20. BÖLÜM / CHAPTER 20

INTEREST RATE PASS-THROUGH MECHANISM IN TURKISH BANKING SECTOR; ANALYSIS OF THE CAUSALITY RELATIONSHIP FROM WEEKLY-O/N REPO RATES TO BANK LENDING INTEREST RATES

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ABSTRACT

Improving policy implications by evaluating the effectiveness of the interest rate transmission mechanism for strengthening monetary policy actions has great importance. The Central Bank of the Republic of Turkey (CBRT) has been maintaining a monetary policy framework focused on price stability, which has been called inflation targeting regime since 2006. In this context, the CBRT has a number of interest rates including weekly repo interest rate, O/N repo interest rate, and late liquidity window interest rate. The objective of this study is to investigate the causality relationship between monetary policy interest rates and bank lending interest rates in the Turkish Banking Sector in the period from 2010:05 through 2018:08. Using monthly O/N-weekly repo rates and bank lending interest rates data from Bloomberg and CBRT, we employ the Fourier KPSS unit root test and Fourier Toda Yamamato causality test in our analysis. The results indicate that both weekly repo rates and O/N interest rates do have impacts on credit interest rates.

Keywords: Bank lending interest rate, Monetary policy interest rate, Pass-through mechanism

1. Introduction

The monetary policy transmission mechanism enables monetary policy decisions to be transferred to the real economy via interest rates changes. For instance, central banks can influence aggregate domestic demand and investment by raising or lowering market interest rates that encourage or deter people and businesses from making certain decisions. Researchers and economists have spent considerable time studying how policy interest rates affect bank lending rates since this is a key indicator of how effective monetary policy is at controlling inflation and stabilizing the economy. In order to improve policy implications and provide recommendations for improving monetary policy effectiveness, it is critical to examine the effectiveness of the interest rate transmission mechanism. The proper implementation of monetary policy necessitates an exact assessment of how rapidly the impacts of policy changes have spread to other sides of the economy and how large these impacts could be. This necessitates a comprehensive understanding of how monetary policy influences economic activity (Pétursson, 2001, p. 2).

The understanding of how monetary policy decisions are transmitted to the financial sector is a very important process from macro and microeconomic perspectives. From a macroeconomic point of view, whether adjustments in monetary policy stance and the practicing of new and unconventional policy instruments are transferred to the real economy via lending to the non-banking sector by commercial banks or not is of great importance. In the international framework, understanding the transition period from monetary policy actions into bank lending conditions across countries is very critical not only for the effectiveness and success of monetary policy but also for financial stability. From a micro-economic point of view, how banks comply with changes and adjustments in the monetary policy standpoint relies on several bank-specific features and the frictions which banks encounter. Several frictions in the asset side and liability side of banks' balance sheets occur under dissimilar circumstances and might be specifically manifested in different kinds of banks (Busch et al, 2018, p. 3).

Traditionally, monetary policy has impacts on investments through two main transmission mechanisms, which are defined as the interest rate and credit channels. In other words, a change and an adjustment in monetary policy have effects on market interest rates and credit volume to the firms. For instance, if the central bank plans to slow down the economy, it would maintain policies that will lead to a reduction in reserves from the banking system that would therefore lead to decreases in assets and liabilities sides of banks. Accordingly, the central bank seeks to reduce the investments of firms owing to higher costs of capital and/or

lower external financing for firms. Two of the key questions that come up at this point are the extent to which a change in the monetary policy impacts the market interest rates and how quickly market interest rates respond to a change in the monetary policy. These two questions are interlaced with regard to the effectiveness of the monetary policy on influencing the real economy (Vithessonthi et al, 2017, p. 130).

In developing economies, the significant components that are frequently acknowledged as major indicators of the monetary policy transmission mechanism are the health and development of the financial system, the exchange rate stability, the central bank independence and institutional environment, and quality of regulations. Firstly, the development and soundness of the financial system affect the effectiveness of the interest rate pass-through mechanism, while the factors such as lack of exchange rate stability, high-level financial dollarization, and bank concentration hamper the interest rate mechanism. The strengthening of the central bank's independence has also a positive impact on the interest-rate transmission mechanism as it provides autonomy for the bank in operating monetary policy actions and increases its signaling function to market participants. Another important factor that contributes to effective monetary policy transmission is eliminating fiscal dominance because it does not subordinate monetary policy to the purposes of fiscal policy and increases the independence of the central bank. Finally, the institutional environment and regulations which are weak and insufficient deteriorate monetary policy transmission as they trigger the asymmetric information problems and contract enforcement which increase the cost of financial intermediation (Cas et al, 2011, p. 4-5). In order to ensure that the monetary policy is adequately transmitted to the financial sector and financing conditions, it is necessary that macroeconomic imbalances are reduced further and the resilience of banks is strengthened.

When considering the dominant role of the banking sector in supplying funds to the real sector, monitoring changes in interest rates has great importance for examining the mechanism through which monetary policy decisions are transmitted to the real economy. They also give information about the degree of integration in the retail banking market. Third, the changes in interest rates are useful in monitoring structural developments realized in the banking system by throwing light upon how banks determine their margins and how the latter respond to external developments. And finally, they complement and enhance the statistics relating to monetary aggregates by giving information about interest rates (Paries et al, 2014, p. 7).

Turkey experienced several financial reforms after the 2000-01 Crises to make the financial system more sound and to promote the efficiency of monetary policy. Concomitant to the reformation process, the CBRT has been conducting its monetary policy under the

inflation-targeting regime since 2006. Accordingly, the CBRT mainly has been using interest rate policy, reserve policy, and open market operations to achieve the clearly defined objective of maintaining price stability. In this context, strengthening the pass-through of the monetary policy rates to market interest rates has great importance for enhancing the effectiveness of monetary policy and helping the CBRT ensure price stability. The purpose of this study is to evaluate the effectiveness of the interest-rate transmission mechanism in Turkey and to provide implications in order to improve monetary policy effectiveness.

In this paper, we focus on the causality relationship from monetary policy interest rates including weekly and O/N repo rates to the bank lending interest rates over the period from 2010:05 through 2018:08 by applying the Fourier Toda Yamamoto causality test. To our best knowledge, there exists no previous study examining the causality relationship between monetary policy rates and bank lending interest rates by using the Fourier approach. The contribution of this study to the academic literature is that we use Fourier KPSS (2006) unit root test and Fourier Toda Yamamoto (2016) causality test by considering the effects of multiple structural breaks in the analysis. These techniques have the considerable advantage of permitting us to test for unit root and cointegration while allowing for multiple structural breaks in the series without requiring prior knowledge concerning the number, dates, and form of structural breaks. This leads to placing greater confidence in the results.

The following section of the study provides a brief explanation of the three major interest rates used by the Central Bank of the Republic of Turkey. The study's third section consists of the literature review and highlights other research and findings connected to the topic. The fourth section employs an econometric analysis to investigate the relationships between O/N repo interest rates and bank lending interest rates, as well as weekly repo interest rates and bank lending interest rates. Finally, the last section tries to make some conclusions and to provide policy implications as well as some recommendations for the future term.

2. A Brief Review of Inflation Targeting Program and Interest Rate Policy of the CBRT

The CBRT has been maintaining a monetary policy framework focused on price stability, which has been called the inflation targeting regime since 2006. Inflation expectations, pricing behavior, and other factors that influence inflation are taken into consideration when making monetary policy decisions. Financial stability is also being taken into account while inflation is clearly targeted to remain close to the objective. In addition, the CBRT continues to cooperate with other institutions to remove structural barriers in order to lower inflation.

Accordingly, the main objective of the CBRT is to achieve and maintain price stability and the inflation target for the 2018-2020 period is set at 5 percent as a result of the agreement reached with the government. The uncertainty band, which is an element of the accountability of the CBRT, is kept at 2 percentage points in both directions. The Bank introduces an open letter to the government if inflation stays out of the uncertainty band at the end of the year (CBRT Report, 2017, p. 2).

In maintaining monetary policy, the CBRT has a number of interest rates including weekly repo interest rate, O/N repo interest rate, and late liquidity window interest rate. In this framework, the CBRT also started to use the asymmetric interest rate corridor as an active monetary policy tool in 2010 and aimed to have control on both credits and foreign exchange rates. The CBRT can affect the interest rates applied by banks and financial institutions in the market, the number of loans received from banks, and the prices of stocks and foreign currencies by using the weekly repo interest rate which is called policy rate and/or marginal funding rate. As of 31.08.2018, the weekly repo interest rate is %17,75 according to the data obtained from the CBRT official site. The second important interest rate is the O/N repo interest rate which shows the daily funding rate of the CBRT. With this tool, the CBRT can affect short-term interest rates, the growth rate of loans in the secondary market, and the foreign exchange rates. The interest rate used by the CBRT for overnight borrowing is %16,25 as of 31.08.2018. Finally, the third of the tools used by CBRT to affect financial markets is the late liquidity window interest rate which is given to the banks waiting until the last moment to close the accounts. In this application, lending interest rates between the hours of 16:00 and 17:00 is %20,75 for the banks that need money and want to borrow from the CBRT. This study focuses on weekly repo rates and O/N interest rates.

There was a continuing upward trend in interest rates during the period of 2017-2018 in Turkey. Especially the last interest rate increases of the Central Bank in May, June, and September have been reflected in both loan and deposit interest rates. In addition to the risks related to the expectations of the U.S Central Bank Federal Reserve (FED) interest rate increases, trade conflicts in the global markets and sharp movements in exchange rates in Turkey have led the CBRT to further tighten. Thus, both consumer and commercial credit interest rates have increased especially in the last nine-month period. It can be seen from the annual data obtained from Bloomberg and the CBRT, while the consumer interest rate which was nearly %16 in the middle of 2017 rose to %38,5 in September, the commercial interest rate which was nearly %17 in the middle of 2017, reached to the peak of %35,9 in September. As a result of the tightening of the ongoing financial conditions in developed countries,

the rise in commodity prices, and the increase in the political stress in domestic markets which trigger the upward trend in interest rates, the CBRT is expected to continue monetary tightening in the following year. Therefore, the upward trend in bank lending rates parallel with the increases in monetary policy rates will inevitably lead to a decrease in aggregate demand, investments, and economic activity in Turkey.

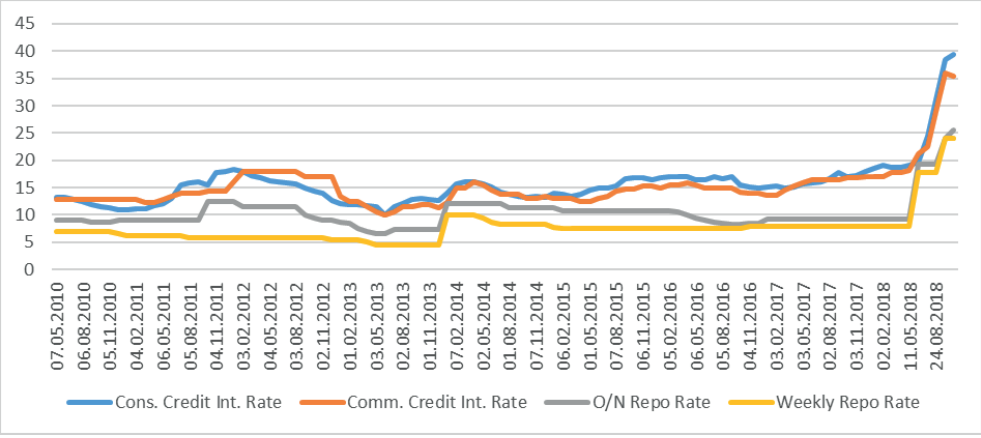

Figure 1. Weekly-O/N Repo Rates and Consumer-Commercial Credit Rates
Source; Bloomberg and CBRT

3. Literature Review

The recent deterioration in economies globally has changed the implementation of monetary policy dramatically. Economists consider the monetary policy as the initial defensive mechanism against economic recessions, particularly when fast action is required to stabilize the economy. Recent studies focus on the effectiveness and success of monetary policy and emphasize the importance of monetary policy to stabilize the economies of emerging countries in particular. How rapid economic stability is accomplished relies on several factors, including the pass-through mechanism from policy rates to bank lending interest rates. The pass-through mechanism of the monetary policy rates to banking sector lending interest rates is a very important issue since it signals the effectiveness of monetary policy in bringing inflation under control and balancing the economy. In the framework of transmission mechanism, the speed of the transmission rate is generally selected as an indicator relating to the effectiveness and strength of monetary policy or how quickly the effect of monetary policy could be felt. If a change and an adjustment in policy rate are passed on bank lending interest rates, which

then affect aggregate domestic demand, investment, and ultimately output, it is accepted that monetary policy is effective. (Matemilola et al, 2015, p. 1).

De Bondt (2005) analyzed the interest rate pass-through mechanism in the Euro-Area by focusing on the pass-through of policy interest rates to longer-term market interest rates and consequently passed through to retail bank interest rates. Using vector error-correction and vector autoregressive models, he found that the transmission mechanism of official interest rates (approximated by the O/N repo rate) to money market interest rates was complete for up to three months. Empirical results of a sub-example beginning in January 1999 seemed qualitatively similar and supported a faster interest rate transmission process since the introduction of the Euro. Sorensen and Werner (2006) investigated the transmission mechanism of market interest rates to bank interest rates in ten Euro-Area countries. They carried out a pass-through approximation for six kinds of retail bank products including current account deposits, time deposits consumer loans, mortgage loans, short-term and long-term loans to enterprises by using monthly data throughout 1999-2004. After testing for cross-country heterogeneity in the pass-through process by employing panel error-correction models using dynamic seemingly unrelated regression (DSUR) methods, their results showed a large heterogeneity in the pass-through mechanism of market interest rates to bank interest rates between the countries in the Euro-Area. They found that while bank interest rates for corporate loans seemed to change in the most efficient way, followed by the interest rates for time deposits and mortgage loans, the adaptation of rates for consumer loans and current account deposits appeared to work the least efficiently.

Testing the speed and adjustment rate of lending interest rates from monetary policy interest rates for several types of loans including cash, housing, automobile, and corporate using bank-level microdata, Aydin (2007) indicated that while cash and automobile loan rates were responsive to the policy rate, corporate loans were not sensitive to changes in the policy rate. In addition, housing loans seemed excessively sensitive to the policy rate. He found evidence in favor of central bank control over the credit market via short-term interest rates, which was more visible in the post-credit boom period. Wang and Lee (2009) examined the interest rate transmission mechanism between the money market rates and the retail interest rates by employing an asymmetric cointegration test. They also investigated the effects of the interest rate fluctuations for some Asian countries and the U.S. Their analysis results showed evidence of complete pass-through solely in the United States deposit rate. The results of the threshold cointegration test showed that while the asymmetric cointegration relationships existed on the lending interest rate in three countries

and on the deposit interest rate in five countries, the symmetric cointegration relationship existed in two countries.

Kwapil and Scharler (2010) analyzed equilibrium determinacy in a sticky-price model in which the transmission mechanism from policy rates to retail interest rates was slow and potentially complete. They also empirically characterized and compared the interest rate pass-through mechanism in the Euro-Area and the U.S by using monthly data. After employing Engle-Granger Cointegration Test and Auto-Regressive Distributed Lag (ARDL) method, they discovered that when the pass-through was imperfect in the long-term, the standard Taylor principle was inadequate to assure equilibrium determinacy. In addition, they found that interest rate pass-through was more significant in the U.S compared to the Euro-Area. Tai et al (2012) investigated the effectiveness of the interest rate pass-through process from money market rates to retail banking rates in a number of Asian countries. They especially analyzed the discrepancies in the level of pass-through from monetary policy rate into deposit and lending rates across countries between the pre-crisis and post-crisis of 1997 by employing Seemingly Unrelated Regression (SUR) equations. Their findings suggested that there was little difference between the pass-through rate into deposit and lending rates, but that the pass-through rate into deposit rate was slightly higher than the pass-through rate into the lending rate. They also found that the rate of transmission from money market rate into deposit and lending rates was slow across economies.

Using a structural vector autoregressive model, Cevik and Teksöz (2012) investigated the strength of the monetary policy pass-through mechanism in the countries of the Gulf Cooperation Council (GCC). As a result of the pegged exchange rate regimes, their findings indicated that, while the exchange rate channel did not seem to have a significant role as a monetary transmission mechanism, the interest rate and bank lending channels were relatively effective in impacting non-hydrocarbon output and consumer prices. They further recommended that structural reforms and policy actions such as improving financial intermediation and encouraging the development of liquidity in domestic capital markets could increase the effectiveness of monetary transmission mechanisms in the GCC countries. Borstel et al (2015) tested the pass-through of monetary policy to bank lending rates in the Euro-Area during the period of sovereign debt crisis by comparing with the pre-crisis period. They employed a factor-augmented vector autoregression model to evaluate the reactions of a wide range of country-specific interest rates and spread. Then, they analyzed the impacts of monetary policy on the components of the interest rate transmission mechanism that represented funding risk of the banking sector such as including sovereign risk and

margins charged by banks over funding costs by taking both conventional and unconventional monetary policy into account. Their findings indicated that despite the fact that the pass-through mechanism of conventional monetary policy to bank lending interest rates had not altered, the structure of the interest rate pass-through process had transformed with the crisis. The use of expansionary conventional monetary policy to reduce sovereign risk in peripheral nations and longer-term bank funding risk in peripheral and core countries during the crisis was particularly effective, but it was ineffective in reducing banks' markups throughout the crisis.

Hills et al (2017) analyzed the cross-border monetary policy transmission by comparing and contrasting the results for Hong Kong and the United Kingdom by examining the impact of monetary policy in the Euro-Area, Japan, and U.S on UK and Hong Kong-resident banks' domestic lending behavior. Concentrating on financial interconnections and other balance sheet characteristics as a transmission mechanism by using individual bank-level data, they found that both of these factors played a significant role in the transmission of foreign monetary policy and revealed critical differences between the two countries. For instance, the currency denomination of lending appeared to have a great role only in the U.K, which possibly reflected Hong Kong's linked exchange rate system. Busch et al (2018) tried to provide evidence on monetary policy transmission mechanism across borders and the sources of heterogeneity in this transmission process. They presented the methodology and wide-ranging results from an internationally organized project conducted by the International Banking Research Network (IBRN) that indicated how changes in monetary policies transmitted internationally to the real economy through bank lending. After exploring the international transmission of monetary policies of the Euro-Area, Japan, U.S, and United Kingdom by using micro-banking data covering the period of 2000-2015, the results indicated that the effects supported both the portfolio channel and international bank lending channel of monetary policy transmission. They also found that the frictions that foreign currency funding and hedging examinations could be an important source of heterogeneity.

4. Econometric Analysis

4.1. Data and Methodology

Past studies carried out regarding the monetary policy transmission mechanism in the literature demonstrate that adjustments in policy rates transferred into changes in bank loan and deposit interest rates. These changes do have impacts on the consumption and investment decisions of households and firms in an economy. In this study, the pass-through

of the policy interest rates to bank lending interest rates in the Turkish Banking Sector has been tried to be analyzed. Therefore, the relationships from the O/N repo rates to the bank lending interest rates as well as from weekly repo rates to the bank lending interest rates are examined empirically in this section. Different from the other studies regarding the monetary transmission mechanism in Turkey, the causality relationship from monetary policy interest rates to banking lending interest rates is examined by using Fourier functions in this study. Our analysis covers the period of 2010:05-2018:08. Therefore, it includes the periods when the market interest rates increased resulting from the 2008-2009 Global Financial Crisis, 2010-2014 European Debt Crisis, and the macro-financial dynamics that imposed enormous stress on financial indicators in both advanced and emerging market countries, with market interest rates on the rise. The study also includes the period of 2017-2018 in which the political stress in Turkey led to gradual increases in interest rates. O/N repo rates, weekly repo rates, and banking credit interest rates, comprising both consumer and commercial credit interest rates, collected from Bloomberg and the CBRT, were utilized to investigate the link between variables.

Table 1
Variables and Expected Relationship

	Variables	**Measure**	**Expected Relationship**
Dependent Var.	Bank Lending Interest Rates	Consumer Credit Rates	(+)
Dependent Var.	Bank Lending Interest Rates	Commercial Credit Rates	(+)
Independent Var.	Monetary Policy Interest Rates	Weekly Repo Rates	(+)
Independent Var.	Monetary Policy Interest Rates	O/N Repo Rates	(+)

4.2. Analysis and Results

The Fourier KPSS Stationary Test was used in the first stage to determine whether the variables were stationary. Becker et al (2006) developed a Fourier test that can identify both sudden and gradual shifts, and it appears that the position, number, and type of structural changes have no effect on the test's power. Following that, the causality relationship between variables was tested using the Fourier Toda Yamamato Causality Test, a new causality approach suggested by complementing the Toda-Yamamoto method with a Fourier approximation. The methodology proposed by Nazlioglu et al (2016) is capable of capturing gradual or smooth changes and requires no prior knowledge of the number, timing, or type of structural breaks.

With no specific information available about the nature of the breaks and no practical knowledge about where to find them or how many breaks to use in testing for stationary, using

an incorrect specification for the number or form of breaks could result in a dilemma, such as ignoring the breaks all at the same time during the testing. Becker et al (2006) devised a stationary test in which a selected frequency component of a Fourier function was used to approximate the model's deterministic components. An unknown function can be modeled using a Fourier series, even if the function is non-regular. The Fourier function, which captures the movement of the unknown function, is the fundamental rationale for using this stationary test. The Fourier methodology developed by Becker et al (2006) is capable of detecting changes that are not just sudden but also gradual in nature and that do not have an impact on the test's performance. Thus, the tests performed well even when subjected to a variety of structural breaks that are frequently encountered in economic research, such as breaks of opposing signs (Tsong, 2016).

When breaks are gradual, the methodology devised by Becker et al (2006) appears to be robust enough to detect sharp and u-shaped breaks as well as smooth breaks near the end of a series. Trigonometric terms are employed by Becker et al (2006) to detect unknown nonlinearities. They created a KPSS-type stationary test (Becker et al, 2006).

The following DGP is considered by Becker et al (2006);

$$y_t = Xt'\beta + Zt'\gamma + r_t + \varepsilon_t$$
$$r_t = r_{t-1} + u_t, \tag{1}$$

where ε_t denotes stationary errors and u_t are independent and identically distributed with variance $\sigma_u{}^2$. To detect a break in the deterministic term, $Z_t = [sin(2\pi kt/T), cos(2\pi kt/T)]'$ was choosen, where k denotes the frequency and T indicates the sample size. It is described as $X_t = [1]$ for a level-stationary process for y_t and $X_t = [1, t]'$ for a trend-stationary process to test if y_t is stationary or not.

To produce the necessary t-statistic for testing the null hypothesis, one of the models mentioned below is estimated and the residuals are acquired ($H_0 = \sigma_u{}^2 = 0$);

$$y_t = \propto_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t \tag{2}$$

$$y_t = \propto_0 + \beta t + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + e_t \tag{3}$$

The following test statistics is obtained;

$$\tau_\mu(k) or\ \tau_\tau(k) = \frac{1}{T^2} \frac{\sum_{t=1}^{T} \tilde{S}_t(k)^2}{\tilde{\sigma}^2} \tag{4}$$

where $\tilde{S}_t(k) = \sum_{j=1}^{t} \tilde{e}_j$ and $\tilde{e}_j$ denote the OLS residuals from the regression (2) for $\tau_\mu(k)$ or (3) for $\tau_\tau(k)$. As in KPSS, a nonparametric estimate $\tilde{\sigma}^2$ of the long-run variance could be acquired by selecting a truncation lag parameter *l* and a set of weights w_j,j = 1,…,*l*;

$$\tilde{\sigma}^2 = \tilde{\gamma}_0 + 2\sum w_j \tilde{\gamma}_j, \tag{5}$$

where $\tilde{\gamma}_j$ corresponds to the *j*th sample auto-covariance of the residuals $\tilde{e}_t$ from equation (2) or (3).

The value that gives the minimum sum of residuals (OLS) is chosen to identify the optimal number of k. In the absence of a non-linear trend in DGP, it could be utilized the standard KPSS test to acquire increased power. Becker et al (2006) suggested using F-test statistics to test for the absence of a non-linear trend. Consequently, the following F-test statistic can be calculated for this hypothesis (absence of a nonlinear trend (i.e. $\gamma_1 = \gamma_2 = 0$) versus the alternative of a nonlinear trend with a given frequency k.

$$F_i(k) = \frac{(SSR_0 - SSR_1(k))/2}{SSR_1(k)/(T-q)} \qquad i=\mu,\tau, \tag{6}$$

In case the null hypothesis of stationary is rejected, the F-test can be used. In the event that the trigonometric terms are not significant, the standard KPSS test statistic would be used. The results of the stationary test are presented below in comparison to the critical values associated with the Fourier Test as reported in the study of Becker et al (2006).

Table 2
Fourier KPSS Stationary Test Results (n=100)

Variable	**Frequency**	**MinSSR**	**FKPSS**	**F-Statistic**
Cons.Credit Interest Rate	4	559.9357	0,770752	25,57688
Difference Cons. Credit Int. Rate	4	97.99814	0,325164***	7,46720*
Comm. Credit Int. Rate	4	538.5922	0,435374**	14, 80547*
Weekly Repo Rate	1	408.2304	0,222985*	11,83089*
O/N Repo Rate	4	375.9046	0,135498***	13,08192*
FKPSS Critical Values (1 and 4)		F-Statistic Critical Values		
1%	0,2699	0,7222		6,730
5%	0,1720	0,4592		4,929
10%	0,1318	0,3476		4,133
Notes: *, **, and *** indicate %1, %5, and %10 levels of statistical significance, respectively.				

As seen in Table 2, while the consumer credit interest rate is not stationary at its level and it becomes stationary after the first difference, the commercial credit interest rate, weekly repo rate, and O/N repo rate are stationary at their levels. Based on F-Test results, it appears that trigonometric terms for both variables are statistically significant when compared to F-statistic critical values reported in the study by Becker et al (2006).

The Fourier Toda Yamamoto Causality Test, developed by Nazlioglu et al (2016), was used in the second stage to examine the causal linkages between monetary policy rates and banking lending interest rates. Traditional econometric approaches, which search for rapid shifts, are ineffective in capturing structural changes because the links between the variables have been subject to gradual shifts and linear specifications are often insufficient to detect the relationships. As a result, Nazlioglu et al (2016) adapted the Granger causality technique of Toda-Yamamoto (1995) by including a Fourier approximation in order to clarify gradual or smooth structural changes. Using the Fourier approximation does not necessitate any prior knowledge of break number, date, or form. Based on the analysis suggested by Enders and Jones (2015), their study employs a Fourier approximation by utilizing a limited number of low-frequency components, with the objective of clarifying the determination of the form of breaks, as well as the approximation of the number and dates of shifts in a VAR framework.

Using a VAR*(p + d)* model, Nazlioglu et al (2016) examined the causal link between oil prices and real estate investment trusts in their study. The lag length of the model is denoted by p, and the maximum integration degree of the variables is denoted by d in their study. The VAR*(p+ d)* model can be expressed as follows;

$$y_t = \alpha + \beta_1 y_{t-1} + \cdots + \beta_{p+d} y_{t-(p+d)} + \epsilon_t \tag{7}$$

where y_t is a set of K endogenous variables, α is a vector of intercept terms, β are coefficient matrices and ϵ_t are white noise residuals. On the basis of zero restriction on first *p* parameters (H_0:β_1=…=β_p=0) of the *Kth* element of y_t, the null hypothesis for Granger non-causality is established. Here, y_t in Equation (7) is assumed not to have any structural breaks by the assumption that the intercept terms α are constant throughout a period of time.

The management of structural breaks and the identification of the original source of breaks become more difficult when using a VAR specification as a break in one variable may trigger shifts in the other variables. When the shifts are sharp, the traditional Granger causality test has the credible size and power qualities; however, when the shifts are gradual, the test performs significantly better. It is also responsive to the unit root and cointegration properties of the VAR model, necessitating the testing of unit root and cointegration for causal

inferences since the Wald test does not have a standard distribution in case the variables in the VAR model are integrated or cointegrated, and it is also dependent on nuisance parameters. The Toda-Yamamoto technique to unit root and cointegration properties of the VAR system appears sound for solving such situations. Nazlioglu et al (2016) present a recent and simple methodology for capturing breaks in Granger causality analysis by extending the Toda-Yamamoto framework with gradual structural breaks and adding a Fourier approximation. They loosen the assumption that the intercept terms are constant across time in order to allow for structural shifts, and adapt the VAR model in Equation (7) as follows;

$$y_t = \alpha(t) + \beta_1 y_{t-1} + \cdots + \beta_{p+d} y_{t-(p+d)} + \epsilon_t \tag{8}$$

where the intercept terms $\alpha(t)$ indicate time functions and any structural break in y_t. In order to be able to detect structural breaks as a gradual process with an unknown date, number, and form of breaks, the Fourier expansion is defined by;

$$\alpha(t) = \alpha_0 + \sum_{k=1}^{n} \gamma_{1k} \sin\left(\frac{2\pi kt}{T}\right) + \sum_{k=1}^{n} \gamma_{2k} \cos\left(\frac{2\pi kt}{T}\right) \tag{9}$$

where n the number of frequencies, γ_{1k} and γ_{2k} indicate the amplitude and displacement of the frequency, respectively. Additionally, a big value of n is most frequently associated with a stochastic parameter variation, resulting in a loss of freedom and an overfitting problem. According to Becker et al (2006), a single Fourier frequency causes a range of shifts in deterministic components without taking into consideration the date, number, and form of breaks. As a result, Nazlioglu et al (2016) employ a single frequency component and express $\alpha(t)$ as;

$$\alpha(t) = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) \tag{10}$$

where k shows the frequency for the approximation. By modifying Equation (10) in Equation (8), they obtain the equation as;

$$y_t = \alpha_0 + \gamma_1 \sin\left(\frac{2\pi kt}{T}\right) + \gamma_2 \cos\left(\frac{2\pi kt}{T}\right) + \beta_1 y_{t-1} + \cdots + \beta_{p+d} y_{t-(p+d)} + \epsilon_t \tag{11}$$

Testing the null hypothesis of Granger non-causality in this identification is the same as in Equation (7), and the hypothesis can be examined utilizing the Wald statistic. The causality results differ from those previously published in various ways when Fourier terms are employed to allow for breaks. Enders and Jones (2015) find stronger relationships and larger groups of interactions between the variables when they use trigonometric functions in the model, as opposed to the Granger-causality results provided by the linear VAR.

Table 3
Fourier Toda Yamamato Causality Test Results

Relationship	p	Wald-Stat	Asymptotic* p-value	Bootstrap p-value
Weekly Int. Rate→ Cons.Credit Int. Rate	3	50.070	0.000*	0.000
O/N Int Rate→ Cons. Credit Int. Rate	3	55.297	0.000*	0.000
Weekly Int Rate→ Comm. Credit Int. Rate	3	31.126	0.000*	0.002
O/N Int. Rate→ Comm. Credit Int. Rate	3	31.768	0.000*	0.000
Cons. Credit Int. Rate→ Weekly Int. Rate	3	0.272	0,965	0,956
Cons. Credit Int. Rate→ O/N Int. Rate	3	1.540	0,673	0,668
Comm. Credit Int Rate→ Weekly Int. Rate	3	7.834	0,050**	0,077
Comm. Credit Int Rate→ O/N Int. Rate	3	13.852	0,003**	0,025

Notes: → shows causality. Optimal k (frequency) and p (lag) are found by the Akaike information criterion. Bootstrap p-values are based on 1000 replications. *, **, and *** show %1, %5, and %10 levels of statistical significance, respectively. Because n>50 in this study, we will take into account the asymptotic p-value in comparison.

Checking the asymptotic p-value for the variables, it appears that there is a causality relationship between the variables both from weekly repo rates to consumer and commercial credit rates and from O/N repo rates to consumer and commercial credit rates. The findings indicate that both the changes in weekly repo rates and O/N repo rates have impacts on bank lending interest rates. Thus the results signaling causality from monetary policy rates to bank lending interest rates which means a change in monetary policy is associated with a change in market interest rates, imply that to have an impact on price stability and some macro-financial indicators as growth, credit volume, and consumption-investment decisions, both O/N repo rates and weekly repo rates can be adjusted according to the monetary tightening or monetary easing purpose of the CBRT. Moreover, while there seems no causality from consumer credit interest rates to the monetary policy interest rates, the results shown in the table above supported the causality relationship from commercial credit interest rates to both the O/N interest rates and weekly interest rates.

5. Conclusion

Monetary policy interest rates do have impacts on both the lending and deposit rates of banks. Using interest rate policy, which is the most effective instrument of monetary policy in terms of affecting market interest rates, central banks can influence the consumption and investment decisions of consumers and businesses, and thus investments and total economic output in the economy. The Central Bank of the Republic of Turkey which has been maintaining a monetary policy framework focused on price stability has a number of interest rates including weekly repo interest rate, O/N repo interest rate, and late liquidity window

interest rate. When the CBRT raises the O/N repo or weekly repo rate, the banking sector's funding costs rise, and the banks pass on these increases to their customers in the form of higher lending interest rates. It will cause a loan contradiction, resulting in a contradiction in both consumption and investment, as well as a slowdown in economic output. The Turkish Lira has depreciated significantly against a basket of foreign currencies in the last two years, particularly in the last two years. As part of the inflation targeting program, the CBRT has begun to gradually raise policy interest rates in order to control speculative appreciation of the U.S dollar and Euro against the Turkish lira as well as inflation expectations. This upward trend in interest rates is expected to lead to a decrease in the number of loans demanded by the private sector in the future term and eventually lead to deterioration in investments. Concurrently, increases in consumer credit interest rates may bring credit demand shrinking.

Since the pass-through of monetary policy rates to the bank lending interest rates is of high importance, the causality relationships between monetary policy interest rates including weekly repo rates - O/N repo rates and bank lending interest rates have been investigated in this study. The findings signaling the causality relationship from monetary interest rates to both consumer and commercial credit interest rates indicate that the Central Bank's decisions and actions about how and to what extent it will increase the monetary policy rates determining role. It is seen that the findings of the analysis are highly consistent with the results of the other studies carried out by De Bondt (2005), Sorenser and Werner (2006), Borstel et al (2015), and Busch et al (2018). The findings are considered to be important for policymakers. Because the CBRT can affect aggregate demand and investments thereby economic activity by adjusting monetary policy rates. The channels and effects of the transmission mechanism of monetary policy interest rates to bank lending interest rates have been extensively examined in the academic literature because it measures the efficiency of monetary policy in controlling inflation and stabilizing the economy. It is critical to assess the effectiveness of the interest rate transmission mechanism in order to enhance policy implications and to make recommendations for improving the effectiveness of the monetary policy. The causality relationship found in this study between monetary policy interest rates and bank lending interest rates implies that the increases in the monetary policy interest rates are expected to lead to movements in bank lending interest rates in Turkey in the near future and aggregate demand, investment, and economic activity might have been affected negatively as a result of increases in loan interest rates. According to the declaration made by the CBRT, recent developments in the inflation outlook pointed to significant risks in terms of price stability. It is noteworthy that the price increases have spread on the basis of sub-items

due to the volatility of the foreign exchange rates. Despite the weakening domestic demand conditions, the deterioration in the pricing behavior continues to pose an upside risk to the inflation outlook. Therefore, monetary tightening is expected to be carried out in the future term to support price stability. On the other hand, when the recession environment is taken into consideration, increasing interest rates may significantly lead to a deterioration of the economic environment and trigger disinvestment in the future term.

References

Aydin, H. İ. (2007). Interest Rate Pass-Through in Turkey, *CBRT Working Papers 07/05*, Research and Monetary Policy Department.

Becker, R., Enders, W. & Lee, J. (2006). A Stationarity Test in the Presence of an Unknown Number of Smooth Breaks. *Journal of Time Series Analysis, 3*(5), 381–409.

Buch, C. M., Bussiere, M., Goldberg, L. & Hills, R. (2018). International Transmission of Monetary Policy. *Deutsche Bundesbank Discussion Paper*, *16*, 1–58.

Cas, S.M., Carrión-Menéndez, A. & Frantischek, F. (2011). The Policy Interest-Rate Pass-Through in Central America. *IMF Working Paper*, *11*/240, 1–22.

Central Bank of the Republic of Turkey. (2018). Electronic Data Delivery System. Avaialable at: https://evds2.tcmb.gov.tr/index.php Access date: 03.10.2018

Central Bank of the Republic of Turkey. (2017). Monetary and Exchange Rate Policy Report for 2018, 5 December 2017, 1–14. Access date: 05.10.2018

Cevik, S., & Teksoz, K. (2012). Lost in Transmission? The Effectiveness of Monetary Policy Transmission Channels in the GCC Countries. *IMF Working Paper*, *12*(191), 1–35.

De Bondt, G. J. (2005). Interest Rate Pass Through: Empirical Results for the Euro Area. *German Economic Review, 6*(1), 37–78.

Enders, W., & Jones, P. (2016). Grain Prices, Oil Prices, and Multiple Smooth Breaks in a VAR. *Studies in Nonlinear Dynamics & Econometrics*, *20*(4), 399-419.

Hills, B., Ho, K., Reinhardt, D., Sowerbutts, R., Wong, E, T., & Gabriel, W. (2017). The International Transmission of Monetary Policy Through Financial Centres: Evidence from the United Kingdom and Hong Kong. *HKIMR Working Paper*, 26/2017, 1–45.

Kwapil, C., & Scharler, J. (2010). Interest Rate Pass-through, Monetary Policy Rules and Macroeconomic Stability, *Journal of International Money and Finance*, *29*(2), 236–251.

Marotta, G. (2009). Structural Breaks in the Lending Interest Rate Pass-through and the Euro. *Economic Modelling*, *26*, 191–205.

Matemilola, B. T., Banny-Ariffin, A. N., & Muhtar, F. E. (2015). The Impact of Monetary Policy on Bank Lending Rate in South Africa. *Borsa Istanbul Review*, *15*(1), 53–59.

Nazlioglu, Ş., Görmüş, A., & Soytaş, U. (2016). Oil Prices and Real Estate Investment Trusts (REITs): Gradual-shift Causality and Volatility Transmission Analysis. *Energy Economics, 60*, 168–175.

Paries, M. D., Moccero, D. N., Krylova, E., & Marchini, C. (2014). The Retail Bank Interest Rate Pass-through: the Case of the Euro Area during the Financial and Sovereign Debt Crisis. *Occasional Paper Series*, *155*, 1–47.

Pétursson, T. G. (2001). The Transmission Mechanism of Monetary Policy: Analysing the Financial Market Pass-Through. *Central Bank of Iceland Working Papers*, No:14, 1–24.

Sorensen, C. K., & Werner, T. (2006). Bank Interest Rate Pass-Through in the Euro-Area: A Cross Country Comparison. *Working Paper Series*, No: 580, 1–65.

Tai, P. N, Sek, S. K., & Har, W. M. (2012). Interest Rate Pass-Through and Monetary Transmission in Asia. *International Journal of Economics and Finance, 4*(2), 163–174.

Tsong, C.C., Lee, C.F., Tsai, L.J. & Hu, T.C. (2016). The Fourier Approximation and Testing for the Null of Cointegration. *Empirical Economics*, *51*(3), 1085–1113.

Vithessonthi, C., Schwaninger, M., & Müller, M. O. (2017). Monetary Policy, Bank Lending and Corporate Investment. *International Review of Financial Analysis*, *50*, 129–142.

von Borstel, J., Eickmeier, S., & Krippner, L. (2015). The Interest Rate Pass-through in the Euro-Area during the Sovereign Debt Crisis, *Discussion Paper Series*, Reserve Bank of New Zealand, 1-56.

Wang, K. M., & Lee, Y.M (2009). Market Volatility and Retail Interest Rate Pass-through. *Economic Modelling*, *26*(6), 1270–1282.

Weth, M. (2002). The Pass-through from Market Interest Rates to Bank Lending Rates in Germany, Economic Research Centre Of The Deustche Bundesbank. *Discussion Paper 11/02*, 1–40.

Yilanci, V. (2017). Analyzing the Relationship between Oil Prices and Economic Growth: A Fourier Approach. *Econometrics and Statistics*, *27*, 51–67.