Araştırma Makalesi / Research Article

Analysis of the Factors Affecting the Residential Property Price Index for New Dwellings in Türkiye

Nurgün KOMŞUOĞLU YILMAZ[1]

Makale Gönderim Tarihi: 1 Mart 2023
Makale Kabul Tarihi: 15 Eylül 2023

Abstract

This study investigates the relationship between the weighted average interest rates applied to housing loans, housing construction labor cost and housing unit prices, and the housing price index for new dwellings for the period 2015-2021. In the time series, a structural break was detected in February 2019. In the results of the regression analysis, differences were determined for the January 2015-January 2019 period and the February 2019-August 2021 period.

Keywords: *New Dwellings, Price Index, Structural Break*

Jel Codes: *R31*

Türkiye'de Yeni Konut Fiyat Endeksini Etkileyen Faktörlerin Analizi

Öz

Bu çalışma 2015-2021 döneminde konut kredilerinde uygulanan ağırlıklı ortalama faiz oranları, konut inşaatı işçilik maliyeti ve konut birim fiyatları ile yeni konutlar için konut fiyat endeksi arasındaki ilişkiyi incelemek-

[1] Dr. Öğr. Üyesi, İstanbul Aydın Üniversitesi, İktisadi ve İdari Bilimler Fakültesi, nurgunyilmaz@aydin.edu.tr, ORCID ID: 0000-0002-9050-9796

tedir. Zaman serisinde 2019 Şubat ayında yapısal kırılma tespit edilmiştir. Regresyon analizi sonuçlarında Ocak 2015-Ocak 2019 dönemi ve Şubat 2019-Ağustos 2021 dönemleri için farklılıklar bulunmuştur.

Anahtar Kelimeler: *Yeni Konutlar, Fiyat Endeksi, Yapısal Kırılma*

Jel Kodu: *R31*

1. Introduction

It is common knowledge that house prices are determined by various variables. The price of a house is affected by its location, size, distance from social areas and health facilities, as well as the age of the house, its earthquake resistance, materials used, workmanship quality, and unit production prices. Influencing variables are not limited to those listed. Moreover, factors such as the increase in state-supported mass housing projects, the decrease in loan interest rates, the increase in the need and demand for housing due to various natural disasters stand out as factors that directly affect the investor. Such situations affect supply and demand, causing changes in real estate prices.

As Goodchild & D'Archy (2019) mentioned in their study there are three interacting forces affecting real estate market and these forces can be listed as 1) local, national and global economic drivers, 2) capital markets and 3) new supply. In this study, the third of the listed forces, the new dwelling supply, is emphasized. Fluctuating economic conditions need that lenders and borrowers have a deeper awareness of the sources of money utilized for lending and the nature of how risk, economic growth, and inflation influence the availability and cost of mortgage funds (Brueggeman and Fisher, 2011).

State and municipal government policies, zoning laws and land use rules, new land development programs and regulations, and building code limits that limit construction methods all have an impact on the availability and pricing of real estate (Ling & Archer 2018).

In the initial phase of this research, a detailed literature review of the variables that were both dependent and independent was included. Housing unit price, mortgage rate and labor cost of residential buildings are considered as independent factors, while new housing price index is included as dependent variable.

The data of these factors between January 2015 and September 2021 were included in the scope of the study. A structural break was detected in

February 2019, a point within this time frame. The relationship between the variables was examined by time series least squares with breakpoints analysis.

2. Theoretical Background

In the historical development process, individual solutions regarding housing have been replaced by industrial solutions, and thus the real estate sector has emerged. Today, the production of the housing sector both plays a role in meeting people's housing needs and stands out as an investment alternative on the other hand.

As an investment alternative, the subject of real estate has attracted the attention of researchers for many years. Especially real estate pricing is the prominent connection point of this field with economy and finance. There are many factors that affect house prices.

Li and Chiang (2012) searched at whether there are stable, long-term equilibrium relationships between housing prices and basic macroeconomic variables like CPI, land sales, and GDP. The article by Chau et al. (2005) analyses the already employed pricing indices in Hong Kong and provides a new transaction-based price index developed utilizing the repeated selling approach. He et al. (2021) studied the significance of the input variable that is believed to influence the price, and as a result, they determined that the primary elements influencing the pricing are price, interior decoration, location, and status.

According to Alkali et al. (2018), the relationship between housing prices and macroeconomic variables in the Nigerian economy was examined, and the primary factors influencing real estate prices were determined to be the GDP, inflation rate, exchange rate, interest rate, and crude oil price. In their study examining the factors affecting housing prices in Shanghai, Wang and Jiang (2016) focused on the effects of disposable income per capita, land transaction price index, construction cost, urbanization rate, interest rate, housing and investment CPI in Shanghai. As a result, they determined that interest rate has no effect from these factors.

Housing price indices show housing price changes and there are many types of them prepared by different institutions in different countries. Some house price index calculations may be based on old data. For example, the Herengracht index includes house prices in the Herengracht area of Amsterdam between 1628 and 1973 (Eichholtz, 1996). The Home Price Index (HPI) shows single-family home prices in the United States and is published by the Federal

Housing Finance Corporation (FHFA). The Home Price Index uses monthly and quarterly data provided by Fannie Mae and Freddie Mac (Liberto, 2022).

Falzon and Lanzon (2013), aimed to reveal the association between alternative housing price indices in their study. For this purpose, Laspeyres, Paasche and Fisher indices were compared using hedonic regression analysis and as a result, they found that all indices move together.

There are various indices created to track housing prices in Türkiye. The most well-known of these are Residential Property Price Index (RPPI), Residential Property Price Index for New Dwellings (NRPPI), Residential Property Price Index for Existing Dwellings (ERPPI) and REIDIN-GYODER New Home Price Index.

Residential Property Price Index for New Dwellings (NRPPI) used in this study is a price index prepared by of Republic of Türkiye Central Bank. NRPPI is a price index produced using the hedonic regression method for residences built in the current and preceding years and including the entire nation (CBRT, 2022a).

In their research, Eryuzlu & Ekinci (2020) examined the relationship between the CBRT housing price index and the real exchange rate using the Dolado-Lütkepohl causality test. On the other hand, Adana Karaağaç and Altınırmak (2018) also investigated the causal relationship between the CBRT Housing Price Index and Industrial Production Index, Consumer Price Index (CPI), Consumer Confidence Index, Exchange Rate, Employment and Unemployment.

The Housing Unit Pricing is the average price per square meter of dwellings that have been sold. The price per unit of housing is crucial information for individuals who wish to invest. It is the average price in TL per square meter for residences in the selected province or city for a specified time period.

Mortgage rate is also an important factor affecting house prices. McGibany & Nourzad's (2004) study reveals that there is almost no short-run effect from mortgage rates to housing prices. According to the research by Abidoye et al. (2019), the interest rate, the unemployment rate, and the size of households were the three most influential factors in determining real estate values.

In this study, the effects of weighted average interest rates on bank housing loans, unit price and labor cost on the housing on the new housing price index (NRPPI) were examined. Importantly, the weighted average

interest rate data for banks includes only fixed-rate loans from housing loans and excludes floating-rate loans that are scheduled to be repaid (CBRT, 2022b).

3. Research Methodology and Findings

3.1. Data

The data for the research variables include monthly data from January 2015 to September 2021. NRPPI as dependent variable and independent variables as unit price, mortgage interest rate and labor cost were included in the study. NRPPI, unit price and weighted average interest rates for banks' housing loans were taken from the CBRT website EVDS database. The independent variable, labor cost, was obtained through TSI (Data Portal for Statistics). Table 1 displays the factors used for this research:

Table 1: Variables used in the analysis.

Variables	Explanation	Source
NRPPI (Dependent Variable)	Residential Property Price Index for New Dwellings	CBRT (EVDS data systems)
Unit Price (Independent Variable)	Housing Unit Prices for Türkiye - TL/sq m	CBRT (EVDS data systems)
Housing Credit Rates (Independent Variable)	Weighted Average Interest Rates For Banks Loans for Housing (Flow Data, %)), (TRY)	CBRT (EVDS data systems)
Labour Cost (Independent Variable)	Residential Buildings Labour Cost	Turkish Statisical Institute (Data Portal for Statistics)

3.2. Research Method

In this study, weighted average interest rates for banks' housing loans, housing unit price and housing labor costs are considered as independent variables, while the new housing price index is included as dependent variable.

Throughout the scope of this investigation, the link between the aforementioned variables was analyzed between January 2015 and September 2021. Before the regression analysis, seasonality analysis and ADF Unit Root Test were applied for each variable. Then, deviations from the regression assumptions were tested and a structural break was detected in the time series.

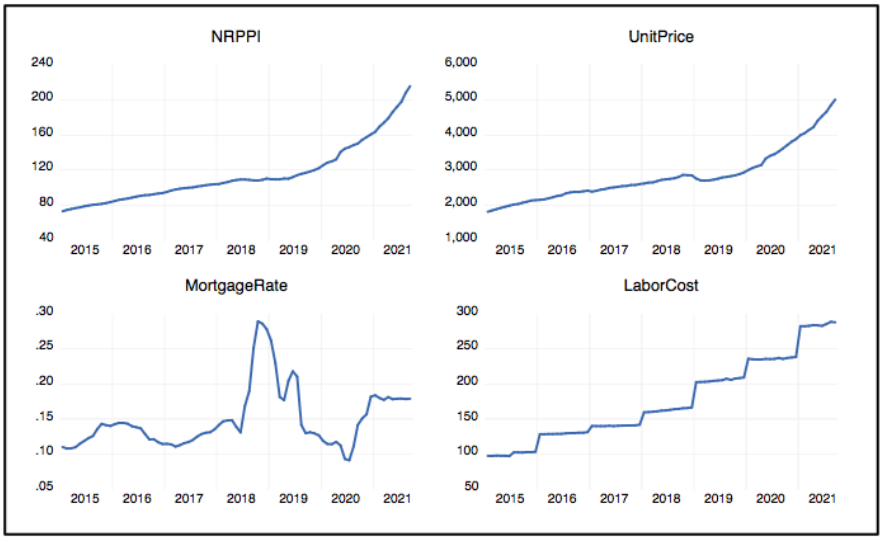
The dependent and independent variables used in the research are described in Table 2 for the 81-month period covering January 2015 to September 2021.

Table 2: Descriptive Statistics

	NRPPI	Unit Price	Mortgage Rate	Labor Cost
Mean	114.6444	2823.4860	0.1494	176.0340
Median	108.0000	2697.9000	0.1383	161.9400
Maximum	215.8000	5011.1000	0.2894	288.7700
Minimum	72.9000	1806.4000	0.0911	97.0100
Std. Dev.	33.2567	734.9118	0.0434	58.4452
Skewness	1.2409	1.1847	1.5469	0.4682
Kurtosis	3.9342	3.8751	5.1310	2.0675
Jarque-Bera	23.73647	21.53493	47.63380	5.894919
Probability	0.000007	0.000021	0.000000	0.052473
Sum	9286.200	228702.4	12.10483	14258.75
Sum Sq. Dev.	88480.98	43207626	0.150940	273267.5
Observations	81	81	81	81

Table 3 shows the visualized graphs of the time-dependent change in the data of the research variables.

Table 3: Graph of Variables



The seasonality test was performed for the data set containing monthly data from the Residential Property Price Index for New Dwellings. Seasonality testing was performed by generating a dummy variable for 12 months and

subtracting one dummy variable from the model. The probability value was found to be > 0.05. As a result of the analysis (Table 4), seasonality was not determined for the variable NRPPI.

Tablo 4: Seasonality Test for the Variable "Residential Property Price Index for New Dwellings" (NRPPI)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	107.9000	13.37783	8.065585	0.0000
@MONTH=2	2.057143	18.91910	0.108734	0.9137
@MONTH=3	3.471429	18.91910	0.183488	0.8550
@MONTH=4	5.228571	18.91910	0.276365	0.7831
@MONTH=5	7.928571	18.91910	0.419078	0.6765
@MONTH=6	10.07143	18.91910	0.532342	0.5962
@MONTH=7	11.78571	18.91910	0.622953	0.5354
@MONTH=8	14.08571	18.91910	0.744523	0.4591
@MONTH=9	15.68571	18.91910	0.829094	0.4099
@MONTH=10	1.650000	19.69163	0.083792	0.9335
@MONTH=11	2.933333	19.69163	0.148963	0.8820
@MONTH=12	4.433333	19.69163	0.225138	0.8225
R-squared		0.023059	Mean dependent var	114.6444
Adjusted R-squared		-0.132685	S.D. dependent var	33.25676
S.E. of regression		35.39440	Akaike info criterion	10.10694
Sum squared resid		86440.70	Schwarz criterion	10.46167
Log likelihood		-397.3310	Hannan-Quinn criter.	10.24926
F-statistic		0.148057	Durbin-Watson stat	0.022561
Prob(F-statistic)		0.999277		

The seasonality test was performed for the dataset containing monthly data on the Unit Price variable. Seasonality test was carried out by producing a dummy variable for 12 months and deducting from one dummy variable model. The probability value was found to be 0.05. As a result of the analysis (Table 5), seasonality was not determined for the variable Unit Price.

Tablo 5: Seasonality Test for the Variable "Unit Price"

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2672.400	295.5545	9.041987	0.0000
@MONTH=2	24.07143	417.9772	0.057590	0.9542
@MONTH=3	57.42857	417.9772	0.137396	0.8911
@MONTH=4	92.12857	417.9772	0.220415	0.8262
@MONTH=5	168.1286	417.9772	0.402243	0.6887
@MONTH=6	213.5286	417.9772	0.510862	0.6111
@MONTH=7	260.1429	417.9772	0.622385	0.5357
@MONTH=8	309.8429	417.9772	0.741291	0.4610
@MONTH=9	362.8714	417.9772	0.868161	0.3883
@MONTH=10	72.06667	435.0444	0.165654	0.8689
@MONTH=11	101.3333	435.0444	0.232926	0.8165
@MONTH=12	130.1000	435.0444	0.299050	0.7658
R-squared		0.023523	Mean dependent var	2823.486
Adjusted R-squared		-0.132147	S.D. dependent var	734.9118
S.E. of regression		781.9637	Akaike info criterion	16.29745
Sum squared resid		42191237	Schwarz criterion	16.65218
Log likelihood		-648.0466	Hannan-Quinn criter.	16.43977
F-statistic		0.151110	Durbin-Watson stat	0.022059
Prob(F-statistic)		0.999204		

The weighted average interest rates for housing loans were tested for seasonality for the dataset containing monthly data. The seasonality test was performed by producing dummy variables for 12 months and deducting from one dummy variable model. The probability value was found to be 0.05. As a result of the analysis (Table 6), seasonality was not determined for the weighted average interest rates for housing loans.

Tablo 6: Seasonality Test for the Variable "Weighted Average Interest Rates Applied In Housing Loans Opened by Banks"

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.153372	0.017388	8.820625	0.0000
@MONTH=2	-0.005236	0.024590	-0.212948	0.8320
@MONTH=3	-0.012787	0.024590	-0.520010	0.6047
@MONTH=4	-0.012011	0.024590	-0.488464	0.6268
@MONTH=5	-0.009956	0.024590	-0.404894	0.6868
@MONTH=6	-0.011189	0.024590	-0.455030	0.6505

@MONTH=7	-0.006328	0.024590	-0.257332	0.7977
@MONTH=8	-0.010481	0.024590	-0.426215	0.6713
@MONTH=9	0.001972	0.024590	0.080200	0.9363
@MONTH=10	0.007616	0.025594	0.297574	0.7669
@MONTH=11	0.006968	0.025594	0.272243	0.7862
@MONTH=12	0.009383	0.025594	0.366600	0.7150
R-squared		0.032528	Mean dependent var	0.149442
Adjusted R-squared		-0.121706	S.D. dependent var	0.043437
S.E. of regression		0.046004	Akaike info criterion	-3.184221
Sum squared resid		0.146030	Schwarz criterion	-2.829487
Log likelihood		140.9609	Hannan-Quinn criter.	-3.041897
F-statistic		0.210902	Durbin-Watson stat	0.122593
Prob(F-statistic)		0.996337		

Labor Cost was tested for seasonality for the dataset containing monthly data. The seasonality test was performed by producing dummy variables for 12 months and deducting from one dummy variable model. The probability value was found to be 0.05. As a result of the analysis (Table 7), seasonality was not determined for the variable Labor Cost.

Tablo 7: Seasonality Test for the Variable "Labor Cost"

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	178.1114	23.64861	7.531580	0.0000
@MONTH=2	-0.051429	33.44419	-0.001538	0.9988
@MONTH=3	0.172857	33.44419	0.005169	0.9959
@MONTH=4	0.438571	33.44419	0.013114	0.9896
@MONTH=5	0.940000	33.44419	0.028107	0.9777
@MONTH=6	0.731429	33.44419	0.021870	0.9826
@MONTH=7	2.242857	33.44419	0.067063	0.9467
@MONTH=8	3.411429	33.44419	0.102004	0.9190
@MONTH=9	2.915714	33.44419	0.087181	0.9308
@MONTH=10	-13.99643	34.80982	-0.402083	0.6889
@MONTH=11	-13.73810	34.80982	-0.394662	0.6943
@MONTH=12	-12.91310	34.80982	-0.370961	0.7118
R-squared		0.011514	Mean dependent var	176.0340
Adjusted R-squared		-0.146071	S.D. dependent var	58.44522
S.E. of regression		62.56835	Akaike info criterion	11.24635

Sum squared resid	270121.1	Schwarz criterion	11.60108
Log likelihood	-443.4772	Hannan-Quinn criter.	11.38867
F-statistic	0.073065	Durbin-Watson stat	0.014194
Prob(F-statistic)	0.999978		

After the seasonality tests, the logarithmic values of the data were taken and the ADF Unit Root Test was applied. First, ADF Unit Root Test at level was made for dependent and independent variables. The variable "lnLabor Cost" does not contain unit root at level. Other variables, "ln NRPPI", "lnUnitPrice", "lnMortgageRate" at first difference were found to be stationary. The results of ADF Unit Root Test at level are presented in Table 8.

Tablo 8: ADF Unit Root Test (At Level)

AT LEVEL	**ADF**	ln NRPPI	lnUnitPrice	lnLaborCost	lnMortgageRate
ADF Unit Root Test at Level Constant	Test Statistic	3.3793	2.2177	-0.5201	-2.7553
	Prob.	1.0000	0.9999	0.8809	0.0695
With Constant & Trend	Test Statistic	2.1776	0.9275	-3.7800	-2.8896
	Prob.	1.0000	0.9998	**0.0227**	0.1715
Without Constant & Trend	Test Statistic	3.3378	3.2842	2.8798	-0.7336
	Prob.	0.9997	0.9997	0.9989	0.3957

In Table 9, the @TREND probability (P=0.0004) for lnlaborcost was found to be $p < 0.05$. The calculated value for the unit root test results for Constant & Trend should be considered, as this means that the series contains a trend. Probability (P= 0.0227) value of <0.05 was found and the series is stationary.

Tablo 9: @TREND probability for lnlaborcost

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Lnlaborcost(-1)	-0.312397	0.082645	-3.779969	0.0003
C	1.432748	0.375635	3.814199	0.0003
@TREND("2015M01")	0.004371	0.001169	3.738259	**0.0004**

In Table 10 ADF Unit Root Test results can be seen for dlnNewResidentialPI. The null hypothesis is presented below.

H_0: The variable has a unit root.

The series has been determined to contain trends (@TREND probability= **0.0060)**. Including trend and intercept H_0 is rejected. The series is found to be stationary (P=0.0007, p <0.05).

Table 10: ADF Unit Root Test for dln NRPPI

dln NRPPI		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.929780	**0.0007**
Test critical values:	1% level	-4.078420	
	5% level	-3.467703	
	10% level	-3.160627	

Variable	Coefficient	Std. Error	t-Statistic	Prob.
dlnNewResidentialPI (-1)	-0.477192	0.096798	-4.929780	0.0000
C	0.001073	0.002021	0.531181	0.5968
@TREND("2015M01")	0.000136	4.83E-05	2.824696	**0.0060**

In Table 11 ADF Unit Root Test results can be seen for dln Unitprice. The null hypothesis is presented below.

H_0: The variable has a unit root.

The series has been determined to contain trends (@TREND probability: **0.0467)**. Including trend and intercept H_0 is rejected. The series is found to be stationary (p=0.0010, p <0.05).

Table 11: ADF Unit Root Test for dlnUnitprice

dlnUnitprice		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.822162	**0.0010**
Test critical values:	1% level	-4.078420	
	5% level	-3.467703	
	10% level	-3.160627	

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DLNUNITPRICE(-1)	-0.464611	0.096349	-4.822162	0.0000
C	0.001810	0.002313	0.782770	0.4362
@TREND("2015M01")	0.000104	5.12E-05	2.022209	***0.0467***

In Table 12 ADF Unit Root Test results can be seen for DlnMortgage-Rate. The null hypothesis is presented below.

H_0: The variable has a unit root.

Trend probability value (@TREND probability: 0.8901) indicates that the series has no trend. For this series, only the intercept was included in the stationarity test. It was found according to the ADF test (p=0.0000, p <0.05). In the model which includes only intercept, H0 is rejected. The series is found to be stationary.

Table 12: ADF Unit Root Test for DlnMortgageRate

DlnMortgageRate		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.438498	**0.0001**
Test critical values:	1% level	-4.078420	
	5% level	-3.467703	
	10% level	-3.160627	

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DlnMortgageRate (-1)	-0.559704	0.102915	-5.438498	0.0000
C	0.005981	0.018990	0.314965	0.7537
@TREND("2015M01")	-5.71E-05	0.000412	-0.138638	**0.8901**

Since the trend probability is greater than 0.05, it is made for Unit root only intercept.

Only Intercept

DlnMortgageRate		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.472138	**0.0000**
Test critical values:	1% level	-3.515536	
	5% level	-2.898623	
	10% level	-2.586605	

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DlnMortgageRate (-1)	-0.559523	0.102249	-5.472138	0.0000
C	0.003695	0.009357	0.394895	0.6940
Prob(F-statistic)				0.000001

A scatter plot is a useful tool for illustrating how the many variables included in a regression model are connected to one another (Gujarati & Porter, 2009). Figure 1, 2 and 3 show the relationship between the dependent

variable and each independent variable on a graph. The scatter plot indicates the direction and strength of the relationship between the dependent and independent variables.

Figure 1: Scatter Plot for "dlnNRPPI" and "dlnUnitprice"

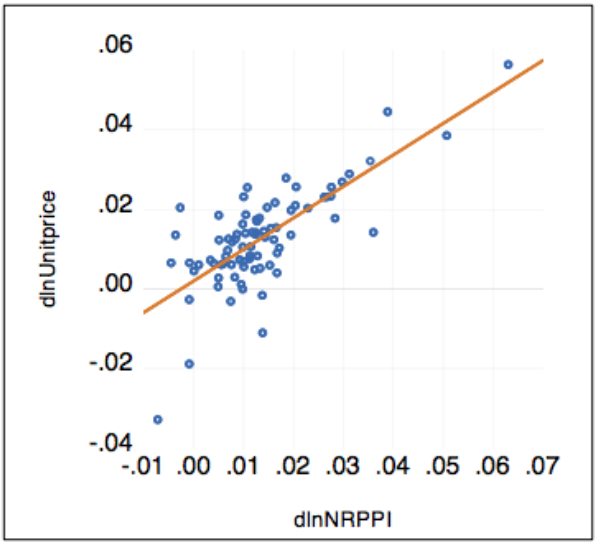


Figure 2: Scatter plot for dlnNRPPI and dlnLaborcost

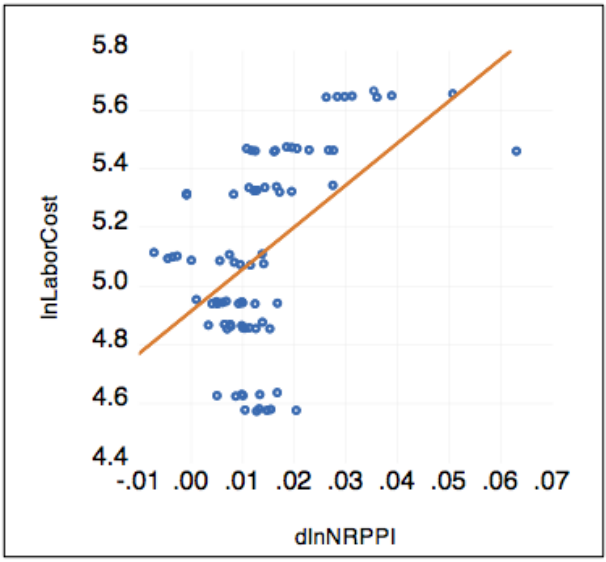
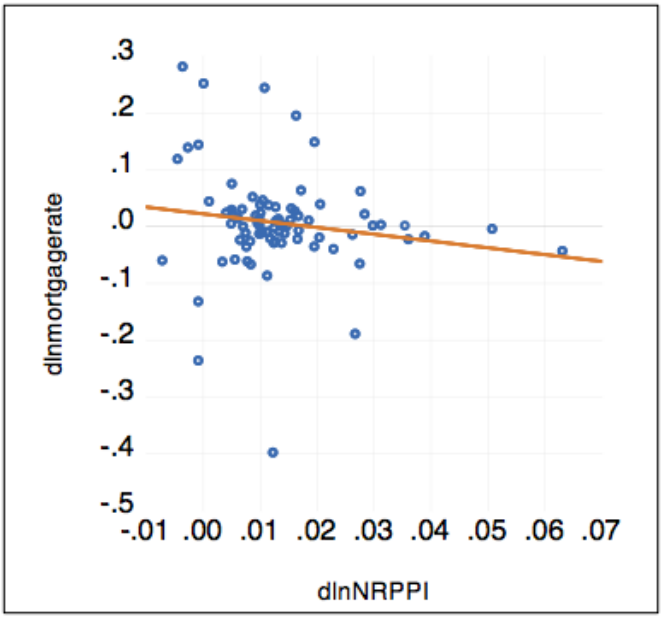


Figure 3: Scatter plot for dlnNRPPI and dlnmortgagerate



In Table 13, correlation analysis is presented to show the relationship between the dependent variable and each independent variable.

Table 13: Correlation Analysis

	D(lnNRPPI)	D(lnMortgage Rate)	ln(LaborCost)	D(lnUnitPrice)
D(lnNRPPI)	1.0000			
D(lnMortgage Rate)	-0.1523 *(0.1773)*	1.0000		
ln(LaborCost)	0.5061 *(0.0000)*	-0.0621 *(0.5839)*	1.0000	
D(lnUnitPrice)	0.7470 *(0.0000)*	0.1572 *(0.1637)*	0.3487 *(0.0015)*	1.0000

In a regression model, stepwise regression is used when deciding on the best explanatory variable set (Gujarati & Porter, 2009). Stepwise regression was performed to select variables, to include significant variables in the model and to remove non-significant ones from the model.

Table 14: Stepwise Regression Analysis

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	-0.039324	0.012274	-3.203729	0.0020
D(lnUnitPrice)	0.661615	0.066133	10.00436	0.0000
D(lnMortgage Rate)	-0.031506	0.008378	-3.760508	0.0003
ln(LaborCost)	0.008737	0.002452	3.563627	0.0006
Prob(F-statistic)	0.000000			
Selection Summary				
D(lnUnitPrice) D(lnMortgage Rate) ln(LaborCost)				

As an outcome of the stepwise regression analysis conducted with the VARSEL method, it was determined that the independent variables for which the model is appropriate should be incorporated into the model, and there is no need to exclude them. Table 14 depicts the relevance ranking of the independent variables.

Variance Inflation Factors (VIFs) are a way to measure the level of collinearity between the regressors in an equation (E-views User Guide, 2022a). If VIF is between 1 and 5 it means moderately correlated (Feldman, 2018). There are no multicollinearities with VIF criteria found to be less than 5 when looking at centered VIF values.

Table 15: Variance Inflation Factors

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
D(lnMortgage Rate)	7.02E-05	1.046655	1.041982
ln(LaborCost)	6.01E-06	284.1386	1.156980
D(lnUnitPrice)	0.004374	2.464545	1.181714
C	0.000151	271.6683	NA

CUSUM (Figure-4) and CUSUM of Squares Graph (Figure-5) depict to check whether the successive residues go out of bounds of the graph, that is, for structural break.

Figure 4: CUSUM Graph

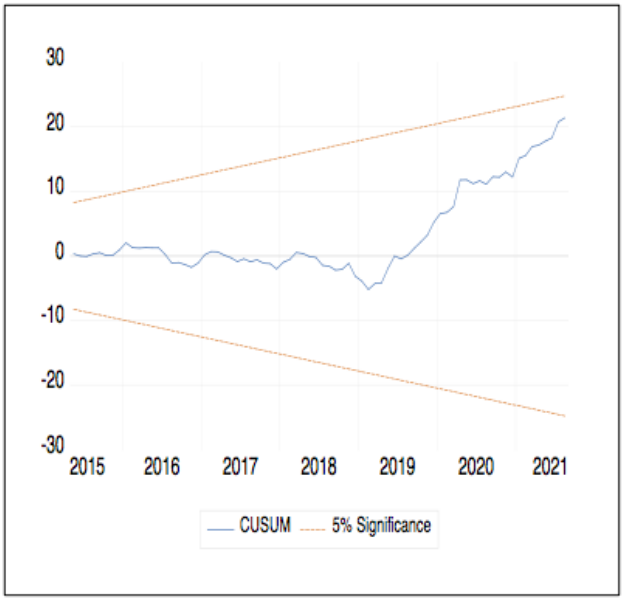
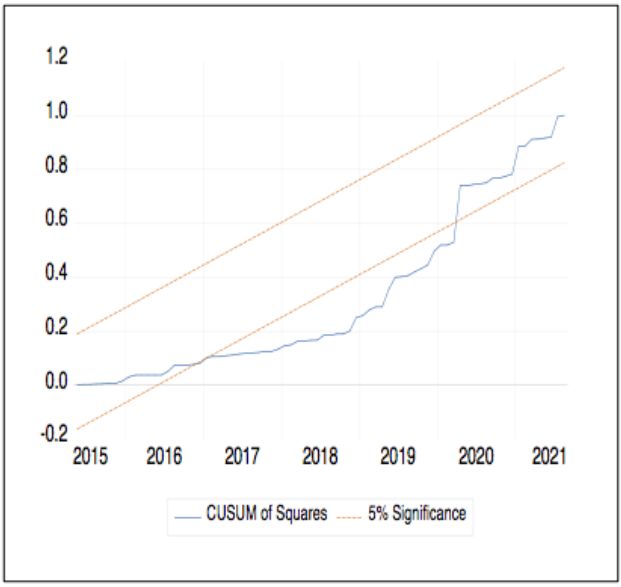


Figure 5: CUSUM of Squares Graph



When examining the CUSUM graph (Figure-4), it was observed that there is no structural break. However, when looking at the CUSUM Square test (Figure-5), a structural break was detected. Quandt-Andrews Unknown Breakpoint Test was applied to determine the timing of the structural break. Quandt-Andrews test findings confirmed the Cusum Square test results. According to the Quandt-Andrews test findings, a single structural break appears in February 2019 (within 15% trimmed data) in the time period included in the study.

Table 16: Quandt-Andrews Unknown Breakpoint Test

Statistic	Value	Prob.
Maximum LR F-statistic (2019M02)	14.55709	0.0000
Maximum Wald F-statistic (2019M02)	58.22835	0.0000
Exp LR F-statistic	5.013836	0.0000
Exp Wald F-statistic	25.75921	0.0000
Ave LR F-statistic	7.166798	0.0000
Ave Wald F-statistic	28.66719	0.0000
Null Hypothesis: No breakpoints within 15% trimmed data		

This study examines the relationship between the weighted average interest rates applied to housing loans opened by banks, housing construction labor cost and housing unit price data, and the housing price index for new houses. Since the first differences were taken in the data set, the time series regression analysis was performed with the data calculated between January 2015 and August 2021. A single structural break was detected for February 2019 within the time frame included in the study. Estimation by linear least squares regression with breakpoints was made with 15% trimmed data.

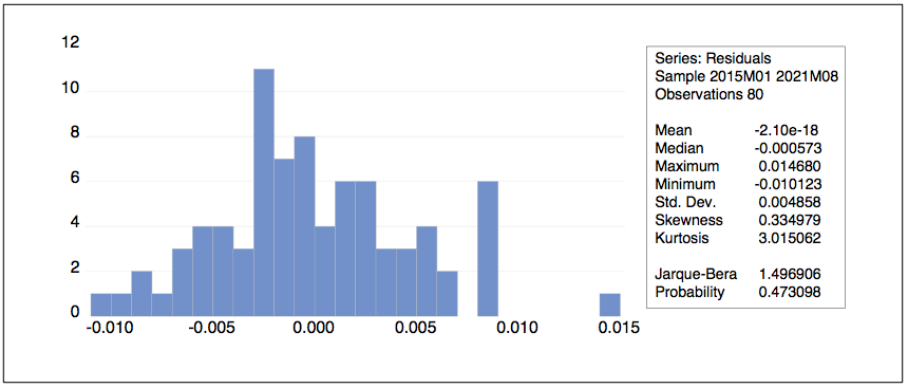
In the analysis of linear least squares regression with breakpoints, it is shown that the unit price effect has a positive effect on the new housing price index, while the labor cost and housing loan interest rate have a negative effect on the 2015 January - 2019 January period. However, for the period of February 2019-August 2021, the effect of housing unit price and labor cost on the new housing price index is positive, while the effect of bank housing loan interest rate is negative.

Table 17: Least Squares with Breakpoints

2015M01 - 2019M01 -- 49 obs				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(lnUnitPrice)	0.164879	0.090104	1.829866	0.0714
ln(LaborCost)	-0.013003	0.004608	-2.821758	0.0062
D(lnMortgage Rate)	-0.033536	0.011249	-2.981092	0.0039
C	0.070955	0.022894	3.099324	0.0028
2019M02 - 2021M08 -- 31 obs				
Variable Coefficient		Std. Error	t-Statistic	Prob.
D(lnUnitPrice)	0.867083	0.096374	8.997071	0.0000
ln(LaborCost)	0.021842	0.009328	2.341495	0.0220
D(lnMortgage Rate)	-0.026246	0.008102	-3.239606	0.0018
C	-0.114883	0.049852	-2.304464	0.0241
R-squared	0.826000	Mean dependent var		0.013566
Adjusted R-squared	0.809083	S.D. dependent var		0.011645
S.E. of regression	0.005088	Akaike info criterion		-7.629088
Sum squared resid	0.001864	Schwarz criterion		-7.390886
Log likelihood	313.1635	Hannan-Quinn criter.		-7.533586
F-statistic	48.82762	Durbin-Watson stat		2.191257
Prob(F-statistic)	0.000000			

Upon examination of the Histogram Normality Test graph presented in Figure-6. Histogram and descriptive statistics about the residuals, such as the Jarque-Bera statistic for testing whether the residuals are normal. If residuals have a normal distribution, the histogram should resemble a bell, and the Jarque-Bera statistic should not be statistically significant (E-views, 2022b). Probability value was found to be higher than 0.05 and it is normal distribution.

Figure 6: Histogram Normality Test



Heteroscedasticity and Autocorrelation

H_0 (null hypothesis): data is homoscedastic.

If P value <0.05, Ho is rejected and conclude that heteroscedasticity is present in the regression model. The probability value was found to be greater than 0.05 in all tests. H_0 is accepted.

Table 18: Breusch-Pagan-Godfrey (Heteroskedasticity Test)

F-statistic	1.602439	Prob. F(7,72)	0.1486
Obs*R-squared	10.78344	Prob. Chi-Square(7)	0.1483
Scaled explained SS	8.800365	Prob. Chi-Square(7)	0.2673

The Breusch (1978)–Godfrey (1978) test examines the autocorrelation of a regression model's errors. The null hypothesis is that there is no serial correlation. If P value <0.05, Ho is rejected and conclude that there is no serial correlation.

Table 19: Breusch-Godfrey Serial Correlation LM Test

F-statistic	0.582258	Prob. F(2,70)	0.5613
Obs*R-squared	1.309098	Prob. Chi-Square(2)	0.5197

Conclusion, Limitations and Recommendations

As it is known, housing prices are affected by many factors, among which mortgage interest rates, labor costs in new housing construction and unit housing prices play an important role. The research examines the relationship between weighted average interest rates applied to housing loans, labor costs, housing unit prices and housing price index for new houses. The data set included in the research includes the period of January 2015-September 2021. Within the specified time period, a structural break was detected in February 2019. The logarithmic values of the data included in the analysis. In addition, the first differences of NRPPI, mortgage rate and unit price variables were included in the analysis.

Structural break regression analysis decomposed as January 2015-January 2019 first period and February 2019-August 2021 second period. According to the results of the analysis, it has been shown that for the first period, labor cost and housing loan interest rate have a negative effect on the new housing price index and the housing unit price has a positive effect. In the second period, the effect of unit price and labor cost on the new housing price index is positive, while the effect of housing loan interest rate is negative. According to the results of the regression analysis, the probability values of

dlnunitprice during the first period are significant at 10 percent significance, while lnlaborcost and dlnmortgage rate are significant at 5 percent significance level. In the period after the structural break, all coefficients of variables are found to be significant at 5 percent significance level.

The limitations of this study are that it only covers a specific time frame, and its results are not generalizable beyond that period. Additionally, the study focuses only on labor costs, and the impact of other cost factors has not been considered. To enhance the scope of the study, many other influential factors can be included. Finally, the study only includes new housing units in its scope. As a recommendation, future studies can incorporate material costs and newly issued government supported housing loans separately for new and old housing for mortgage rates.

References

Abidoye, R. B., Chan, A. P., Abidoye, F. A., & Oshodi, O. S. (2019). Predicting property price index using artificial intelligence techniques. International Journal of Housing Markets and Analysis, 12(6), 1072–1092. https://doi.org/10.1108/ijhma-11-2018-0095

Adana Karaağaç, G. & Altınırmak, S. (2018). Türkiye konut fiyat endeksi ve düzey bazlı konut fiyat endeksleri ile seçili değişkenler arasındaki nedensellik ilişkisi. Karadeniz Uluslararası Bilimsel Dergi, 39(39), 222–240. https://doi.org/10.17498/kdeniz.415650.

Alkali, A. M., Sipan I., & Razali, N. M. (2018). An Overview of Macro-Economic Determinants of Real Estate Price in Nigeria. *International Journal of Engineering & Technology*, *7*(3.30), 484. https://doi.org/10.14419/ijet.v7i3.30.18416

Brueggeman W. B. & Fisher J. D. (2011) Real Estate Finance and Investments 14th Edition, The McGraw-Hill/Irwin, P.77

Breusch, T. S. (1978). Testing for Autocorrelation in Dynamic Linear Models. Australian Economic Papers. 17: 334–355. doi:10.1111/j.1467-8454.1978.tb00635.x.

CBRT (2022a) KFE-Metaveri, Web: https://www.tcmb.gov.tr/wps/wcm/connect/b4628fa9-11a7-4426-aee6-dae67fc56200/KFE-Metaveri.pdf?MOD=AJPERES&CACHEID=ROOTWORKSPACE-b4628fa9-11a7-4426-aee6-dae67fc56200-n-ivv0n Accessed at: 22-02-2023

CBRT (2022b) Bankalarca Açılan Kredilere Uygulanan Ağırlıklı Ortalama Faiz Oranları Web: https://www.tcmb.gov.tr/wps/wcm/connect/17cf95e1-0d16-4583-8c84-eac20719123c/Metaveri_Kredi_Ag%C4%B1rl%C4%B1kl%C4%B1_T%C3%BCrkce.pdf?MOD=AJPERES Accessed at: 22-02-2023

Chau, K., Wong, S., Yiu, C., & Leung, H. (2005). Real Estate Price Indices in Hong Kong. Journal of Real Estate Literature, 13(3), 337–356. https://doi.org/10.1080/10835547.2005.12090166

Eichholtz, P. M. A. (1996). A Long Run House Price Index: The Herengracht Index, 1628-1973. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.598

Eryüzlü, H. & Ekici, S. (2020). Konut fiyat endeksi ve reel döviz kuru ilişkisi: Türkiye örneği. İktisadi İdari ve Siyasal Araştırmalar Dergisi, 97–105. https://doi.org/10.25204/iktisad.650420

E-Views User Guide (2022a) Coefficient Diagnosis, https://eviews.com/help/helpintro.html#page/content%2Ftesting-Coefficient_Diagnostics.html%23ww182212 Accessed at: 28-02-2023

E-Views Users Guide (2022b) Residual Diagnostics, https://eviews.com/help/helpintro.html#page/content%2Fmultibreak Least_Squares_with_Breakpoints.html%23ww36959 Accessed at: 28-02-2023

Falzon, J. & Lanzon, D. (2013) Comparing alternative house price indices: evidence from asking prices in Malta. International Journal of Housing Markets and Analysis, 6(1), 98–135. https://doi.org/10.1108/17538271311306048

Feldman, K. (2018) Variance Inflation Factor (VIF), https://www.isixsigma.com/dictionary/variance-inflation-factor-vif/

Godfrey, L. G. (1978) Testing Against General Autoregressive and Moving Average Error Models when the Regressors Include Lagged Dependent Variables. Econometrica. 46: 1293–1301. (https://www.jstor.org/stable/1913829)

Goodchild R. & D'Archy E. (2019) An International Overview of Real Estate Markets: Similarities and Differences. In: Mac Gregor BD, Schulz R and Green RK. Routledge Companion to Real Estate Investment New York: Routledge. P.12.

Gujarati, D. N. & Porter, D. C. (2009) Basic Econometrics. Fifth Edition. The McGraw-Hill.

He, H. M., Chen, Y., Xiao, J. Y., Chen, X. Q., & Lee, Z. J. (2021) Data Analysis on the Influencing Factors of the Real Estate Price. Artificial Intelligence Evolution, 52–66. https://doi.org/10.37256/aie.222021966

Li, J., & Chiang, Y. (2012) What pushes up China's real estate price?. International Journal of Housing Markets and Analysis, 5(2), 161–176. https://doi.org/10.1108/17538271211225913

Liberto D. (2022) What Is the House Price Index (HPI), Investopedia, https://www.investopedia.com/terms/h/house-price-index-hpi.asp, Updated January 27, 2022, Accessed at: 26-02-2023

Ling D. C. & Archer W. R. (2018) Real Estate Principles A Value Approach Fifth Edition McGraw-Hill Education, P.10

McGibany, J. M., & Nourzad, F. (2004) Do lower mortgage rates mean higher housing prices? Applied Economics, 36(4), 305–313. https://doi.org/10.1080/0003684041000167423 1

Turkish Statisical Institute, (Accessed at: 28-10-2022), web page: https://www.tuik.gov.tr/

Wang, Y., & Jiang, Y. (2016) An Empirical Analysis of Factors Affecting the Housing Price in Shanghai. Asian Journal of Economic Modelling, 4(2), 104–111. https://doi.org/10.18488/journal.8/2016.4.2/8.2.104.111