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Housing Prices In Turkey: Macroeconomic Factors and Structural Changes

Türkiye'de Konut Fiyatları: Makroekonomik Faktörler ve Yapısal Değişimler

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ABSTRACT

This study examines the effects of macroeconomic variables on housing prices in Turkey within the framework of structural breaks. Given Turkey's geopolitical position and its frequent economic fluctuations driven by both domestic and external dynamics, the originality of this study lies in conducting all analyses by incorporating structural breaks. The empirical analysis utilizes monthly data from 2015 to 2023, employing time series methods to investigate the determinants of housing prices. By considering structural breaks in all analyses, the study emphasizes long-term and permanent effects rather than short-term economic shocks. The analyses are conducted within the framework of supply-side and demand-side variables. The results indicate a significant causal relationship between cement production, construction cost index, and the housing price index among supply-side variables. However, no direct relationship is found between building permits and the housing price index. On the demand side, a significant causal relationship is identified between the housing price index and all demand-side variables. The findings highlight that structural breaks are a crucial determinant of the housing market and provide valuable insights for policymakers regarding the long-term effects of macroeconomic variables.

Keywords: *Housing Prices, Structural Breaks, Macroeconomic Indicators, Time Series Analysis*

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ÖZET

Bu çalışma, yapısal kırılmalar çerçevesinde Türkiye'deki konut fiyatları üzerinde makroekonomik değişkenlerin etkilerini incelemektedir. Türkiye'nin jeopolitik konumu ve hem iç hem de dış dinamiklerin etkisiyle sık sık yaşanan ekonomik dalgalanmalar göz önüne alındığında, bu çalışmanın özgünlüğü tüm analizlerin yapısal kırılmaları da dikkate alarak gerçekleştirilmesinde yatmaktadır. Ampirik analiz, 2015 ile 2023 yılları arasındaki aylık verileri kullanarak zaman serisi yöntemleriyle konut fiyatlarının belirleyicilerini incelemektedir. Tüm analizlerde yapısal kırılmalar dikkate alınarak, çalışma kısa vadeli ekonomik şoklardan ziyade uzun vadeli ve kalıcı etkileri vurgulamaktadır. Analizler, arz tarafı ve talep tarafı değişkenleri çerçevesinde gerçekleştirilmiştir. Sonuçlar, arz tarafı değişkenleri arasında çimento üretimi, inşaat maliyet endeksi ve konut fiyat endeksi arasında önemli bir nedensel ilişki olduğunu göstermektedir. Ancak, inşaat ruhsatları ile konut fiyat endeksi arasında doğrudan bir ilişki bulunmamaktadır. Talep tarafında ise konut fiyat endeksi ile tüm talep tarafı değişkenleri arasında önemli bir nedensel ilişki tespit edilmiştir. Bulgular, yapısal kırılmaların konut piyasasının önemli bir belirleyicisi olduğunu vurgulamakta ve politika yapıcılar için makroekonomik değişkenlerin uzun vadeli etkileri konusunda değerli bilgiler sağlamaktadır.

Anahtar Kelimeler: *Konut Fiyatları, Yapısal Kırılmalar, Makroekonomik Göstergeler, Zaman Serisi Analizi*

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1. Introduction

In today's world, the housing market stands out as one of the fundamental components of economic development and financial stability (Yıldırım, 2017:1). Housing prices are a critical factor influencing both individual well-being and macroeconomic balances (Şeyranlıoğlu, 2023,1714). Therefore, understanding the determinants of housing prices is essential for the effective management of economic policy. In particular, supply and demand factors are among the key elements shaping the movements of the housing price index, necessitating a detailed examination of these factors.

The determinants of supply and demand balance in the housing market are influenced by various macroeconomic and sectoral dynamics (Hilbers, Hoffmaister, Banerji and Shi, 2008:9). On the supply side, construction costs, land prices, financing opportunities required for housing development, and regulatory policies play a significant role. On the demand side, economic indicators such as income levels, interest rates, inflation rates, and demographic factors determine the direction of housing prices. The interaction between these two fundamental dynamics causes fluctuations in housing prices and shapes the overall trajectory of the market.

In the case of Turkey, the dynamics of the housing market exhibit a more complex and distinctive structure compared to other countries worldwide (Şeyranlıoğlu, 2023:1715). Specifically, geopolitical risks, economic fluctuations, interest rate volatility, and government policies directed toward the construction sector play a crucial role in determining housing prices.

Structural breaks also hold significant importance in the determination of housing prices (Kaya, 2012:9). Factors such as macroeconomic crises, political uncertainties, natural disasters, and global financial fluctuations can create sudden and lasting effects on housing prices (Öztürk and Gövdere, 2010:394). Therefore, when evaluating the factors affecting the housing price index, it is necessary to focus on structural breaks. In countries like Turkey, which have dynamic economic and political structures, traditional economic analysis methods alone are insufficient; instead, these analyses must be designed to account for structural breaks.

This study aims to analyze the determinants of the housing price index in Turkey within the framework of supply and demand dynamics and to reveal the impact of macroeconomic variables through structural break time series analyses. The findings contribute to the academic literature and provide valuable insights for policymakers, enabling them to make more informed decisions regarding the housing market.

2. Literature Review

Numerous studies in the literature have examined the macroeconomic variables affecting housing prices. In particular, research analyzing the impact of factors such as interest rates, inflation, exchange rates, the industrial production index, and housing loan interest rates on housing prices has revealed significant findings using different methods and datasets. Recent studies on this subject are presented below. Understanding the relationship between the housing market and macroeconomic variables is crucial for assessing the effects of factors such as global financial crises and political uncertainties.

Nneji et al (2013) examined the sensitivity of housing prices to macroeconomic variables based on different regimes. Using a three-regime Markov switching model and a probit model, their analysis found that decreasing interest rate spreads help economies recover from crisis periods. They concluded that housing prices fluctuate more during periods of economic growth but become less responsive to macroeconomic variables during crisis regimes.

Xifilidou and Karanikolas (2014) analyzed the relationship between housing activities and macroeconomic factors in Greece. Their study found that housing prices declined after the 2008 financial crisis, and excessive housing supply and increasing taxes negatively affected market stability. However, tourism investments were found to have a positive impact on the real estate sector.

Shinwari and Özdemir (2022) examined the short- and long-term effects of the industrial production index and CPI on the housing price index in Turkey for the period 2010–2020 using the ARDL bounds test and the Toda-Yamamoto causality test. Their findings indicated that increases in the industrial production index and CPI negatively affected the housing price index in the short term. However, no significant long-term relationship was found between these variables and housing prices.

Zulkifli et al (2022) analyzed the macroeconomic variables affecting the housing price index in Malaysia using the ARDL model, unit root tests, and causality tests. Their study found that Gross Domestic Product (GDP) and money supply (M3) had a positive impact on housing prices, whereas the Consumer Price Index (CPI) had a negative effect. Additionally, GDP and money supply were found to significantly influence housing prices in the short term.

Ding (2022) examined the effects of macroeconomic variables on housing prices in the U.S. over the past 15 years. Using a multiple regression model and Stata/IC 16.1 software, the study found that stock market growth and economic expansion had a positive effect on housing prices. Conversely, mortgage interest rates and the unemployment rate exerted downward pressure on housing prices, while population growth had no statistically significant effect.

Abasimi et al(2023) analyzed the impact of macroeconomic variables on the housing price index in G20 countries using panel data analysis. Their findings indicated that the Consumer Price Index (CPI) and Purchasing Power Parity (PPP) had a positive and significant effect on the housing price index, while exchange rates and unemployment rates had a negative effect. No significant impact was found for construction GDP or population density.

Akyol Özcan (2023) examined the impact of the exchange rate, housing loan interest rates, and the Consumer Price Index on the housing price index using ARDL and NARDL models. The results indicated that positive shocks in housing loan interest rates increased the housing price index, while negative shocks led to a decrease. Positive shocks in CPI were found to reduce housing prices, whereas negative shocks increased them. The exchange rate had no significant effect on the housing price index.

Aydın (2023) investigated the causality relationship between the housing price index and macroeconomic indicators in Turkey from 2010 to 2023 using the Toda-Yamamoto causality test and the VAR model. The findings revealed a bidirectional causality relationship between the housing price index and the construction material price index, exchange rate, and Consumer Price Index. Additionally, a unidirectional causality relationship was found from the industrial production index to the housing price index and from the housing price index to housing loan interest rates.

Soylu and Kaynak (2024) analyzed the macroeconomic variables influencing housing prices in Turkey and, using the AR(3)-TGARCH(1,1) model, found that economic growth and inflation positively affected housing prices, whereas interest rates and exchange rates had a negative impact.

Yiu and Murray (2024) examined the effect of vacant housing units on prices in the Hong Kong housing market. Using time series and dynamic panel data models, their analysis found that vacant housing had a negative effect on housing prices. However, unexpectedly, new housing supply was found to have an upward effect on prices.

3. Data

The time series analysis variables used in this study aim to comprehensively analyze various factors affecting the housing price index. The data utilized in this study were obtained from the Turkish Statistical Institute (TÜİK) and the Central Bank of the Republic of Turkey's Electronic Data Distribution System (EVDS). The data are in monthly frequency, covering the period between 2015 and 2023. The logarithms of all variables used in the analysis were taken to perform time series analysis. These variables are categorized into two main groups: supply-side and demand-side series.

The supply-side series consist of indicators reflecting the production capacity and costs of the construction sector. The Cement Production Index and the Construction Cost Index help assess construction costs and production processes within the sector, while Building Permit data provide insights into future trends in housing supply. These indicators are crucial for understanding the impact of fluctuations in housing supply on prices.

The demand-side series include variables that measure the level of demand in the housing sector. The Occupancy Permit data reflect the number of completed housing units, while macroeconomic indicators such as the Industrial Production Index help analyze the impact of overall economic activity on housing demand. Indicators such as housing sales statistics and housing loan interest rates are used to assess how consumer demand and financial conditions shape the sector's demand. Additionally, the Consumer Price Index (CPI) is analyzed to measure the impact of general inflationary pressures on housing prices.

4. Empirical Method

4.1. Detecting Seasonality in the Series: Variance Analysis Technique

In this study, the Variance Analysis Technique is applied to determine whether seasonality exists in the series. This technique identifies seasonal fluctuations by testing whether time series exhibit significant differences across specific periods (Dilek, 1988). Based on separate analyses conducted for each variable, the presence of seasonality in the series is evaluated.

Table 1

Detection of Seasonality in Supply-Side Series Using the Variance Analysis Method

	Dependent Variable	Supply-Side Series		
	LKFE	**LCUE**	**LIME**	**LYR**
Within-Month Variances (S_W^2)	0,712	0,028	0,613	0,277
Between-Month Variances (S_B^2)	0,074	0,323	0,043	0,596
Z Value	-1,131	1,223	-1,33	0,384
Critical F Value (F0.05;11,96)	1,89	1,89	1,89	1,89
F Values of Variables	0,104	***11,55***	0,07	***2,155***

When examining the results in Table 1, it is observed that the F values of the LCUE and LYR series exceed the critical F value. This indicates the presence of a seasonal effect in the LCUE and LYR series. On the other hand, the F value of the LIME series is significantly below the critical value, suggesting that there is no seasonal effect in this series. Consequently, among the supply-side series, only the LCUE and LYR series exhibit statistically significant seasonal fluctuations.

Table 2

Detection of Seasonality in Demand-Side Series Using the Variance Analysis Method

	Dependent Variable	Demand-Side Series				
	LKFE	**LYKI**	**LSUE**	**LKSI**	**LKI**	**LTUFE**
Within-Month Variances (S_W^2)	0,712	0,057	0,023	0,184	0,114	0,341
Between-Month Variances (S_B^2)	0,074	0,294	0,053	0,034	0,063	0,036
Z Value	-1,131	0,822	0,423	-0,852	-0,295	-1,117
Critical F Value (F0.05;11,96)	1,89	1,89	1,89	1,89	1,89	1,89
F Values of Variables	0,104	***5,177***	***2,331***	0,182	0,554	0,107

When examining the results in Table 2, it is observed that only the F values of the LYKI and LSUE series exceed the critical F value. This indicates the presence of a seasonal effect in the LYKI and LSUE series. In the other series, the F values remain below the critical threshold, suggesting that there is no seasonal effect in these series. Consequently, among the demand-side series, only the LYKI and LSUE series exhibit statistically significant seasonal fluctuations.

According to these analysis results, the F values of the Cement Production Index, Occupancy Permit Data, Industrial Production Index, and Construction Cost Index are 11.550, 5.177, 2.331, and 2.155, respectively, exceeding the critical value. This finding indicates that seasonal effects in these series are statistically significant.

4.2. Seasonal Adjustment

After detecting seasonality in the series, the seasonal adjustment process was carried out for these series. This process was applied using the Census X-13 method. This technique identifies seasonal fluctuations by testing whether time series exhibit significant differences across specific periods (Lee and Lee, 2014:133). Separate analyses were conducted for each variable to evaluate the presence of seasonality in the series.

Table 3

Seasonally Adjusted Series

	LCUE	LIME	LYKI	LSUE
Within-Month Variances (S_W^2)	0,0241	0,5393	0,0521	0,0222
Between-Month Variances (S_B^2)	0,0036	0,0767	0,005	0,0044
Z Value	-0,949	-0,975	-1,1761	-0,8139
Critical F Value (F0.05;11,96)	1,89	1,89	1,89	1,89
F Values of Variables	0,1499	0,1423	0,0952	0,1964

Table 3 demonstrates that the seasonal adjustment process has been successfully implemented, and the series no longer exhibit seasonal effects. The within-month and between-month variance values are significantly lower, indicating that the series have attained a more stable structure after the removal of seasonal fluctuations. These results confirm that the series can be analyzed independently of seasonal effects, allowing for more consistent and reliable outcomes.

4.3. Bai-Perron - Multiple Structural Break Test

The Bai-Perron multiple structural break test is an important statistical method used to identify structural breaks in time series data (Bai and Perron, 1998).

4.3.1. Structural Break Test for Supply-Side Series

Structural breaks in the housing price index and supply-side series were analyzed using the Bai-Perron multiple structural break test. The results indicated three structural breaks in the housing price index, three in the cement production index, four in the construction cost index, and two in building permits.

Table 4

Bai-Perron Multiple Structural Break Test Results for Supply-Side Series

	Dependent Variable	**Supply-Side Series**		
	LKFE	**LCUE**	**LIME**	**LYR**
Number of Bai-Perron Structural Breaks	3	3	4	2
Break Dates	Feb. 17	Feb. 17	Jan.17	Aug.18
	Jun.20	Nov.18	Jul.18	
	Apr.22	Jun.20	Jul.20.20	Jun.20
			Feb.22	

Examining the reasons behind these structural breaks, the failed coup attempt in 2016 triggered issues regarding investment confidence, which were further intensified by fluctuations in global markets and domestic political uncertainties. Additionally, the global economic volatility following this period had significant repercussions on the housing market. Particularly, the currency crisis in August 2018 sharply increased construction costs, resulting in fluctuations in cement demand. The construction sector, heavily burdened by increased borrowing costs in foreign currency, experienced project delays and a decline in new building permit applications. Concurrently, imported materials became costlier, leading to additional pressure on construction costs.

The COVID-19 pandemic in 2020 introduced further instability by disrupting global supply chains and creating economic uncertainties, resulting in significant fluctuations in construction costs. Although the introduction of low-interest housing loans during the pandemic temporarily boosted housing demand, it simultaneously led to rising prices of raw materials required for cement production. Consequently, these cost pressures had an adverse effect on the sector's overall production and investment capacity.

In February 2022, global disruptions caused by rising energy prices stemming from geopolitical tensions due to the Russia-Ukraine war led to increased construction costs, triggering another set of structural breaks. Elevated energy prices exacerbated cost pressures within the construction sector, intensified difficulties within supply chains, and resulted in fluctuations in raw material availability. These developments significantly impacted the housing price index by creating additional pressures on construction costs and project sustainability.

4.3.2. Structural Break Test for Demand-Side Series

Structural breaks in the housing price index and demand-side series were analyzed using the Bai-Perron multiple structural break test. The analysis identified three structural breaks in the housing price index, three in occupancy permits, three in the industrial production index, four in housing sales statistics, four in housing loan interest rates, and four in the consumer price index.

Table 5

Bai-Perron Multiple Structural Break Test Results for Demand-Side Series

	Dependent Variable	**Demand-Side Series**				
	LKFE	**LYKI**	**LSUE**	**LKSI**	**LKI**	**LTUFE**
Number of Bai-Perron Structural Breaks	3	3	3	4	4	4
Break Dates	Feb. 17	Nov.16	Nov.16	Jan.17	Jul.18	Jan.17
	Jun.20	Jun.19	Sep.20	Jan.19	Nov.19	Sep.18
	Apr.22	Sep.22	Feb.22	Jan.21	Mar.21	Aug.20
				Sep.22	Sep.22	Mar.22

Examining the primary causes of the structural breaks, it is evident that the economic uncertainties and loss of confidence following the 2016 coup attempt led to the first major fluctuations in the housing market and related macroeconomic indicators. The 2018 currency crisis triggered sudden spikes in exchange rates, resulting in rapid inflation and rising interest rates. During this period, significant effects were observed on industrial production and housing sales statistics, while construction costs increased, and access to housing loans became more challenging. The rise in exchange rates led to higher costs in the construction sector, which relies heavily on imported inputs, thereby constraining housing supply. On the demand side, higher credit interest rates made home purchases more difficult.

In 2020, the impact of the COVID-19 pandemic caused significant structural changes in the housing market and demand-side indicators. Global economic uncertainties and supply chain disruptions contributed to rising construction costs, while housing demand surged due to low-interest housing loans. During this period, increases in occupancy permits and housing sales statistics were observed, and interest rate cuts boosted demand for housing loans. However, following the initial effects of the pandemic, the slow pace of economic recovery and continued disruptions in global production chains caused structural breaks in variables such as industrial production and the consumer price index. Rising inflation led to a noticeable increase in the consumer price index, causing fluctuations in housing demand.

By 2022, global economic crises and geopolitical developments resulted in new structural breaks in the housing market. In particular, the Ukraine-Russia war drove up energy and raw material prices, increasing construction costs and exacerbating supply-demand imbalances. Rising costs fueled an upward trend in housing prices while simultaneously causing fluctuations in the consumer price index and industrial production. Global inflationary pressures led to volatility in interest rates, and changes in housing loan interest rates had a direct impact on housing sales statistics.

4.4. Carrion-i Silvestre Unit Root Test

Due to the high presence of structural breaks in the series, traditional unit root tests were deemed insufficient, leading to the preference for the Carrion-i Silvestre unit root test. This test stands out for its ability to provide reliable results, particularly in series with two or more structural breaks (Russo and Foster-McGregor, 2021:719). The Carrion-i Silvestre test evaluates the stationarity of the series while incorporating breakpoints into the analysis. This approach prevents misleading results that may arise when structural changes are not considered, ensuring a more accurate examination of the series' stability (Carrion-i-Silvestre et al, 2007).

When applying the Carrion-i Silvestre unit root test, the codes used were directly obtained from the "codes" section of Josep Lluis Carrion-i Silvestre's official website (Silvestre). A key feature of these codes is their ability to determine break dates autonomously during the test. However, these breakpoints may differ from those identified in the Bai-Perron test. To obtain more accurate and contextually relevant results, the codes were optimized by incorporating the break dates identified through the Bai-Perron test. This modification enabled a more reliable assessment of the effects of structural breaks on the series.

Table 6
Carrion-i Silvestre Unit Root Test Results at Level

	Level Values (I0)				
	P_T	MP_T	MZ_α	MSB	MZ_t
LKFE	9,276 [7.245]	8,354 [7.245]	-28,574 [-33.388]	0,132 [0.122]	-3,78 [-4.063]
LCUE	20,743 [7.746]	19,312 [7.746]	-13,428 [-33.481]	0,193 [0.122]	-2,588 [-4.083]
LIME	12,467 [8.202]	10,59 [8.202]	-26,556 [-35.150]	0,137 [0.119]	-3,643 [-4.171]
LYR	13,28 [7.130]	11,829 [7.130]	-16,835 [-28.353]	0,171 [0.133]	-2,887 [-3.747]
LYKI	10,638 [8.262]	10,335 [8.262]	-27,865 [-35.599]	0,134 [0.118]	-3,731 [-4.198]
LSUE	12,467 [7.427]	11,714 [7.427]	-20,879 [-33.353]	0,155 [0.122]	-3,228 [-4.063]
LKSI	13,77 [6.040]	12,848 [6.040]	-14,085 [-29.041]	0,186 [0.133]	-2,621 [-3.804]
LKI	14,282 [7.469]	13,472 [7.469]	-19,296 [-34.962]	0,161 [0.119]	-3,105 [-4.167]
LTUFE	19,201 [9.025]	17,223 [9.025]	-24,871 [-46.612]	0,142 [0.103]	-3,526 [-4.826]

Indicates stationarity at the 5% significance level. The values in parentheses represent critical values generated using 1,000 iterations with bootstrap.

According to the Carrion-i Silvestre unit root test results in Table 6, it is observed that all series contain a unit root at their level values, indicating that they are not stationary. This finding suggests that the series are not stationary at their levels and require additional transformations to ensure stability in econometric analysis.

Table 7
Carrion-i Silvestre First-Difference Unit Root Test Results

	First Differences (I1)				
	P_T	MP_T	MZ_α	MSB	MZ_t
LKFE	5,025 [7.286]	4,595 [7.286]	-51,932 [-33.317]	0,098 [0.122]	-5,095 [-4.053]
LCUE	5,267 [6.989]	4,679 [6.989]	-51,231 [-33.785]	0,099 [0.122]	-5,057 [-4.104]
LIME	6,135 [8.193]	5,85 [8.193]	-47,536 [-34.647]	0,103 [0.119]	-4,875 [-4.129]
LYR	5,729 [7.208]	5,091 [7.208]	-39,169 [-28.047]	0,113 [0.133]	-4,419 [-3.729]
LYKI	7,743 [8.028]	6,813 [8.028]	-42,499 [-35.745]	0,108 [0.118]	-4,608 [-4.217]

LSUE	5,921 [7.896]	5,508 [7.896]	-51,516 [-36.043]	0,098 [0.117]	-5,072 [-4.225]
LKSI	7,189 [6.119]	6,749 [6.119]	-18,58 [-21.216]	0,164 [0.153]	-3,047 [-3.226]
LKI	6,597 [7.345]	6,356 [7.345]	-38,669 [-33.531]	0,114 [0.122]	-4,39 [-4.076]
LTUFE	7,974 [8.079]	7,175 [8.079]	-48,226 [-42.522]	0,102 [0.108]	-4,909 [-4.608]

Indicates stationarity at the 5% significance level. The values in parentheses represent critical values generated using 1,000 iterations with bootstrap.

In Table 7, after taking the first differences of the series, the Pτ, Mπ, Mz, and MSB statistics became significant, indicating that the series are stationary at their first differences and have achieved stationarity.

4.5. Maki Multiple Structural Break Cointegration Test Results

If the structural breaks present in the series used in the study are ignored, the cointegration tests conducted tend to indicate that there is no cointegration relationship among the series. Therefore, when structural breaks are present in the analysis, it is essential to integrate them into the examination (Göçer et al 2013). The cointegration test developed by Maki, which allows for the endogenous determination of structural breaks, permits the inclusion of up to five structural breaks in the analysis (Maki, 2012).

4.5.1. Maki Cointegration Test Results for Supply-Side Series

In this section, the Maki cointegration test, which accounts for multiple structural breaks, was applied to determine the long-term equilibrium relationship between supply-side series and the housing price index, and the existence of a cointegration relationship was evaluated. Since the Bai-Perron multiple structural break analysis previously identified up to four structural breaks in the supply-side series and the dependent variable, the Maki test was applied to provide results for up to four structural breaks:

Table 8

Maki Multiple Structural Break Cointegration Test Results for Supply-Side Series

	At Most 1 Break	At Most 3 Breaks	At Most 2 Breaks	At Most 4 Breaks
Model 0 (Level)	-3,331[-5,341]**	-4,317 [-5,517]**	-4,317 [-5,912]**	-4,842[-6,345]**
Model 1 (Regime Shift)	-4,081 [-5,645]**	-4,204 [-5,796]**	-4,571[-5,957]**	-4,811 [-6,086]**
Model 2 (Trend Shift in Regime)	-5,088 [-6,035]**	-5,088 [-6,702]**	-5,088 [-7,018]**	-6,125 [-7,650]**
Model 3 (Shift in Intercept and Trend)	-6,314 [-6,464]	-7,074 [-7,201]**	-7,127 [-7,743]**	-7,127 [-8,269]**

Values in [ ] represent the critical values at the 5% significance level calculated by the GAUSS program. ** indicates the presence of a cointegration relationship at the 5% significance level.

Examining Table 8, it is observed that in all models, the calculated test statistics are smaller than the critical values. Therefore, no significant cointegration relationship is found between the supply-side series and the housing price index. This indicates that the series do not move together in the long run, and conducting long-term analysis using level values may pose a spurious regression risk. As a result, it has been concluded that estimating long-term cointegration coefficients between the series is not appropriate.

4.5.2. Maki Cointegration Test Results for Demand-Side Series

In this section, the Maki cointegration test, which accounts for multiple structural breaks, was applied to determine the long-term equilibrium relationship between demand-side series and the housing price index, and the existence of a cointegration relationship was evaluated. Since the Bai-Perron multiple structural break analysis previously identified up to four structural breaks in the demand-side series, the Maki test was applied to provide results for up to four structural breaks.

Table 9

Maki Multiple Structural Break Cointegration Test Results for Demand-Side Series

	At Most 1 Break	At Most 3 Breaks	At Most 2 Breaks	At Most 4 Breaks
Model 0 (Level)	-3,851 [-5,650]**	-4,126 [-5,839]**	-4,126[-5,992]**	-4,518[-6,132]**
Model 1 (Regime Shift)	-4,145[-5,913]**	-4,595[-6,055]**	-4,726[-6,214]**	-4,770[-6,373]**
Model 2 (Trend Shift in Regime)	-4,388[-6,520]**	-4,888[-7,244]**	-4,949[-7,803]**	-5,507[-8,292]**
Model 3 (Shift in Intercept and Trend)	-4,446[-6,911]**	-5,457[-7,638]**	-5,457[-8,254]**	-6,826[-8,871]**

Values in [ ] represent the critical values at the 5% significance level calculated by the GAUSS program. ** indicates the presence of a cointegration relationship at the 5% significance level.

Examining Table 9, it is observed that in all models, the calculated test statistics are smaller than the critical values. Therefore, no significant cointegration relationship is found between the demand-side series and the housing price index. This indicates that the series do not move together in the long run, and conducting long-term analysis using level values may pose a spurious regression risk. As a result, it has been concluded that estimating long-term cointegration coefficients between the series is not appropriate.

4.6. Fourier Toda-Yamamoto Causality Test Results

The Fourier Toda-Yamamoto test enhances the traditional Toda-Yamamoto causality test by providing a more effective approach to handling structural breaks in time series. This method is particularly useful in financial time series where structural breaks do not occur abruptly but rather emerge gradually over time. By incorporating Fourier functions, the test improves the reliability of results, especially in cases where structural breaks develop progressively.

A significant contribution to the development of this method was made by Şaban Nazlıoğlu, who integrated Fourier functions into the model. This addition enables a more flexible modeling approach, particularly when structural breaks appear gradually rather than instantaneously (Nazlıoğlu et al, 2016). By extending the test with Fourier functions, this approach eliminates the need for prior knowledge regarding the number, timing, or nature of structural changes, thereby increasing the model's accuracy. Thanks to Nazlıoğlu's contributions, this method has been successfully applied in capturing gradual structural breaks and has been widely used in financial market analyses.

The results of the Fourier Toda-Yamamoto Causality Test for supply-side series, which examine the causal relationships between the housing price index and other variables, are presented in Table 10:

Table 10

Causality Test Results for Supply-Side Series

Fourier Toda-Yamamoto Causality Test Results for Supply-Side Series					
H_o	Lag Length	Frequency	Test Statistic	Asymptotic (p-value) Probability	Bootstrap (p-value) Probability Value
LKFE ≠>LCUE	2	3	1,731	0,045**	0,038**
LCUE ≠>LKFE	2	3	0,811	0,666	0,679
LKFE ≠>LIME	2	3	12,877	0.002***	0.001***
LIME ≠>LKFE	2	3	23,366	0***	0***
LKFE ≠>LYR	2	3	0,495	0,781	0,754
LYR ≠>LKFE	2	3	0,142	0,931	0,92

*, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The analyses were conducted using 1,000 bootstrap simulations.

Examining the results in Table 10, a unidirectional causality relationship is identified from the housing price index to the cement production index at the 5% significance level. However, no causality relationship is found from the cement production index to the housing price index. Additionally, a bidirectional causality relationship exists between the housing price index and the construction cost index, indicating that both variables mutually influence each other.

The results of the Fourier Toda-Yamamoto Causality Test for demand-side series, examining the causal relationships between the housing price index and other variables, are presented in Table 11:

Table 11

Causality Test Results for Demand-Side Series

Fourier Toda-Yamamoto Causality Test Results for Demand-Side Series					
H_o	Lag Length	Frequency	Test Statistic	Asymptotic (p-value) Probability	Bootstrap (p-value) Probability Value
LKFE ≠>LYKI	3	3	9,802	0.02**	0.02**
LYKI ≠>LKFE	3	3	1,322	0,724	0,727
LKFE ≠>LSUE	3	3	24,608	0***	0***
LSUE ≠>LKFE	2	3	10,619	0.014**	0.024**
LKFE ≠>LKSI	2	3	10,204	0.006***	0.011**
LKSI≠>LKFE	2	3	5,742	0.057*	0.076*
LKFE ≠>LKI	2	3	3,565	0,168	0,18
LKI ≠>LKFE	2	3	37,934	0***	0***
LKFE ≠>LTUFE	4	3	29,195	0***	0***
LTUFE ≠>LKFE	4	3	43,628	0***	0***

*, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. The analyses were conducted using 1,000 bootstrap simulations.

Examining the results in Table 11, a unidirectional causality relationship is identified between the housing price index and the occupancy permit variable. This relationship is detected from occupancy permits to the housing price index at the 5% significance level. A strong causality relationship is observed from the housing price index to the industrial production index at the 1% significance level, indicating that changes in housing prices significantly influence industrial production. Additionally, a bidirectional causality relationship exists between the industrial production index and the housing price index at the 5% significance level, suggesting mutual influence. A strong causality relationship is also found from the housing price index to housing sales statistics at the 1% significance level. When analyzing the causality relationship between housing sales statistics and the housing price index, a limited causality relationship is detected at the 10% significance level. Regarding the relationship between the housing price index and the weighted average interest rates on housing loans, a strong causality relationship is identified from interest rates to the housing price index at the 1% significance level. Finally, when examining the causality relationship between the housing price index and the consumer price index (CPI), it is found that both variables strongly influence each other at the 1% significance level.

5. Conclusion

This study analyzes the supply- and demand-side variables affecting the housing price index in Turkey, revealing the impact of macroeconomic factors on the housing market. The study's unique contribution lies in incorporating structural breaks into all analyses when conducting time series analysis. This approach allows for a more accurate identification of the effects of economic shocks and sudden market dynamics on housing prices. The empirical findings indicate that housing prices are highly sensitive to both supply and demand factors.

In supply-side analyses, significant causality relationships were identified between the cement production index, construction cost index, and the housing price index. These findings suggest that construction costs and production capacity in the sector directly impact housing prices. In this context, controlling the costs of construction materials and providing incentives to the construction sector could contribute to a more balanced price formation in the housing market. The study's results align with previous research emphasizing the sensitivity of housing prices to cost dynamics on the supply side. However, no relationship was found between building permits and the housing price index, suggesting that building permits do not directly influence housing price determination.

In demand-side analyses, significant causality relationships were found between the housing price index and occupancy permits, industrial production index, housing sales statistics, interest rates, and the consumer price index (CPI). Particularly, macroeconomic indicators such as interest rates and inflation emerged as key determinants of housing market demand fluctuations. The findings are generally consistent with the existing literature on demand-side housing market dynamics. Policies aimed at controlling interest rates and reducing inflation are crucial for ensuring a sustainable price balance in the housing market. Additionally, policies supporting economic growth should be aligned with supply-side strategies to effectively accommodate rising housing demand.

This study contributes to both the academic literature and policy decision-making by highlighting the sensitivity of the housing market to macroeconomic indicators. In terms of academic contribution, empirical analyses incorporating structural breaks provide a new framework for understanding the long-term impact of economic shocks on housing prices. By going beyond traditional time series analysis, this study enables a more accurate interpretation of sudden changes in market conditions.

From a policy perspective, strategies for managing costs and supply should be developed to reduce housing market fluctuations and ensure price stability. Given the structural breaks identified, effective management of variables such as interest rates and inflation can contribute to a sustainable housing market balance. In particular, reducing construction costs and improving financing conditions can help stabilize the market while increasing investor and consumer confidence.

Future research can expand on these findings by conducting similar analyses across different countries and regions, offering a broader perspective on housing market dynamics. Additionally, further studies should focus on developing effective policy strategies to reduce market volatility and ensure long-term housing price stability.

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