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THE ANALYSIS OF THE RELATIONSHIP BETWEEN HOUSING PRICES AND INTEREST RATES IN TURKEY

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ABSTRACT

Today, the size of the mortgage-backed asset market shows us that the housing market can profoundly affect not only the real economy but also the financial sector. The crisis in 2008 is a proof of this circumstance. Compared to developed countries, there is no deepened financial market for mortgage-backed assets in Turkey. However, in Turkey, which implements a growth strategy based on the construction sector, interventions in the housing market have become a part of the economic policy to keep the sector alive. For this reason, policymakers are trying to keep housing loan rates low to differentiate them from other interest rates. However, the effect of these interventions on housing loan rates on housing demand and housing prices is ambiguous. Therefore, the main objective of this study is to investigate the effects of housing loan interest rates on house prices in Turkey in the period of 2010-2020. To analyze the causality between housing loan rates and house prices indexes, we applied Hacker and Hatemi-J (2010) bootstrap Toda-Yamamoto causality test and Hatemi-J (2012) time-varying symmetric Toda-Yamamoto test. The main finding of the study is that there is no causality from the housing loan interest rates to the housing price index in the related period.

Keywords: *Housing Market, Housing Price Index, Mortgage Credits, Interest Rate, Time-Varying Symmetric Toda-Yamamoto Test*
Jel Codes: *E43, R31*

TÜRKİYE'DE KONUT FİYATLARI VE FAİZ ORANLARI ARASINDAKİ İLİŞKİNİN ANALİZİ

ÖZ

Günümüzde, ipoteğe dayalı varlık piyasasının büyüklüğü bize konut piyasasının yalnızca reel ekonomiyi değil, aynı zamanda finansal sektörü de derinden etkileyebileceğini göstermektedir. 2008 yılında yaşanan kriz de bu durumun bir kanıtıdır. Gelişmiş ülkelerle kıyaslandığında Türkiye'de ipoteğe dayalı varlıklar için derinleşmiş bir finansal piyasa söz konusu değildir. Ancak inşaat sektörüne dayalı bir büyüme stratejisi uygulayan Türkiye'de sektörü canlı tutmak için konut piyasasına yönelik müdahaleler ekonomi politikasının bir parçası haline gelmiştir. Bu nedenle konut kredisi faizleri diğer faiz oranlarından ayrışacak ölçüde düşük tutulmaya çalışılmaktadır. Bununla birlikte, konut kredisi faizlerine yapılan bu müdahalelerin konut talebi ve konut fiyatlarına ilişkin etkisi muğlaktır. Bu nedenle bu çalışmanın amacı temel amacı, 2010-2020 döneminde Türkiye'de konut kredisi faiz oranlarının konut fiyatlarına etkisini araştırmaktır. Konut kredisi faiz oranları ile konut fiyat endeksleri arasındaki nedenselliği analiz etmek için Hacker ve Hatemi-J (2006) bootstrap Toda-Yamamoto nedensellik testi ve Hatemi-J (2012) zamanla değişen simetrik Toda-Yamamoto testi uygulanmıştır. Çalışmanın temel bulgusu, ilgili dönemde konut kredisi faiz oranlarından konut fiyat endeksine doğru bir nedenselliğin olmadığıdır.

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INTRODUCTION

People are social being and their most basic life requirement is housing. Houses, which are simply the spatial equivalent of housing, protect people from external factors and provide a safe environment (Tasdemir and Dama, 2016). So, houses are durable consumer goods that provide shelter.

The macroeconomic aspect of the housing market makes it possible to link developments in this market with issues such as economic growth, distribution, and income/wealth inequality (Coskun, 2018, p. 29). Therefore, although it is important to analyze the housing market or the relationship of this market with basic economic indicators, it shows a complex feature due to the socio-economic, cultural, political aspects and comprehensive effects of the subject (Coskun, 2016, p. 135).

The main motivation of this study is to investigate the effect of housing loan interest rates on housing prices in Turkey. To analyze the causality between housing loan rates and house prices indexes, we applied Hacker and Hatemi-J (2010) bootstrap Toda-Yamamoto causality test and Hatemi-J (2012) time-varying symmetric Toda-Yamamoto test. According to the findings, policy recommendations have been developed that prioritize economic efficiency.

The organization of the study is as follows: The introduction explains the general characteristics of the housing market. This is followed by explanations on the subject and scope. The descriptive information about the data is followed by a literature survey. Then, the analysis performed with empirical methods. According to the findings, economic and social dimensional determinations are made, and macroeconomic recommendations are developed for policymakers.

The findings are important for understanding the housing market dynamics in Turkey. Contrary to popular belief, the contribution of the study to the literature is that it shows that market interest rates are not one of the main determinants of the housing market. This situation causes us to think that the market dynamics in the housing market have deteriorated. Economic stability is needed to ensure that the housing market maintains a solid relationship with the financial mechanism.

THEORETICAL FRAMEWORK

The housing market is one of the important issues that require the real and financial sectors of the economy to be handled together and for all economic units. The construction sector in Turkey's economy has gained popularity in recent years. The housing market, which includes the outputs of this sector, is an important research subject. Thus, analyzing the relationship between housing prices in the economy and interest rates, which is a key element of the financial market link, constitutes one of the important and popular research topics.

In the last decade, the housing and construction sector in Turkey's economy has almost become the main economic activity. This is due to the importance given by the government to the construction industry. In the Urgent Action Plan announced after the November 2002 elections, "housing mobilization" was declared (Ceviker Gurakar, 2018, p. 159). However, it does not seem possible to consider this attitude as an issue depending on the country's housing policy. Although the housing policy is defined as "all of the legal and operational measures taken according to the priorities determined by the states to meet the housing needs of families" (Keles, 2016, p. 460), the situation encountered in practice does not comply with this definition. In modern economic conditions, countries should design their housing policies with sustainability principles (Lock, 2000; Bramley, Munro and Pawson, 2004).

Housing investments or the production capacity of the construction sector is not only a beneficial activity but also the source of a significant portion of the income generated in the world (Ling and Archer, 2008, p. 5). Housing investments have significant interaction with other sectors and sectors in the economy at national, regional, and local levels (Eraydin, Turel and Guzel, 1996, p. 130). On the other hand, construction industry outputs strengthen the consumption trend of the economy.

In macroeconomic terms, this real estate-based growth process may lead to inefficient use of high-cost resources (Coskun, 2018, p. 27). Hepsen and Asici (2013) shows that there is a positive relationship between the current account deficit in housing prices in Turkey. So, in addition to studies on the supply and demand dynamics of the housing market, studies investigating the long-term effects of economic policies on this market should be considered (Tasdemir and Dama, 2016). Otherwise, the main purpose of the economic theory will be ignored and the resource allocation in the economy will not be efficient (Kangalli Uyar and Yayla, 2015). This will result in the economic policies breaking away from theory.

In Figure 1, the housing price index graph in Turkey is given monthly for the period of January 2010 and November 2020. It is seen in the graph that housing prices have a stable increasing trend. It is considered that this increasing trend became sharper especially after 2013, but short-term volatility increased slightly. Especially after 2019, a divergence between new and old house prices draws attention.

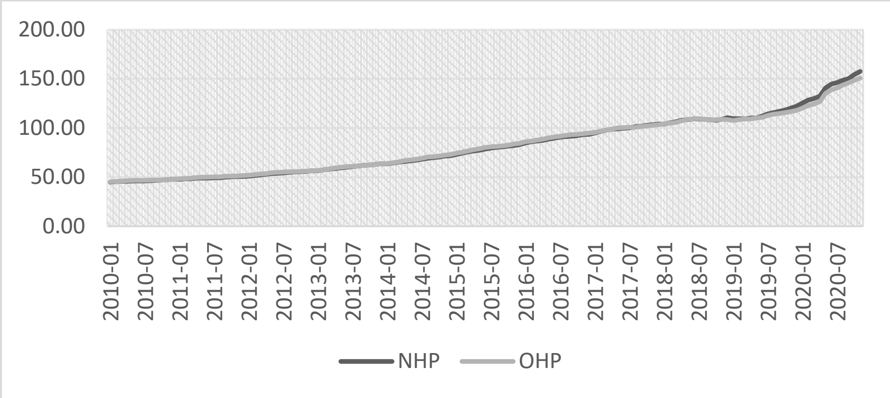

Figure 1. Old and New House Price Indices in Turkey (2010:01-2020:11)
Source: CBRT (2020).

The graph of housing loan interest rates in Turkey is given in Figure 2 monthly for the period of January 2010 and November 2020. In addition to the upward trend in the interest rate, it is observed that the volatility structure is stronger.

The key role of the interest rate between the real sector and the financial sector in the economy easily explains that this volatility occurs with the effect of macroeconomic developments corresponding to these periods.

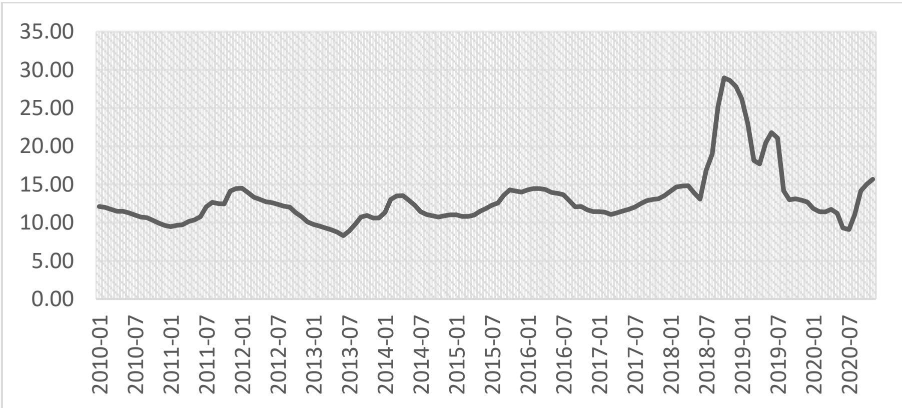

Figure 2. Housing Loan Interest Rates in Turkey (2010:01-2020:11)
Source: CBRT (2020).

LITERATURE REVIEW

There are various studies about the housing market in the literature. Some of them investigate the economic and social dimensions of the housing market (Gasparenienea, Venclauskienea and Remeikiene, 2014; Tasdemir and Dama, 2016; Bailey et al., 2016), some of the market's supply-demand dynamics (Afsar, 2011; Erdem and Coskun, 2012; Yang and Zhang, 2013; Askitas, 2015; Uysal and Yigit, 2016; Afsar, Yilmazel and Yilmazel, 2017; Yilmazel, Afsar and Yılmazel, 2017), and others the relationships between the housing market and macroeconomic indicators

(Oner Badurlar, 2008; Clayton, Miller and Peng, 2010; Cankaya, 2013; Kargi, 2013; Belej and Cellmer, 2014; Coskun and Umit, 2016; Dilber and Sertkaya, 2016; Alper, 2017; Wahab et al., 2017; Yalcin, Tirasoglu and Cevik, 2017; Yıldırım and Ivrendi, 2017; Akkay, 2021).

The relationship between the housing price index and housing loan interest rates is the most common empirical research in the literature. McGibany and Nourzad (2004) examine whether low mortgage interest rates lead to higher home prices. The findings of the study reveal that the factors determining the housing demand and housing demand have a long-term relationship, as well as the inelastic elasticity of housing prices to changes in housing loan interest rates. This finding is consistent with similar studies in the literature (Munro and Tu, 1996; Kenny, 1999).

Jiang et al. (2018) examines the relationship between housing loans and housing prices with the analysis of both macro and micro level policy effects and shows that the dramatic increase in housing prices, especially in China in recent years, has a delayed reaction to the changes in housing prices. In addition, the study reveals that the efficiency of the housing loans opened by banks varies according to the cities. In this context, it should be emphasized that credit policies should be developed not on a national basis but on a city basis.

The differences encountered in the relationship between housing prices and housing loans draw attention to the maturity of the loan (Gecer, 2014). So, housing loans have an optimum maturity depending on interest rates. Borrowing with a maturity longer than that results in financial fatigue. Because these conditions of high inflation and interest rate cause the sensitivity of the optimum maturity approach to decrease. Berberoglu (2009) also confirms this, stating that it is not possible for the housing loan system to be effective in a situation where the economic units' trust in the economy is not sufficient.

Although the economic theory predicts a negative relationship between housing demand and interest rate, Ozturk and Fitoz (2009) find a positive relationship. Painter and Redfearn (2002), which investigated the determinants of homeownership in the United States, states that the effect of interest rate on housing demand is low and even, in the long run, the interest rate is ineffective on housing demand. Within the framework of this literature summary, it is seen that the studies on the housing market differ in theoretical/practical terms, and the studies investigating the relationship between housing prices and interest rates differ in terms of method, period, and case.

Kartal et al. (2021)'s analysis for the Turkish economy shows that market variables are more important than macroeconomic variables. Monetary indicators reveal that it has a negative and significant effect at low quantities. These findings are important in terms of their compatibility with the objectives and findings of our study. At the same time, as Gunes and Apaydin (2021) emphasizes, the depreciation of the Turkish Lira in recent years has negatively affected the Turkish housing market. In conclusion, a stable economy is essential for a robust mortgage market in Turkey.

DATA AND METHODOLOGY

The data used in the study consists of monthly data covering the period 2010: 01-2020: 11. The variables included in the analysis, real old house price index (ROHPI), real new house price index (RNHPI), and real housing loan interest rate (RCRE), were obtained from the CBRT electronic data distribution system. To test the causality between variables, the bootstrap Toda-Yamamoto causality test developed by Hacker and Hatemi-J (2010), asymmetric causality test developed by Hatemi-J (2012), and time-varying symmetric and asymmetric versions of this test were applied.

In the time series analysis Granger (1969)'s method is frequently used to discover causal associations between variables. After the unit root revolution, Granger (1986, 1988) and Engle and Granger (1987) inducted the approach of performing tests for causality within an error correction model to take account for the effect of unit roots (Hatemi-J, 2011, p. 2). So, to apply the Granger (1988) causality test, the series must be stationary or cointegrated. For this reason, Granger's (1988) method requires many pre-tests and multiple conditions to be realized simultaneously (Buyukakin et al., 2009, p. 111). However, the method developed by Toda and Yamamoto (1995) allows testing causality in the absence of cointegration. So, the series's integration order is not essential.

Although its applicability is high, the Toda-Yamamoto (1995) causality test, based on the asymptotic standard chi-square distribution, does not give reliable results in applications performed on small samples. For this reason, Hacker and Hatemi-J (2006) expanded the Toda-Yamamoto methodology with a new MWALD test with a leveraged bootstrap distribution that gives reliable results also in small samples, while Hacker and Hatemi-J (2010) have modified this test to determine the number of lags endogenously.

The Granger causality test is based on a VAR (p) model. So, it requires series to be stationary or co-integrated. Nevertheless, Toda-Yamamoto (1995) developed a causality test based on the augmented VAR (p + d) model formulated with level values-p expresses the optimal lag length, and d is the maximum integration order of the series. Consequently, the Toda-Yamamoto (1995) methodology is insensitive to the series' characteristics, such as stationarity and co-integration. Therefore, no pre-testing for co-integration and estimation of a vector error correction model is needed.

While the causality test developed by Granger (1996) is given in Equation (1) and Equation (2), the Toda-Yamamoto causality test is given in Equation (3).

$$X_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + \mu_{1t} \tag{1}$$

$$Y_t = \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{j=1}^{m} \delta_j X_{t-j} + \mu_{2t} \tag{2}$$

Equation (1) and Equation (2) imply that the behaviors of X in period t are affected by the past values of Y and X while Y's behaviors in the t period are affected by the past values of X and Y. Therefore, in Granger sense, testing of causality is based on testing whether the behavior of a variable in the current period are affected by the lagged values of another variable and its own lagged values.

$$y_t = v + A_1 y_{t-1} + ... + A_p y_{t-p} + ... + A_{p+1} y_{t-p-d} + \mu \quad (3)$$

In Equation (3) y_t, a vector consisting of k variables v is a vector of constants μ, a vector of error terms, and A is a matrix of parameters. The null hypothesis that there is no Granger causality is tested by applying a constraint that the first p parameter in Equation (3) is equal to zero. The MWALD statistic obtained has an asymptotic chi-square distribution with p degrees of freedom. However, as mentioned before, Hacker and Hatemi-J (2010) adopted MWALD statistics based on bootstrap distribution because of the poor performance of MWALD statistics with standard chi-square distribution in small samples (Konat, et al., 2017, p. 54).

To test the null hypothesis that expresses Granger non-causality ($H_0 : C\beta = 0$), Toda- Yamamoto employs the Wald statistics. To explain the Toda-Yamamoto test statistics, we need to make some extra definitions;

$Y : \left(y_1,...,y_T\right)$, an (*nxT*) matrix;

$\hat{D} = \left(\hat{v}, \hat{A}_1,...,\hat{A}_p,...,\hat{A}_{p+d}\right)$ an (*n x* (1+*n*(*p*+*d*))) matrix

$$Z_t = \begin{vmatrix} 1 \\ y_t \\ y_{t-1} \\ \vdots \\ y_{t-p-d+1} \end{vmatrix}$$ a ((1+*n*(*p*+*d*))x1) matrix, for *t*=1,...,*T*;

$Z = (Z_0,...,Z_{T-1})$ a ((1+*n*(*p*+*d*))xT) matrix; and

$\hat{\delta} = (\hat{\mu}_1,...,\hat{\mu}_T)$, an (*nxT*) matrix

With these definitions, a VAR (p+d) model comprising an estimated constant ($\hat{v}$) can be written as;

$$Y = \hat{D}Z + \hat{\delta} \quad (4)$$

Then we start by estimating δ_U the (*nxT*) matrix of estimated unrestricted regression residuals. We then calculate these residuals' variance-covariance matrix as $S_U = \left(\hat{\delta}_U^{'}\hat{\delta}_U\right)/T$. Then we define $\beta = vec(v, A_1,...,A_p, 0_{nxnd})$ and $\hat{\beta} = vec(\hat{D})$, where *vec* is the column-stacking operator, and *0nxnd* denotes a zero matrix with n rows and n(d) columns. Now MWALD statistics can be written as in Equation 5;

$$MWALD = (C\beta)'\left[C\left((Z'Z)^{-1} \otimes S_U\right)C'\right]^{-1}(C\beta) \quad (5)$$

In Equation 5, $\otimes$ represents the Kronecker product, and C denotes a $p \times n(1+n(p+d))$ matrix that contains constraints. Each of C's p rows corresponds to a restriction to zero of one of the parameters in *β*. The corresponding row of C takes on the value of one if the corresponding parameter in *β* is zero under the null hypothesis, and each element is zero if there is no such restriction under the null. Neither of the rows in C is corresponding restrictions on the last $n^2(d)$ elements in β, which correspond to the 0_{nxnxn} matrix. Using this method of notation, the null hypothesis of non- Granger causality would be given as $H_0 : C\beta = 0$.

The Modified Wald (MWALD) statistics have the Chi-Square distribution as Toda and Yamamoto stated. On the other hand, Hacker and Hatemi-J (2003) demonstrated that the MWALD statistic might over-reject the H0 because of non-normality and ARCH effects (Gunduz and Hatemi-J, 2005). Hacker and Hatemi-J (2006) adopted a bootstrapping procedure to evaluate the risk of encountering these incidents. They concluded that leveraged bootstrap distribution is more accurate, mainly in the case of non-normality or ARCH effects (Hatemi-J and Roca, 2005, p. 542).

This methodology does not separate the effects of symmetric and asymmetric shocks. However, a negative shock might affect the economy in a different way than a positive shock might. There is, therefore, a possibility that more information can be gathered concerning the effects of negative and positive shocks. Hence Hatemi-J (2012) developed a causality test that considers negative and positive shocks separately based on the Granger and Yoon (2002);

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i} \quad (6)$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i} \quad (7)$$

In Equations (6) and (7), $t = 1,2,...T$, $y_{1,0}$ and $y_{2,0}$ are the constants, y_{1t} and y_{2t} are the series' initial values and $\varepsilon_{1,i}$ and $\varepsilon_{2,i}$ are the white noise error terms. Positive and negative shocks are defined respectively as $\varepsilon_{1i}^{+} = \max(\varepsilon_{1i}, 0) = \max(\varepsilon_{2i}, 0), \varepsilon_{1i}^{-} = \min(\varepsilon_{1i}, 0)$ and $\varepsilon_{2i}^{-} = \min(\varepsilon_{2i}, 0)$. So, $\varepsilon_{1i} = \varepsilon_{1i}^{+} + \varepsilon_{1i}^{-}$ and $\varepsilon_{2i} = \varepsilon_{2i}^{+} + \varepsilon_{2i}^{-}$. Through the use of these representations, we can modify Equation (6) and (7) as;

$$y_{1t} = y_{1t-1} + \varepsilon_{1t} = y_{1,0} + \sum_{i=1}^{t} \varepsilon_{1i}^{+} + \sum_{i=1}^{t} \varepsilon_{1i}^{-} \quad (8)$$

$$y_{2t} = y_{2t-1} + \varepsilon_{2t} = y_{2,0} + \sum_{i=1}^{t} \varepsilon_{2i}^{+} + \sum_{i=1}^{t} \varepsilon_{2i}^{-} \quad (9)$$

The positive and negative shocks now can be reformulated in a cumulative form as:

$$y_{1t}^{+} = \sum_{i=1}^{t} \varepsilon_{1i}^{+}, y_{1t}^{-} = \sum_{i=1}^{t} \varepsilon_{1i}, y_{2t}^{+} = \sum_{i=1}^{t} \varepsilon_{2i}^{+} \text{ and } y_{2t}^{-} = \sum_{i=1}^{t} \varepsilon_{2i}^{-} .$$

So we can obtain a VAR(*p*) model -including only cumulative positive shocks- for the test of causality under the assumption that $\left(y_t^+ = y_{1t}^+, y_{2t}^+\right)$[1]:

$$y_t^+ = v + A_1 y_{t-1}^+ + ... + A_p y_{t-1}^+ + u_t^+ \quad (10)$$

In Equation (10) y_t^+ expresses a 2x1 vector of variables, v is a 2x1 intercepts vector, and u_t^+ is a 2x1 vector including the error terms. Eventually, A_r is a 2x2 parameter matrix with lag order *r* (*r= 1,..., p*).

The method of time-varying causality testing can be explained as follows: First, sub-samples are selected, containing equivalent observations. The Hacker and Hatemi-J (2010) causality test is then used for the subsample, including the first observation and the last observation (n) in the first subsample. The first observation is then discarded, and this implementation proceeds with the second sub-sample comprising the second observation and the (n+1)th observation. This process is continued until the last observation is used. The Wald test statistics and the bootstrap critical values also vary in time during this process. Consequently, in this study, the acquired test statistics for each sub-sample are normalized by the obtained 10 percent bootstrap critical value to make the interpretation easier. Then the normalized values are plotted to evaluate the resulting Wald test statistics. The values over the "1" line record that the null hypothesis (non-Granger-causality) should be rejected.

FINDINGS

As stated earlier, the method used in the analysis does not essentially require the series to be stationary or cointegrated, as it produces bootstrap critical values. However, as explained in the methodology, the maximum integration order must be known to apply the test. For this reason, before proceeding to the causality analysis, various unit root tests were applied to determine the integration orders of all series.

Table 1. Unit Root Tests for ROHPI

ROHPI	Level				First Difference			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
ADF	0.5657	[0.9883]	-3.5968	[0.0343]	-	-	-	-
PP	1.2959	[0.9986]	-1.6631	[0.7619]	-6.7528	[0.0000]	-6.9599	[0.0000]
KPSS	1.4194	(0.4630)	0.11463	(0.1460)	0.2256	(0.4630)	0.1081	(0.146)

The values in square brackets are the probability values and the values in paranthesis are the %5 test critical values.

The findings obtained from the ADF, PP, and KPSS unit root tests applied for ROHPI give contradictory results regarding the degree of integration of the series.

[1] For the test of causality between cumulative negative shocks ($y_t^- = y_{1t}^-, y_{2t}^-$) vector can be used.

While the series is I(0) according to the ADF test result, it is I(1) according to the PP test and I(0) according to the KPSS tests.

Table 2. Unit Root Tests for RNHPI

RNHPI	Level				First Difference			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
ADF	1.2874	[0.9985]	-2.6097	[0.2769]	-2.8743	[0.0512]	-3.2415	[0.0812]
PP	1.8331	[0.9998]	-1.3478	[0.8713]	-8.0146	[0.0000]	-8.2887	[0.0000]
KPSS	1.4190	(0.4630)	0.0946	(0.1460)	0.3260	(0.4630)	0.1098	(0.146)

Results for RNHPI are also contradictory, similar to those for ROHPI. According to the ADF test, the series is I(I) considering the 10% critical value, while the PP test indicates that the series is I(1) according to the 5% critical value. However, the KPSS test shows that the series is stationary at its level.

Table 3. Unit Root Test for RCRE

RCRE	Level				First Difference			
	Intercept		Trend and Intercept		Intercept		Trend and Intercept	
ADF	-2.2710	[0.1831]	-2.8139	[0.1953]	-4.5266	[0.0003]	-4.4927	[0.0024]
PP	-4.1165	[0.0013]	-4.1944	[0.0060]	-	-	-	-
KPSS	0.3730	(0.4630)	0.11861	(0.1460)	-	-	-	-

ADF test indicates that RCRE is I(1), while the PP and KPSS tests show that the series is I(0). Despite the contradictory results obtained, the findings suggest that the maximum degree of integration of the series may be 1. However, before accepting the higher probability, it is helpful to dig deeper into the analysis. For this reason, Fourier unit root tests were applied to evaluate the possibility that there may be structural changes in the series and, therefore, results are contradictory. For the Fourier unit root test, the augmented version of the Fourier ADF (FADF) test developed by Enders and Lee (2012) with a fractional frequency by Omay (2015) was preferred.

Table 4. Fourier ADF Unit Root Test (Intercept)

Variable	Frequency	Min. SSS	F Constraint test stat.	F Table	Optimal Lag Length	FADF Test stat.	Critical Values
ROHPI	1.700000	0.005618	5.867926	6.35*	1	0.965814	−3.63945*
RNHPI	0.800000	0.006216	6.733300	6.35*	1	4.168734	−3.91682**

RCRE	4.400000	251.5857	2.865081	6.35*	2	-4.157741	−2.61779*

*%10 critical values
** %5 critical values

FADF unit root test results for the model with intercept are given in Table 4. According to the results, the F-test statistic for the RNHPI is greater than the F tabular value. So, the Fourier terms are significant. However, for other variables, the Fourier terms are meaningless. It is, therefore, appropriate to proceed with the Fourier ADF (FADF) test for RNHPI. According to the results obtained, the H_0 hypothesis is rejected because the FADF test statistic is greater than the 5% table critical value in absolute value. It is stationary at the series level.

Table 5. Fourier ADF Unit Root Test (Trend and Intercept)

Variable	Frequency	Min. SSS	F Constraint test stat.	F Table	Optimal Lag Length	FADF Test stat.	Critical Values
ROHPI	1.700000	0.005617	7.638413	7.78*	12	-4.673725	−3.87113*
RNHPI	1.500000	0.006172	5.932741	7.78*	1	0.833929	−3.97792*
RCRE	4.400000	247.4671	3.111709	7.78*	2	-4.567699	−4.21542*

*%10 critical values

On the other hand, looking at the graphs of the series, it is observed that ROHPI and RNHPI follow a trend. Therefore, it may be more appropriate to rely on the findings from the model with trend and intercept. In the model with trend and intercept, the Fourier terms are not significant for all variables. Therefore, the interpretation of the results of the FADF test is not appropriate. Therefore, in the light of the information provided by the ADF, PP, and KPSS tests and based on Dolado and Lütkepohl (1996, p. 6)[2], when there is uncertainty about whether the series is I(0) or I(1), choosing the maximum integration order as one will achieve beneficial results from the analysis.

In the analysis to investigate the causal relationship between housing price index and housing loan interest rates in Turkey in the period of 2010-2020 the Bootstrap Toda-Yamamoto causality test, asymmetric causality test, and time-varying symmetric and asymmetric tests were applied. Due to the analysis, the findings from the Bootstrap Toda-Yamamoto causality test are summarized in Table 6.

2 Dolado and Lütkepohl (1996, p. 6) say; *"…if there is uncertainty whether the variables are I(1) or I(0), one may simply add the extra lag and then perform the test to make sure to be on the safe side*".

Tablo 6. Bootstrap Toda-Yamamoto Causality Test

Causality from Housing Loan Rates to Old Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
0.548	10.464	6.315	4.656
Causality from Housing Loan Rates to New Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
2.493	10.332	6.376	4.753

The results of the Bootstrap Toda-Yamamoto Causality test are summarized in Table 6. According to the results, test statistics are smaller than the bootstrap critical values. It is expected that the changes in housing loan rate Granger Cause the changes in both ROHPI and RNHPI. Because changes in housing loan rates change the cost of purchasing a house, and ROHPI and RNHPI are also proxies of demand in the housing market. Nevertheless, the findings show that there is no causality from housing loan interest rates (RCRE) to either the old housing price index (ROHPI) or the new housing price index (RNHPI).

Asymmetric Bootstrap Toda-Yamamoto Causality Test

For further analysis, we adopted the asymmetric version of the bootstrap Toda-Yamamoto test. As is known, the impact of negative and positive shocks can be different. So, it is possible to see whether such asymmetric effects exist for the housing market or not. The findings obtained from Asymmetric the Bootstrap Toda-Yamamoto causality test are summarized in Table 7.

Tablo 7. Asymmetric Bootstrap Toda-Yamamoto Causality Test Findings

Causality from Positive Shocks in Housing Loan Rates to Positive Shocks in the Old Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
0.977	16.859	11.357	8.995
Causality from Negative Shocks in Housing Loan Rates to Negative Shocks in the Old Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
24.229	23.636	16.709	13.975
Causality from Positive Shocks in Housing Loan Rates to Positive Shocks in New Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
2.889	14.886	9.284	7.114

Causality from Negative Shocks in Housing Loan Rates to Negative Shocks in New Housing Price Index			
Test Stat.	**Critical Values**		
	%1	%5	%10
0.937	11.114	4.208	2.491

According to the findings obtained from the asymmetric causality test, causality was found only from negative shocks in housing loan interest rate to negative shocks in the old housing price index. There is no causality between positive shocks.

Time Varying Symmetric Causality Test

According to the time-varying causality test results; generally, causality from RCRE to ROHPI appears in short periods of several months. Uninterrupted causality was detected for one year only between 2013:11 and 2014:11. This situation also supports the findings given in Figure 3 (detailed in Appendix 1). Therefore, no causality relationship is reflected throughout the period that is the subject of the analysis.

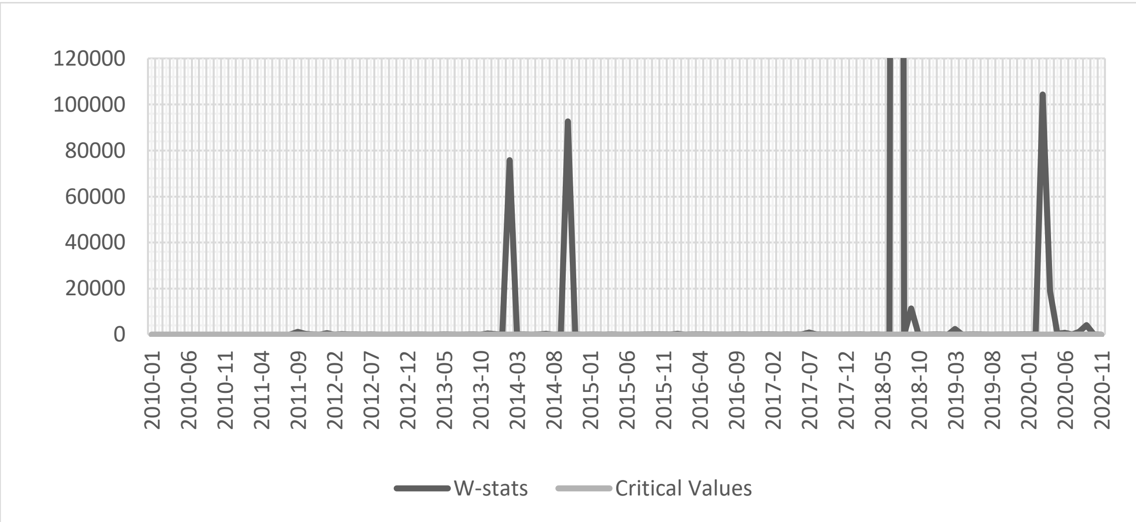

Figure 3. Causality from Housing Loan Rate to Old Housing Price Index

The results of the time-varying causality from Housing Loan Rate to New Housing Price Index are given in Figure 4. A similar situation exists for the time-varying causality test results from RCRE to RNHPI. The longest duration of causality was detected in the 7-month period between 2018:1 and 2018:7.

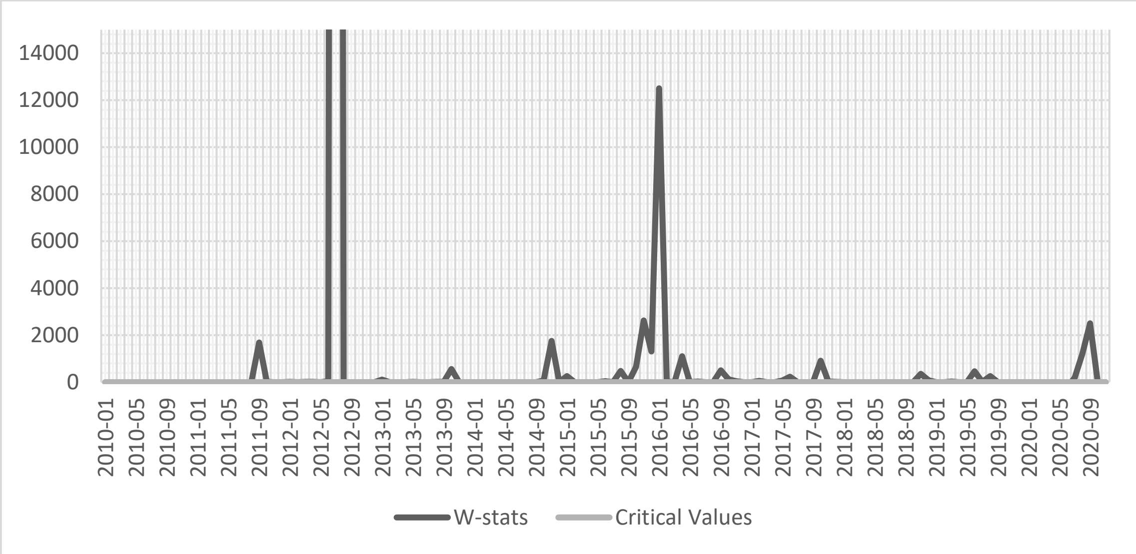

Figure 4. Causality from Housing Loan Rate to New Housing Price Index

Interventions to keep the construction sector and especially the housing market active in Turkey have become widespread. However, time-varying causality tests uncover the reality that there is no causal relationship between housing loan rate and the house price indexes in Turkey in the subjected period. The causality is observed in short periods. This finding is crucial as it shows that interventions to the housing market through the housing loan interest rate have only very short-term effects.

CONCLUSION

There are several fundamental reasons why housing prices in Turkey are not affected by the interest rate. The first reason is that the housing price is usually shown based on the real estate's declared value to avoid tax in the title deed transactions. The fact that the contractors cannot show the land costs in the housing costs, especially in the first sales, causes the housing costs to be shown lower than in the accounting records. Since this situation causes a very high tax accrual if the housing price is declared in full, the contractors make invoices based on off-land costs in official transactions. Since the housing prices in the primary market are generally based on the declared value of the real estate, the actual prices of the houses are not included in the official numbers. Since the real estate declared value is constant throughout the year, it may be found in the analysis that there is no relationship between the house prices and the interest rate since the official transactions carried out based on this value are predominant.

The second reason is that a particular down payment is usually made at the beginning of the project in primary sales. There is no opportunity to use credit until the construction reaches a particular stage. Therefore, it seems that the changes in the interest rate do not affect the use of credit and, hence, the sale price. Because those who buy a house on the project come to a particular stage and can use credit after the deed transactions are made, they have to take credit to pay their remaining debts. The fact that the housing purchase transactions in the primary market in Turkey are not simultaneously reflected in the title deed transactions may be another reason why the expected theoretical relationship between the interest rate and the housing price did not emerge in the test.

When the person or institutions that buy a house in the primary market sell it before the end of five years, it is taxed over the increase in value. Therefore, in secondary sales made before the expiry of five years, the house's market value is not declared in the title deed transactions for tax avoidance or tax evasion. In transactions made after the end of the five years, the amount of credit needed by the buyer is a factor that determines the declared value of the housing price.

The findings show that the change in interest rates is not a significant factor in Turkey in determining housing prices over demand, and housing prices may be determined more based on costs and expectations.

Policymakers in Turkey are constantly intervening in the market with loan rates in order to affect housing sales. This study aims to test the existence of this relationship and investigate whether the change in the housing loan interest rate is effective on the housing demand and, therefore, the housing price.

The result may meet the theoretical expectations if there is a separate index for the houses that the same person has owned for five years after the purchase (as the increase in value will be tax-free). However, the most critical problem in Turkey is that the prices are far from reflecting the truth in official transactions due to the high tax rates and the lack of tax morale.

In addition to being open to multidimensional effects in terms of supply and demand, the housing market has become an essential and equally popular research topic because it constitutes the outputs of the construction sector, which is a major sector in Turkey. It is undeniable that the government's position in prioritizing the construction sector in Turkey played a significant role in this. Although current studies on this subject tend to address some of the dimensions described in the literature summary, the broad spectrum inherent in the subject necessitates more extensive research on the housing market. Because the findings of such comprehensive studies will constitute the inputs of economic and social policies, they are closely related to the long-term results of these policies. While this study aims to contribute to the current findings of the Turkish economy based on the existing literature, it also undertakes to emphasize once again the need for more comprehensive research explained here.

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Appendix 1. Causality from Housing Loan Rate to Old Housing Price Index

Period	Causality	Period	Causality
2011:08-2012:01	✓	2016:03-2016:05	✓
2012:02	×	2016:06-2106:07	×
2012:03-2012:07	✓	2016:08-2017:08	✓
2012:08-2013:03	×	2017:09	×
2013:04-2013:05	✓	2017:10-2017:12	×
2013:06-2013:08	×	2018:01	×
2013:09	✓	2018:02-2018:05	✓
2013:10	×	2018:06	×
2013:11-2014:08	✓	2018:07	✓
2014:09-2014:11	✓	2018:08	×
2014:12-2015:02	×	2018:09-2018:10	✓
2015:03-2015:04	✓	2018:11	×
2015:05-2015:08	×	2018:12-2019:01	✓
2015:09-2015:11	✓	2019:02	×
2015:12	×	2019:03-2019:06	✓
2016:01	✓	2019:07-2019:11	×
2016:02	×		

Appendix 2. Causality from Housing Loan Rate to New Housing Price Index

Period	Causality	Period	Causality	Period	Causality
2011:08 2011:10	✓	2014:05 2014:07	×	2017:04 2017:07	✓
2011:11 2011:12	×	2014:08 2014:11	✓	2017:08	×
2012: 01	✓	2014:12	×	2017:09 2017:12	✓
2012:02	×	2015:01	✓	2018:01 2018:07	×
2012:03 2012:04	×	2015:02	×	2018:08 2018:09	✓
2012:05	×	2015:03 2015:04	✓	2018:10	×
2012:06	✓	2015:05	×	2018:11	✓

2012:07				2019:01	
2012:08	×	2015:06	✓	2019:02	×
2012:09	✓	2015:07	×	2019:03 2019:04	✓
2012:10 2012.12	×	2015:08	✓	2019:05	×
2013:01	✓	2015:09	×	2019:06 2019:08	✓
2013:02 2013:03	×	2015:10 2016:04	✓	2019:09 2019:10	×
2013:04 2013:05	✓	2016:05	×	2019:11 2020:01	✓
2013:06 2013:07	×	2016:06 2016:07	✓	2020:02	×
2013:08 2013:11	✓	2016:08	×	2020:03 2020:04	✓
2013:12	×	2016:09 2016:11	✓	2020:05 2020:06	×
2014:01	✓	2016:12 2017:01	×	2020:07 2020:10	✓
2014:02 2014:03	×	2017:02	✓	2020:11	×
2014:04	✓	2017:03	×		