A spatiotemporal exploratory analysis of real estate sales in Turkey using GIS

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Abstract

Purpose – The purpose of this paper is to examine the real estate sales in Turkey on a district basis to reveal the current state of real estate sales and any meaningful changes in the last period. The real estate market is important and is an indicator of the country’s general economic health, as real estate is seen as an investment.

Design/methodology/approach – As a powerful method of spatial analysis and evaluation, geographic information systems have been used to examine real estate data in both spatial and temporal ways. In this study, 14 years of sales data covering the years 2004 to 2017 obtained from government agencies on a district basis were evaluated using spatiotemporal methods. Several maps were produced using Getis-Ord Gi* and local Moran’s I indices, which showed the spatiotemporal change of sales and sales rates.

Findings – When looking at the maps, provinces such as Istanbul, Ankara, Izmir, Antalya and their surrounding districts have buoyant real estate markets compared to the other side of the country. Real estate sales are more stagnant in the eastern and northern parts of the country. In addition, the authors found that the growth rate of annual average real estate sales was approximately seven times higher than the annual average population growth.

Originality/value – This spatiotemporal study, which presents 14 years of performance data of the real estate market and, by extension, the economic situation, also highlights the regions that stand out for investment planning throughout the country. The results of spatiotemporal analysis also present a new way of real estate market visualization using maps with well-designed categorizations.

Keywords GIS, Real estate, Mann–Kendall, Getis-Ord Gi*, Local Moran’s I, Spatiotemporal analysis

Paper type Research paper

Introduction

It is a well-known fact that the real estate market in the world economy affects financial stability, both directly and indirectly. Along with the global economic indicators, changes which are observed in real estate prices and sales in national and international markets have frequently revealed that stability in the real estate market is an important economic indicator. However, various indicators of real estate sales show the general condition of the economy, together with household investment and consumption preferences. The real estate sector in Turkey has rapidly developed and mobilized in recent years because of an increasing number of foreign investors. In this context, house sales to foreigners in Turkey can be seen in Table I as an indicator. Real estate, which is sometimes regarded as an investment, or sometimes a consumer durable by households, changes and develops over time, depending on economic, social, cultural, geographic and demographic factors. Long-term economic factors play an
important role in determining real estate demand at the social level. In this sense, temporal and spatial fluctuations in real estate sales are important in terms of indicating temporal and spatial changes regarding economic factors. In addition to economic factors, population growth rate, age, sex composition and sociodemographic factors such as changes in the form of the family can also be effective. These factors can affect individual real estate demand and lead to qualitative/quantitative changes in the social demand for real estate (Ertürk, 1996). In addition to the structural factors mentioned above, the influence of real estate as a high-yielding investment instrument in Turkey has meant that real estate supply, demand and prices have increased considerably in recent years over the whole country [Figure 1(a) and (b)]. In this context, the reasons for and results of real estate sales values and price changes, which have reached important dimensions in the Turkish real estate market, have great importance in terms of the economic decision makers because of the widespread effects of real estate ownership at the household and general economy level. The global financial crisis has also shown that monitoring changes in real estate prices and sales as a basic barometer of the real estate market in countries with strong real estate–finance ties is important for understanding the degree of risk accumulation in the general economy.

In terms of investment planning, annual real estate sales statistics for the region are crucial. Analysis of these data using spatial and temporal statistics is important in that the stability of the real estate market is an important economic indicator, and the areas in which possible investment zones can be selected or economically assisted can be determined at various scales. In addition to the studies on spatial panel data and dynamic space-time panel data models, spatial econometric studies also perform spatial analysis of phenomena that occur at a specific time. However, as all phenomena in the world have a process depending on the time, both spatial and temporal changes are important in terms of understanding these phenomena. In addition, knowledge extracted from spatiotemporal data will help to predict the spatial processes and events better. Therefore, it is important to carry out analyses of spatiotemporal data sets. This introduces the aspect of time to such analysis and, consequently, gives its spatiotemporal character (Cichociński and Dąbrowski, 2013).

Geographic information system (GIS) is a framework for conducting various spatial operations as well as analyzing, storing, manipulating and visualizing. With GIS, one can make spatiotemporal analysis and present the results through maps. In this context, GIS is a convenient tool for analyzing space-time patterns of real estate sales and sales rates.

<table>
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<tr>
<th>City</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
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<td>634</td>
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<tr>
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<td>783</td>
<td>717</td>
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<tr>
<td>Sakarya</td>
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<td>833</td>
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<tr>
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<td>599</td>
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<tr>
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<td>Total</td>
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<td>18,959</td>
<td>22,830</td>
<td>18,189</td>
<td>22,234</td>
</tr>
</tbody>
</table>

Table I.
House sales to foreigners in Turkey

Source: TurkStat
Figure 1. Graphs for (a) total housing stock in Turkey, (b) index of house prices in Turkey, (c) population of the country and (d) house and real estate sales.

Source: CBRT and TurkStat
Real estate in Turkey is a reliable and robust investment. Especially in times when the national currency lost value, real wages declined and interest rates were volatile, real estate investments were able to maintain value against money.

In this study, the regional and temporal effects and changes in real estate sales in 957 districts of Turkey were examined during a 14-year period between 2004 and 2017. In this sense, spatiotemporal analyses were applied by using GIS in the context of spatial econometrics to examine regional and temporal distribution in real estate sales in Turkey at the district level, and their results were discussed. The study reveals the medium-term regional and temporal changes in housing demand and implements a spatiotemporal econometric analysis using GIS to obtain evidence which can give direction to Turkish real estate policy.

2. Literature review

In the literature, the demand for real estate is considered in several theoretical dimensions. However, the number of empirical studies that exist within the scope of spatial econometrics is relatively small. There are few numbers of studies on the demand for real estate, especially in terms of socioeconomic explanatory parameters such as migration, population growth, income and the temporal and regional analysis of the spatial effect on real estate sales. These studies also lack visual presentations such as maps.

Hedonic price models are widely used to evaluate house prices by considering factors such as natural environment, social life and local characteristics. Bowen et al. (2001) examined hedonic housing price models by using spatial statistical data and applied this model to the real estate market of Cuyahoga County to determine price estimates. Orford (2000) also presented hedonic price models in terms of the local housing market and used a multilevel approach to investigate the housing market of Cardiff. Although Orford (2000) argues that multilevel models can properly capture the spatial effects, Chasco and Le Gallo (2012) analyzed whether spatial effects at hedonic prices was properly captured by a multilevel model. Fingleton et al. (2018) studied estimation methods for panel data models with spatial dependence and applied this model to the English housing market.

Spatial statistics are also widely used in the housing market to determine neighborhood effects. Pace et al. (1998) used spatiotemporal autoregressive models of neighborhood effects in their study. They analyzed 70,822 observations on housing prices and applied a filtering approach to improve estimation. Case et al. (2004) also present spatiotemporal models of house price patterns using a comparison of four models. As a result of the study, these authors found that the importance of nearest neighbor transactions for out-of-sample predictions.

In the literature of spatial econometrics, there are studies which deal with spatial and space-time panel data models. Anselin et al. (2008), studied specification, estimation and diagnostic testing for spatial effects in panel data models. Millo and Piras (2012) implement an R package named “splm” for testing and estimation of various spatial panel data specification. Debarsy et al. (2012) focused on model estimation with an interpretation of a dynamic space-time panel data model.

Spatiotemporal methods have been used also in different fields besides econometrics. For instance, Kulldorff (2001) studied space-time scan statistic to present a geographically localized disease surveillance system. On the other hand, in GeoDa workbook, there are several implementations of space-time exploration methods from different study areas (Anselin, 2018).

When looking real estate studies about Turkey, Bocutoğlu and Ertürk (1991) dealt with the demand for real estate in the country and stated that the high population growth was the
most important variable affecting housing demand. Öztürk and Fitöz (2009) investigated the determinants of real estate supply and demand in the real estate market in Turkey by using regression analysis. As a result of this analysis, they found a positive relationship between per capita income, real estate prices and interest rates variables and real estate demand. Lebe and Akbaş (2014) stated that marital status, per capita income and the increase in the parameters of industrialization had a negative effect; interest, real estate prices and the increase in employment in the agricultural sector had a positive effect on housing demand in Turkey for the 1970-2011 period. Coskun and Ertugrul (2016) analyzed house price return volatility patterns in Turkey’s major cities and state that housing can be considered long-term investment instrument because of the house prices are relatively more resistant to structural shocks. The authors also state that volatility affects some regions more than others and at different times during housing market cycles.

Another study by Akseki and Türkcan (2016) which addressed the demand for real estate discussed the relationship of real estate and the labor market with some internal migration, based on the provinces of Turkey. As a result, they found that there is no causal relationship between regional migration and the rate of unemployment in the time interval under consideration (2008 and 2013), but that there was a mutual causality between real estate sales and regional migration in that time interval.

Hatipoğlu and Tanrıvermiş (2017) examined the factors affecting investment decisions in terms of supply and demand. The authors used population growth, distribution of population, age, immigration and household size as demographic variables and gross domestic product, per capita income, employment, growth rate, interest rates and real estate loan rates as economic variables. The fact that the country has a young population, the high proportion of people who can work and the decrease in household size are the most important factors that increase housing demand. They also found that income per capita, as well as income distribution within society, directly affected real estate expenditure, real estate investment preferences and the decrease in the interest rate associated with real estate loans, which increased the demand of households for real estate. As the real estate market is important for economic indicators, Boitan (2016) has studied a model for house price forecasting model for some European countries.

When the studies of econometric modeling using GIS are examined, the study conducted by Can (1998) is one of the first applications of GIS and spatial analysis regarding real estate and credit markets. In the study, the author used various real estate and mortgage data to determine the effects of various environmental criteria on the formation of real estate prices and to examine the basic weighting criteria used to determine neighborhood relationships.

In Elder and Zumpano’s (1991) study, it was determined that the demand for real estate was positive, being influenced by the size of the households and high income but was negatively influenced by real estate prices. Anderson and Elliott (2006) conducted a detailed analysis of the real estate market using real estate sales and mortgage data. The study was conducted in all US states based on villages between 1996 and 2004. The authors provided evidence that GIS technology is important for showing regional opportunities in the use of credit for residential sales. Cichocński and Dąbrowski (2013) used GIS to examine the temporal and regional changes in real estate prices. By presenting the bases of spatial coding in the GIS platform, they provided suggestions as to how to express the changes using maps when considering the time dimension.

GIS has played an important role in the development of spatial analytical tools in housing and mortgage research. In this sense, many studies have addressed the complex questions encountered in spatial analysis and modeling of neighborhood effects (Anselin and Lozano-Gracia, 2008; Getis and Aldstadt, 2004).
Most of the studies related to real estate sales have examined the reasons affecting the real estate prices and the changes in time. However, visualization of changes in the spatiotemporal approach is still not presented well in the literature of spatial econometrics. Although these studies use strong spatial–temporal statistical analyses through simple maps, they have lack of advanced visualization possibilities offered by GIS. To overcome this issue, in our study, we used 17 categories to describe the change in space and time on the maps which are produced by space-time pattern mining module of ArcGIS with default settings. The data regarding direct real estate sales are much more common in special reports than in publications, and it is thought that such studies showing regional and temporal changes are strategically important in terms of banks or companies that want to invest.

3. Data and methodology

The data used in the study were obtained from the Turkish Statistical Institute (TurkStat) and the General Directorate of Cadaster and the Land Registry (GDCL). For this purpose, the 14-year real estate sales data for the years between 2004 and 2017 are obtained from the GDCL and organized as panel data. Population data related to the districts where the directorates are located were also taken from the TurkStat and brought together with the title registry records (real estate sales) as a single table. These records are related to the graph of the district data in the database environment for analysis.

Population growth has increased the demand for all goods and services, as well as the demand for real estate (Arslan et al., 2013). In this context, population by years and house sales with real estate sales are presented in Figure 1(c) and (d). Real estate sales by months are also given in Figure 2(d). The graphs for annual inflation, the exchange rate of TRY against USD and annual interest rate are given in Figure 2(a), (b) and (c) to capture the general outline of the market (CBRT, 2018; TurkStat, 2018).

As mentioned above, the increase in population, which is the most significant demographic factor that increases residential sales, is also important in terms of determining the regional and temporal change of the urbanization-related events, together with the economic indicators, as it is a criterion related to urbanization at the same time. In this sense, the relationship between the real estate demands of the regions that are closest in terms of location may indicate that the spatial effect is an important determinant of the regional demand for real estate. Classic statistical and econometric methods do not take into consideration the spatial effect, which is the result of spatial interaction. These methods assume that the observations are independent and that the variance is constant. In the case of dependency between the measures, these assumptions lose their validity. Violation of these assumptions can also lead to inconsistent and divergent results. In other words, not considering the spatial effect, which is an important determinant in regional studies, will cause the estimation of results obtained from the analysis to be misaligned and inconsistent (Kangallı Uyar and Kılıç, 2017).

Spatial statistical methods have been used frequently in econometrics which considers the neighborhood relationship between the observations and the processes in which these relationships exist.

Spatial data related to urban sciences, sociology, demographics and regional studies usually present with administrative, geographical or political boundaries which were obtained as point data and analyzed by integrating the observed phenomena. These spatial analyses usually aim to determine clusters and trends in the distribution of data. In this context, spatial analyses are categorized into two different groups, namely, first-order analyses and second-order analyses. The first-order analyses examine the spatial variation...
Figure 2. Graphs for (a) annual inflation, (b) annual interest rate, (c) annual exchange rate and (d) real estate sales by month.
of the data, whereas the second-order analyses examine the spatial covariance between the data. First-order analyses aim to find global and regional trends with a change in the target, whereas second-order analyses seek to find spatial dependency and a change in the spatial dependence between data.

To observe the first-order effects in terms of sales numbers, excess risk and spatial rates in which population-based rates of sales are considered were also examined. The excess risk is the ratio of the observed rate to the average rate computed for both numbers of district sales. It is used for the determination of districts which have the highest rates. This average is not the average of the district rates. Instead, it is calculated as the ratio of the total sum of all sales over the total sum of populations in the country. In this context, an excess risk map with regard to numbers is shown in Figure 3. An excess risk rate greater than 1.0 indicates that more sales were made than expected; a ratio of less than 1.0 indicates fewer sales than expected (Erdogan, 2009).

In addition to the excess risk rate, a spatial rate smoothing, based on the notion of a spatial moving average, was constructed for explorative spatial data analysis. The purpose of integrating the spatial rate smoothing method was to emphasize the global variations and trends in the sales data by averaging rates under a moving window. Spatial rate smoothing does not compute an estimate from the raw rate for each district. Instead, it computes it for that district, together with a set of reference neighbors. Methodological details and further illustrations of the spatial rate smoother method are discussed in Anselin et al.’s (2006) study.

It is common practice to compare cities or countries in terms of rates and to rank them in terms of risk indicators such as sales rates, which are often expressed as the number of sales per 100,000 people. In this sense, the number of sales per 100,000 people in the provinces is shown as demonstrating excess rate values in terms of indicating soaring sales rates and spatial rate values in terms of regional changes.

In econometrics, attention is dedicated to their spatial components. The main purpose of spatial econometric models is to test for the existence of spatial interaction effects and, related to that, spatial spillover effects. The main advantage of working with spatial panel data is the ability to control spatial and time-specific effects (Shekhar et al., 2017).

Spatial dependence is the relationship between the values of the random variable measured in a certain position and the values of the random variable measured in another position. Spatial dependence is tested with spatial autocorrelation and semi-viariogram measures. Spatial autocorrelation refers to two states, positive or negative. In the positive case, it is understood that the variables observed in the neighboring locations influence each other linearly (a collection of similar values-cluster), whereas in the negative case, it is understood that the variables observed in the neighboring locations were inversely related to each other (mutually unequal values-contradictions). In this context, the different situations that these conditions imply for spatial patterns can be used to identify and express the distribution of patterns under clustering analyses. Here, the critical concept is the spatial weight matrices to express the spatial autocorrelation used in the modeling of spatial dependence. In econometric studies, the spatial weight matrix is used to express the spatial sequential dependence, which is the neighborhood relationship. These weights indicate the degree of relationships between objects in terms of mathematical expressions. Based on these weights, a spatial model is constructed, and the prediction phase of the model is realized. Weight matrices are the most important factor that is used in expressing spatial relationships, interaction and dissemination between spatial units, which directly affect the analysis results. The spatial adjacency of each spatial unit with the other units is interpreted by spatial weight matrices. The spatial weight matrix, $W$, which varies
Figure 3. Raw, excess risk and spatial rate maps of sales in the districts of Turkey.
depending on the spatial sequence or proximity of the areas, is \( n \times n \) dimensions, and \( "n" \) is the number of fields. There is one row or column for each field. It shows whether each field in this matrix is adjacent/related to the other rows and columns. In this context, there are different methods to form the weight matrices. The main ones are the matrices which are created by using the criteria of the neighborhood, distance and boundary shares, which can start from simple boundary sharing but can also consider first, second and third orders of neighbors (Getis and Aldstadt, 2004).

All the work is carried out using ArcGIS and GeoDa software. Two main approaches were used to define the neighborhood: contiguity (shared borders) and distance. Based on these two concepts, the nearest 8, 24, 48 and 96 different neighbors were determined by taking the distances of the weight centers of the area units to each other as a criterion to investigate the distribution of variables of interest (Celebioglu and Dall’erba, 2010). Fixed number of neighbors based on nearest neighbor was used instead of distance criteria in the study because of the variable area of districts. For instance, a district which covers a large area may have few numbers of neighbors or even none when choosing short distance value as a criterion (Chasco et al., 2017). As the number of nearest neighbors increased, the characteristics of the analysis shifted toward a more general view. This means when taking 96 nearest neighbors into account, the analysis shows a more regional status, but when taking 8 nearest neighbors, the analysis shows a more local status. According to this method, “1” is given if a neighbor relationship exists; otherwise, “0” is given. Then, the standardization process is performed, and a spatial weight matrix is generated.

The choice of bandwidth or the number of neighbors is crucial to the weight matrix. These parameters control the amount of smoothing. There is no obvious and unique definition of the optimal number of neighbors or optimal distance in the bandwidth selection, as it depends on the objective. One analyzer might be interested in the precise location of the phenomenon, whereas other analyzers might be more interested in the regional location of the phenomenon. We showed these two different situations with four different numbers of neighbors. Therefore, when the sales and sales rates of real estates are examined spatiotemporally using different numbers of neighbors, different weight matrices are created, and the analyses use these weight matrices. The weight matrices which created in this study are stable at each number of neighbors, and they are not evolving over time. However, a recent study which conducted by Angulo et al. (2018) presents an estimation of weight matrix and its constancy over time.

Although disparate indices can be used in determining spatial dependence and interaction, the most commonly used ones are Moran’s I and Getis-Ord Gi* indices. We can say that the beginning of the spatial interaction test in spatial econometrics is Moran’s (1950) sequential dependency test. In this test, which is used to determine spatial sequential dependence, the spatial correlation under the alternative hypothesis is not clear. For this reason, it only gives information about the existence of spatial sequential dependence (i.e. the clusters in the pattern) and does not give information about its type. In this sense, the LISA (Local Indicators of Spatial Association) index, which is a form of Moran’s I statistic developed by Anselin (1995) and informs us about the type of dependency, is seen more frequently. Local Moran’s I value was used to investigate the clusters formed by similar and dissimilar variables. Statistically significant, a high I value indicates the relevant variables clustered by similar values (high or low) in the relevant area, whereas a low I value indicates the relevant variables clustered by dissimilar values. The Z value also indicates the statistical significance of the I value. Mathematical formula of the local Moran’s I and Z score can be written as below, where \( \bar{X} \) is the mean value, and \( S^2 \) is the variance:
Local analyses, based on the local Moran statistic, were visualized in the form of significance and cluster maps. These analyses may be interpreted as indicators of local pockets of non-stationarity or hot spots, or they may be used to assess the influence of individual provinces and to identify outliers (Anselin, 1995).

Indeed, Gi* statistics were used to detect local pockets of dependence as suggested by Getis and Ord (1992). A significant and high value of the Gi* statistic indicates a positive spatial autocorrelation (cluster of high values), whereas a low value of the Gi* statistic indicates a negative spatial autocorrelation (cluster of low values) around the area. The mathematical formula of the Gi* statistic and the Z score of the statistic can be written as follows, where $W_{ij}$ is the weight for the target neighbor pair (Mitchel, 2005):

$$G_{i}^{*}(d) = \frac{\sum W_{ij}(d)X_{j}}{\sum X_{j}} \quad Z(G_{i}^{*}) = \frac{G_{i}^{*} - E(G_{i}^{*})}{\sqrt{Var(G_{i}^{*})}}$$

Although there are several techniques for detecting space-time patterns, we used a combination of Getis-Ord Gi* and Moran’s I with Mann–Kendall statistics by using a space-time pattern mining module of the ArcGIS software. In this procedure, a spatiotemporal analysis is performed in two stages as an econometric technique. In the first stage, a space-time cube is created by summarizing real units into space-time bins that are stored in a NetCDF (Network Common Data Form), which is a file format used to store array-oriented data. This will result in a cube that is structured using those defined areal units, with one set of attributes per time. Although producing the space-time cube, we set a one-year time step interval that will define the bin dimensions for areal units. The time step interval defines the time span for each bin. The aggregation of areal units across space is dependent upon the determined distance interval. The distance interval defines the spatial dimensions of the bins, which extend across the study area as a cube structured by the borders of districts (Gates, 2017).

In the second stage, both the Getis-Ord Gi* and Moran’s I (LISA) analyses were applied to investigate the trends over space, in addition to trends over time for both sales and sales rates. Clustering patterns of panel data were analyzed. Both the Getis-Ord Gi* and Moran’s I (LISA) took the space-time cube as input and conducted a spatiotemporal analysis as a hot spot analysis using the Getis-Ord Gi* statistic and Cluster and Outlier analysis using the local Moran’s I (LISA) for each individual bin. The Neighborhood Distance and Neighborhood Time Step parameters in the software define how many surrounding bins, in both space and time, will be considered when calculating the statistic for a specific bin. Then, statistically significant hot and cold spots and statistically significant clusters and outliers, in the context of both space and time detected by the spatial analysis, were evaluated using the Mann–Kendall test, to determine whether the trends are persistent, increasing or decreasing over time.

The Mann–Kendall test is a rank correlation analysis known as Kendall’s tau statistic. This is a non-parametric test, meaning that it does not assume any priority in the distribution of the data and allows the presence of a tendency over the period of panel data. The Mann–Kendall test has two parameters that are important for trend detection. These

$$I_{i} = \frac{(X_{i} - \bar{X})}{S^{2}} \sum W_{ij}(X_{j} - X) \quad Z(I_{i}) = \frac{I_{i} - E(I_{i})}{\sqrt{Var(I_{i})}}$$
parameters are the slope magnitude estimate, which indicates the direction as well as the magnitude of the trend and the significance level, which indicates the value of the test (Yavuz and Erdoğan, 2012). A positive value in the test results indicates an upward trend, whereas a negative value indicates a downward trend. In this context, the maps which indicate hot or cold spots for both sales and sales rates with Getis-Ord Gi*, are shown in Figures 4 and 5, respectively.

In the analysis of clustering, results are symbolized using seventeen different categories describing the degree of statistical significance. The patterns, descriptions, and attributes of the patterns can be seen at http://pro.arcgis.com/en/pro-app/tool-reference/space-time-pattern-mining/learnmoreemerging.htm.

Another pair of maps which indicates the clusters and outliers with local Moran’s I for both sales and sales rates is shown in Figures 6 and 7, respectively.

In the analysis of clusters and outliers using local Moran’s I (LISA) involving location trends over time, the results are symbolized using six different categories describing the statistical significance. The significant results (at 5 per cent) of the LISA statistics interpreted. First, a cluster of high-high values; second, an outlier of high-low values; third, an outlier of low-high values; fourth, a cluster of low-low values; fifth, multiple types of clusters; and sixth were never significant. This legend performs a quick exploratory space-time pattern analysis to confirm that the number of sales and sales rates is increasing overall and that the increase is statistically significant.

4. Results
In recent times, spatial econometric studies have shifted their interest to spatial panel data. The main purpose of spatial econometric models is to test for the existence of spatial interaction effects. The advantage of working with spatial panel data is that one can control for space- and time-specific effects. In this study, temporal and regional changes, interpreted with various spatial econometric models, were investigated by using real estate sales panel data on a district basis.

When the sales are analyzed by month [Figure 2(d)], it can be seen that sales in December showed an increase compared to other months. This was because of buyers seeking to avoid possible tax increases in the New Year.

When population growth rates and real estate sales rates are examined, it is seen that the two parameters generally interact. It seems that there has been a steady increase in sales volumes since 2004. The sales that stagnated between 2011 and 2012, because of the European debt crisis and the after-effects of the global financial crisis, have risen again since 2012 with the decreased impact of the crises [Figure 1(d)]. Looking at this graph, there was a sharp increase between 2012 and 2013. This arises from the fact that, since 2013, TurkStat’s house sales data have not been based on provincial centers, but on total province sales. For this reason, the rate of increase from 2012 to 2013 was ignored when the increase in rates was examined. The share of housing sales in total real estate sales has increased in recent years. Real estate sales, which followed a volatile course until 2013, increased at a steadier rate after that point. It was also found that the annual average population growth rate was 1.37 per cent between 2004 and 2017, whereas the annual average real estate sales rate was 9.60 per cent, which is very high alongside the population growth rate. Despite the lack of household data, this inference gives general information about the situation. However, after the aforementioned financial crises, the rate of increase gradually decreases. The value of the Turkish lira, inflation and interest rates are also important factors affecting real estate sales. When the effects of these factors on real estate sales are analyzed, it is seen that interest rates have the greatest effect (Figure 2).
SALE OF REAL ESTATES IN TURKISH DISTRICTS
SPATIO-TEMPORAL PATTERN ANALYSIS OF SALES
(TREND IN TIME AND LOCATION)

LEGEND
PATTERN
New Hot Spot
Consecutive Hot Spot
Intensifying Hot Spot
Persistent Hot Spot
Diminishing Hot Spot
Sporadic Hot Spot
Oscillating Hot Spot
Historical Hot Spot

New Cold Spot
Consecutive Cold Spot
Intensifying Cold Spot
Persistent Cold Spot
Diminishing Cold Spot
Sporadic Cold Spot
Oscillating Cold Spot
Historical Cold Spot
No Pattern Detected

NSN=Number of Spatial Neighbors

PROVINCES
DISTRICTS

Figure 4.
Spatiotemporal analysis of the sales in the districts of Turkey using Getis-Ord Gi®

Data has been taken from the General Directorate of Land Registry and Cadastre for the period of 2004-2017.

1 : 9,000,000
Figure 5.
Spatiotemporal analysis of the sales rates (the number of sales per 100,000 people) in the districts of Turkey using Getis-Ord $G'_I$.
SALE OF REAL ESTATES IN TURKISH DISTRICTS
SPATIO-TEMPORAL PATTERN ANALYSIS OF SALES
(CLUSTERS AND OUTLIERS IN TIME AND LOCATION)

Figure 6. Spatiotemporal exploratory analysis of the sales in the districts of Turkey using local Moran’s I.

Data has been taken from the General Directorate of Land Registry and Cadastre for the period of 2004-2017.
SALE OF REAL ESTATES IN TURKISH DISTRICTS
SPATIO-TEMPORAL PATTERN ANALYSIS OF SALES RATES
(CLUSTERS AND OUTLIERS IN TIME AND LOCATION)

Figure 7.
Spatiotemporal analysis of the sales rates (the number of sales per 100,000 people) in the districts of Turkey using local Moran’s I.

Notes: *Since 2013, TurkStat's house sales numbers have not been based on provincial centers but on total province sales numbers for the 2008-2012 period, only provincial centers sales numbers are included.

Source: TurkStat, REIDIN-GYODER and GDCL.

NSN=Number of Spatial Neighbors

1 : 9.000.000
Data has been taken from the General Directorate of Land Registry and Cadastre for the period of 2004-2017.
To model the temporal and regional effects and to analyze the results, exploratory spatial data analysis related to first-order effects on sales was used first, and Mann–Kendall time series analyses were integrated with Getis-Ord Gi* and Moran’s I analyses. An effective classification technique was used to improve the understanding of the results. When the analysis is examined, real estate sales rates in Yalova (Armutlu, Termal), Tekirdağ (Marmara Ereğlisi), İzmir (Karaburun), Ankara (Ayaş), Aydın (Didim) and Denizli (Baklan) districts are four times higher than the national average. Regional changes across the country are seen in the spatial rate map in Figure 3. A very significant increase is seen from the east of the country to the west. The increase toward the northwest of the country is clearly observed. When the analysis made with Getis-Ord Gi* of real estate sales examined, it was observed that the sales in Adana, Mersin, Gaziantep, Ankara, Istanbul, Kocaeli and Antalya were clustered as hotspots and showed a change in growth over time. The provinces where sales have increased over time were identified as follows: Antalya (Center, Manavgat), İzmir (Buca) and Istanbul (Avcılar, Eyüp, Sultan, Başakşehir, Sultanbeyli, Üsküdar, Ümraniye, Sancaktepe, Kartal, Beykoz, Esenyurt, Beylikdüzü, Büyükçekmece, Kucuçekmece, Gaziosmanpaşa, Bağcılar). Particularly in Istanbul, it can be seen that persistent hotspots in the old settlements around the Bosporus continue to be stable. Sales in the remaining districts of the second belt located outward from this center, mentioned above, have increased in clusters over time. Consecutive hotspots in the districts in the outermost belt that surround this zone, including the districts of İzmit, have been identified in recent years. In addition, sporadic spatiotemporal clusters with increasing sales in the period have been observed in those districts that are close to the central areas of Kayseri and Şanlıurfa. A diminishing hotspot in Ankara and the surrounding regions has been predominant in the last period, and the severity of excess in sales is decreasing. When the analysis made with Moran’s I is examined, it is seen that the results substantially overlap with the results of the Getis-Ord Gi* analysis. The areas where low sales show clusters are mostly in eastern Anatolia, southeast Anatolia and the Black Sea regions. The areas where high sales volumes are clustered are in the centers and districts of Istanbul, Antalya, İzmit, Adana, Mersin, Gaziantep, Ankara and Konya. The classification techniques used in Moran’s I analysis also determine the temporal and regional outliers, as well as spatiotemporal clusters, where high or low sales occur. Denizli (Çivril), Kahramanmaraş (Elbistan), Ordu (Altınordu) and some provincial centers are regions where local high sales volumes are found in areas where there are low sales. In contrast, the districts with low sales volumes in the high sales areas are scattered, especially around the metropolitan cities.

The same classification technique used in sales data has been used in sales rates. Thus, spatiotemporal clusters with high or low sales rates were identified, as well as temporal and regional outliers. Kastamonu (Seydiler, Abana), Samsun (Atakum, Canik), Sakarya (Serdivan) and Osmaniye (Hasanbeyli) are confirmed as regions with high sales rates in areas where there are low sales rates locally.

When the real estate sales rates analysis carried out with Getis-Ord Gi* is examined, it can be seen that the southern part of the East Anatolian and eastern part of the Southeast Anatolian region are clustered with low values in terms of sales rates. The low values in sales rates are a diminishing cold spot characteristic, indicating that this region has lost its sales rate intensity. The sales rates in the Central Anatolian region and the northwest region of the country are clustered with high sales rates, as well as showing consecutive cold spot characteristics, indicating that there is currently an intensification in rates. Ankara (Polatlı, Sincan), Konya (Çeltik), Eskişehir (Günayüzü), Burdur (eltıkçı), Yozgat (Yerköy), Kırşehir (Boztepe), Nevşehir (Kozaklı) and Kırıkkale (Sulakyurt) provinces have been determined as the provinces where intense clustering has increased over time.
5. Discussion
In this study, 14 years of Turkish real estate data was analyzed for the 2004-2017 period at the district level by using spatial econometric tests to reveal the regional patterns of sales and sales rates.

When we look at real estate sales in Turkey in general, they have changed depending on the month, and that sales have increased in the last month of the year. In recent years, the development of real estate projects, the provision of alternatives for different budgets and the increase in economic growth have increased the interest in real estate and residential sales. When the graphs are examined, the real estate sector has continued to grow steadily, even though it shows seasonal increases or decreases.

As Turkey shares a border with Syria and has accepted large numbers of refugees during the Syrian civil war, the maps show that these refugees have an effect on the real estate market at the border provinces such as Gaziantep, Hatay, Şanlıurfa and Kilis.

Ankara, the capital of Turkey and the second largest province after Istanbul, shows remarkable development in terms of real estate sales. Central districts of Ankara fall into the Multiple Types category in sales rates, which means there are regions where sales rates are both increasing and decreasing (Figure 7). This evidence supports the finding of high volatility of house price return in Ankara, which was identified by Coşkun and Erteğul (2016).

One of the most important results, especially shown up in the analyses performed using Getis-Ord Gi*, is the big difference in real estate sales between the eastern and western part of the country. The fact that the country’s biggest cities are located in the west seems to be the major factor affecting this situation. On the other hand, it is observed that there are very few sales in the eastern part of the country, and stagnation in the real estate market is dominant.

In this spatiotemporal study, Turkey’s real estate market by the district has been revealed through data patterns and maps employing meaningful categorizations. This kind of visualization of spatial statistics is rare in the real estate market. It is seen that there are obvious differences between east and west in terms of real estate sales. These analyses, which provide information on the general economic situation, also give insight into migration, population distribution and urbanization.

Future research will concentrate on the modeling of the number of real estate sales with various demographic and economic indicators by using geographically weighted regression.

References


Further reading


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