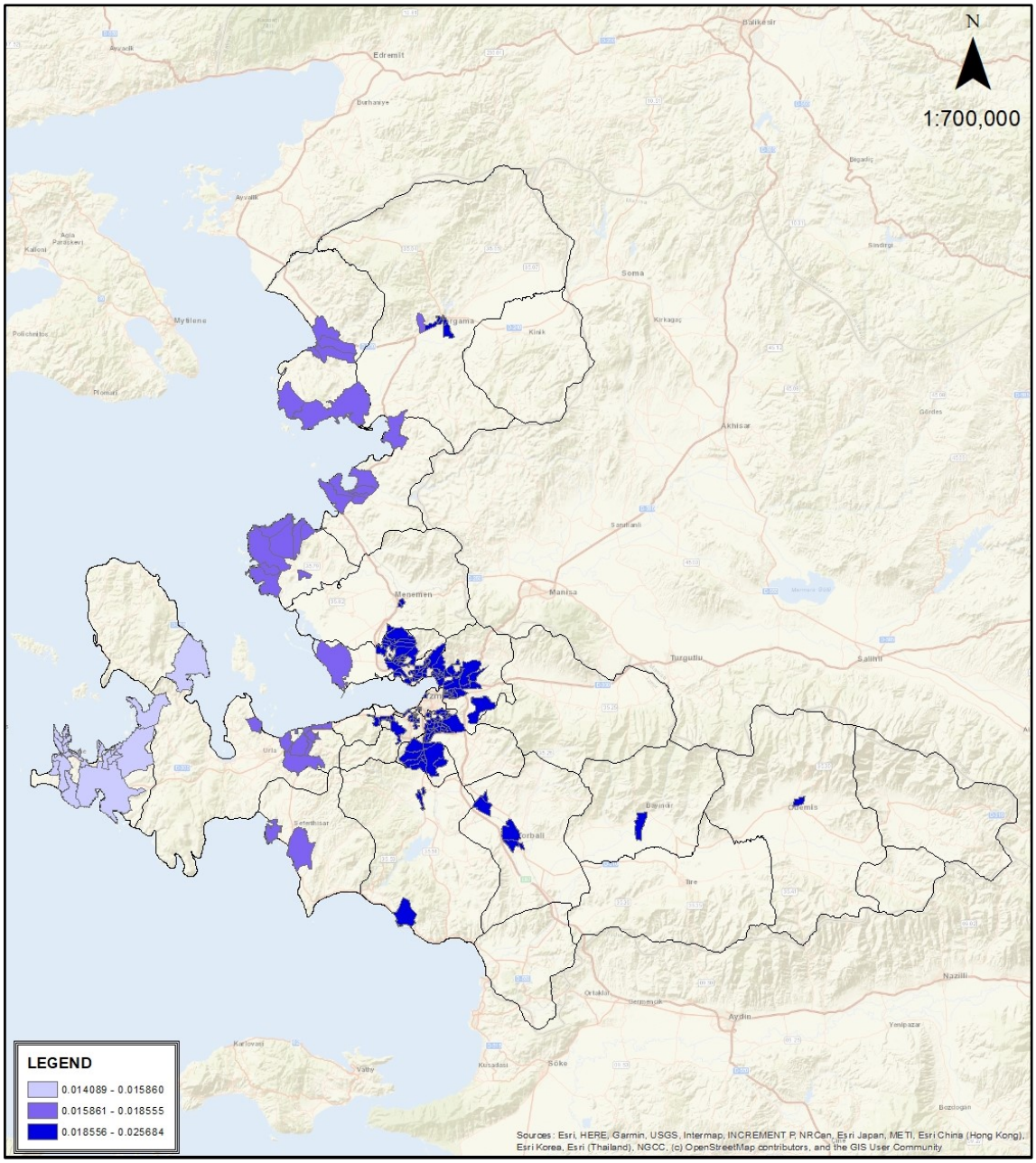

Figure 24. GWR Coefficients of Existence of Commercial Function

Figure 25 shows the distribution of the local R^2 value. As the local R^2 value increases, the fit of the model increases. According to Figure 25, the model is most suitable for the neighborhoods located in Çeşme, Urla, Seferihisar, Güzelbahçe, Menderes, Gaziemir, Torbalı and Bayındır districts.

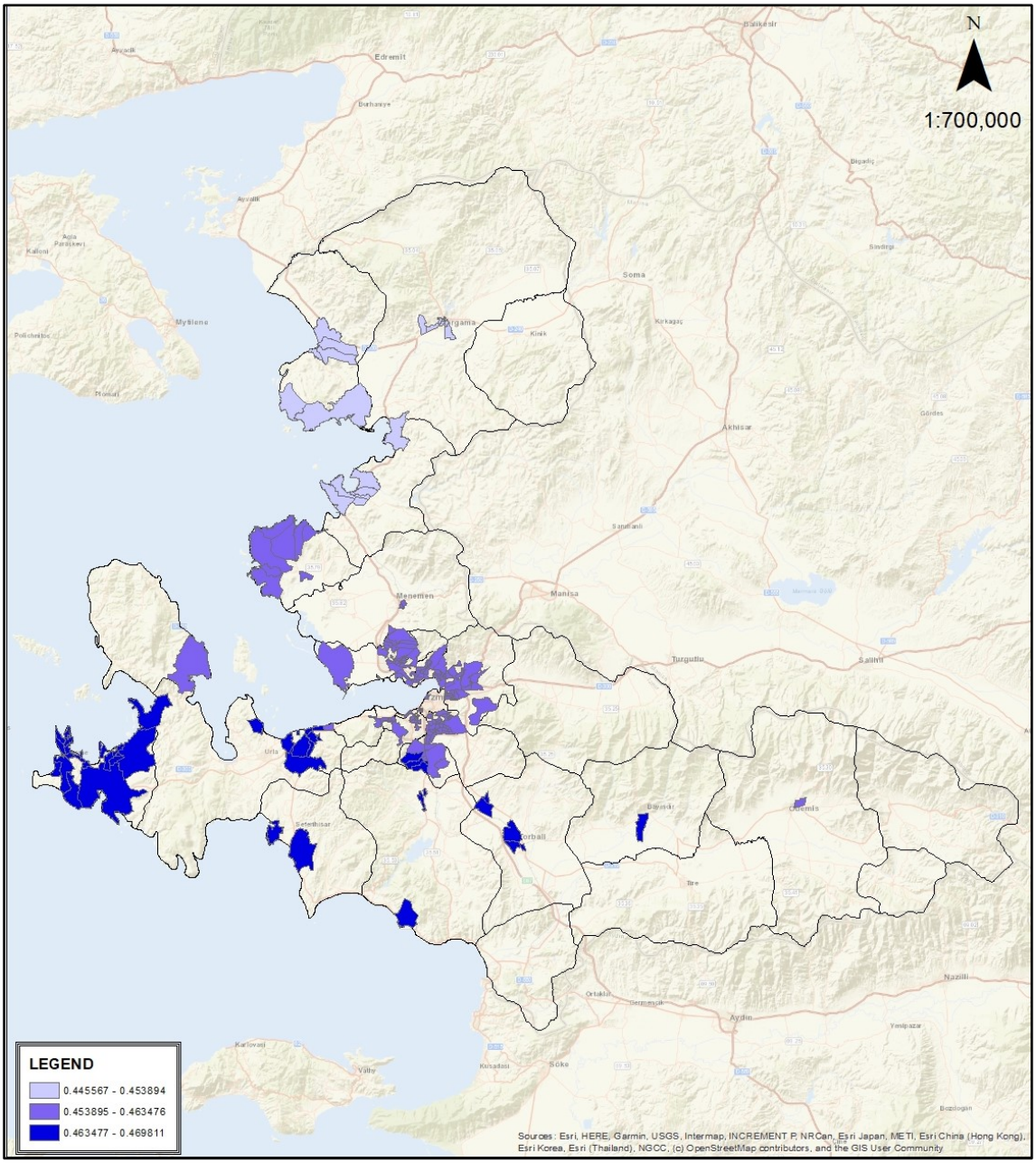

Figure 25. Local R^2

CHAPTER 6

CONCLUSION

Understanding and correctly interpreting the dynamics that determine housing prices will guide policymakers and decision-makers in their planning for the housing sector. In this empirical study, the determinants of housing prices were investigated with a panel data set on a neighborhood basis with a holistic perspective. This comprehensive approach is critical for understanding the dynamics of housing prices, with the data set being a panel and the spatial unit being a neighborhood. As mentioned in the introduction, Baltagi (2021) underlined that the use of panel data sets has certain advantages over cross-sectional or time-series analysis. In this study, the most prominent among these advantages is the panel data set's ability to evaluate individual heterogeneity. The fact that the spatial unit, which is considered as "individual" in the study, is neighborhood, ensures that the heterogeneity of the neighborhoods is reflected in the results obtained through empirical analysis. When a house is selected for purchase, a neighborhood is also selected because access to jobs and social opportunities, local public amenities and taxation, and environmental quality differs across the neighborhoods (O'Sullivan, 2011).

This point of view will help us to interpret on a more local scale in Izmir and to interpret the dynamics that have taken place over-time correctly. In this respect, it will contribute to the empirical studies (Üçdoğruk, 2001; Yankaya and Çelik, 2005; Abayhan, 2009; Çetintahra and Çubukçu, 2011; Akçay, 2019; Özsoy and Şahin, 2021) of housing price determinants for Izmir.

Empirical analyses, particularly in Turkey, have shown some expectations for the study's results as a consequence of the literature review in order to understand the determinants of housing prices and to reveal the variables that will be tested as determinants in the study. While the results were generally consistent with the literature, the variables in the neighborhood-specific category produced results that fell short of expectations. These unexpected findings could give rise to new research questions in the future. Table 28 details the expectations and results of the random effects model in specification 1.

Table 28. Expectations and Results

VARIABLES	EXPECTATIONS	RESULTS		
		Panel Linear Regression	Spatial Error Model	Spatial Lag Model
USD	+	+	Not Significant	Not Significant
CPI	+/-	+	+	Not Significant
IPI	+	+	Not Significant	Not Significant
IRFHL	+/-	-	-	Not Significant
Population	-	Not Significant	Not Significant	Not Significant
0-14 Age Population Ratio		-	-	-
15-64 Age Population Ratio	+	-	-	-
BSc, MSc, and PhD Degree Population Ratio	+	+	+	+
Existence of Commercial Function	+	+	+	+
Accessibility to Preschools	+	-	-	-
Accessibility to Primary Schools	+	Not Significant	+	Not Significant
Accessibility to Mid Schools	+	Not Significant	Not Significant	Not Significant
Accessibility to High Schools	+	Not Significant	Not Significant	Not Significant
Accessibility to Family Health Center	+	-	Not Significant	Not Significant
Distance to CBD	-	-	-	-
Size	+	+	+	+
Number of Rooms	+/-	Not Significant	-	-
Age of Building	+/-	Not Significant	Not Significant	Not Significant
Number of Floors	+/-	Not Significant	Not Significant	Not Significant
Balcony	+	+	+	+
Number of Bathroom	+	+	Not Significant	+
Site	+	Not Significant	Not Significant	Not Significant
Natural Gas	+/-	-	-	-
Geothermal	+	Not Significant	Not Significant	Not Significant

The results of macroeconomic variables are in line with expectations.

Since no study tests the child population ratio as a variable in the reviewed literature, no expectation has emerged for this variable, and the result proves that this variable has a statistically significant negative effect on housing prices. The active population ratio and preschool accessibility did not meet the expectations for each outcome, according to the results of the panel linear regression and the spatial models. It has been proven in the literature that the economically active population increases housing prices (Essafi and Simon, 2015; Choi and Jung, 2017; Choi et al., 2018).

Therefore, this result for Izmir has the potential to be examined in a different study because these variables may be the result rather than the cause.

The positive effect of education level on housing prices can be explained indirectly by associating it with income. Empirical studies focusing on the relationship between education and income in Turkey prove that this relationship is positive, that is, as the level of education increases, the income level of users increases (Çiftçi and Kangallı, 2015). Therefore, this result shows that the increase in the income of the users reveals the willingness to pay more for the housing. The fact that the existence of a commercial function increase housing prices can be explained by the desire of people to be close to these facilities or job opportunities.

Although the variable of accessibility to preschools does not meet the expectation, this can be explained by the separation of educational institutions from public and private. Within the scope of the study, only public education institutions were evaluated. In their study, Moralı and Yılmaz (2020) proved that the increase in distance from public education institutions in Istanbul affects housing prices positively, while the increase in distance from private education institutions negatively affects housing prices. Li et al. (2019) underlined that users' willingness to pay for private services is higher than for public services. Although this situation depends on the users in the area where the empirical study was conducted, in the geographically weighted regression for the effect of access to preschools on housing prices (Figure 21) within the scope of the study, the neighborhoods where the level of access has the most negative impact on housing prices are located in the districts of Çeşme, Karaburun, Urla, and Seferihisar. In these neighborhoods, which have tourism characteristics and have a relatively high level of education, it can be expected that the willingness to pay private education institutions is high. This expectation can be tested with a separate research question. In this case, calculating only the accessibility of public education institutions may appear as a limitation of the study. In addition, the method of calculating accessibility can be included in these discussions. The decrease in housing prices as the distance to the central business district increases is consistent with the previous researches (Işık, 2015; Akçay, 2019). The desire of people to go to central business districts in less time can explain this result.

The results obtained in housing structural characteristics are in line with the expectations. The large size of the house and the small number of rooms affect the house prices positively. Although the presence of natural gas is seen as an opportunity in the house, heating costs can have an adverse effect (Afşar et al., 2017).

Spatial autocorrelation was determined housing sales prices in May 2017 and October 2019, and also in prices' annual percentage changes. When the annual percentage change is examined in the Local Moran's I test, which is conducted to detect spatial clusters and spatial outliers, it is seen that high-priced clusters are formed in the neighborhoods of Foça, Karaburun, Urla, Çeşme and Gaziemir districts.

The high lambda coefficient in the LM test performed before the spatial models prove that the spatial autocorrelation and thus the spatial dependence is high in the spatial panel regression. The fact that the effect levels and effect signs of the variables in different specification tests are similar proves the robustness of the results. As a result of the Spatial Error Model and the Spatial Lag model, spatial dependence and significant spatial spillovers were determined.

The GWR analysis for October 2019 provides very specific findings for examining the local effects of the variables in the neighborhoods. As a consequence of this analysis, it has been determined in which neighborhoods the analyzed variables will have a positive or negative effect, as well as the degree of that effect. Understanding the impact of an integrated and comprehensive data set on a local spatial unit is considered very beneficial.

The a-spatial research part of the study answers the following question: "How do variables affect housing prices?" In this context, answers to research questions 1 and 2 have emerged. The spatial research part of the study answers the following question: "Is there spatial dependence and spatial spillover in the effects of variables on housing prices?" In this context, answers to research questions 3 and 4 have emerged. Geographically weighted regression, which is the last part of the empirical analysis, answers the following question: "In which spatial units is the effect of the variables on housing prices observed?" In this context, the answer to research question number 5 has emerged.

Since the findings are at the scale of neighborhood, which is a spatial unit with high heterogeneity, it is an important tool for policy decisions to be taken regarding the housing market. The neighborhood-specific category and the housing structural characteristics category are closely related with planning discipline. When examined from the perspective of planning decisions, integrating the results of the spatial models in the category of neighborhood-specific variables into upper-scale plan decisions will provide a more balanced urban growth. Besides, integrating the results of the spatial models in the category of housing structural variables into lower-scale plan decisions and

deciding on the construction conditions will be beneficial. In this study, although accessibility was evaluated in terms of public education, public health services, and distance from the central business area, it is concluded that the affordability of housing prices is relatively lower in the neighborhoods with high accessibility, even in this context. For this reason, more affordable housing should be provided in the neighborhoods with high accessibility, or services should be increased in the neighborhoods lacking accessibility. The fact that the service increase will be determined in the right neighborhoods will make urban growth more balanced when the spatial dependence and spatial spillover are considered. To examine the issue of accessibility in more detail, density analyzes of various facilities obtained through social media or telephone signals, which are observed as a data supply tool especially in the international studies, and plan decisions can be dynamically integrated into this comprehensive approach. Another limitation of the study is that the structural characteristics of the houses are kept constant in time since the advertisements of the houses sold in the past were inaccessible on the real estate websites. Dynamically integrating these characteristics into the comprehensive approach will enable a better interpretation of the results. To make the study more dynamic, it may be useful to integrate periods with important breaking points such as epidemics and earthquakes into the data set.

In conclusion, the housing market is a contentious issue because it is both a fundamental component of macroeconomics and strongly linked to social issues. Descriptive analyses, statistical methods, and spatial models applied within the scope of the study have been a great resource for understanding the dynamics of housing prices and have proven the importance of spatial dependence in housing market studies for the case of Izmir.

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