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Revisiting of Interest Rate Channel: Nonlinear transmission of Monetary Policy Shocks to the Turkish Economy[1]

Abstract: This study examines the effectiveness of non-linear monetary policy interest rate channel shocks for the Turkish economy using the threshold VAR analysis in the period of 2006-2019. The interest channel is examined with the two models for both consumption transfer and investment transfer models. The results show that the interest rate channel is effective in the high regime (high macroeconomic instability) for the consumption transfer model, and it is partially effective in the low regime (low macroeconomic instability). On the other hand, for the model with investment expenditures flow, the interest rate channel is partially effective in both high and low regimes.

Keywords: Turkish Economy, Monetary Policy Shocks, Nonlinear transmission, Interest Rate Channel.

JEL Classification: E43, E52, E58, C24

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1. Introduction

There has been a growing interest in monetary policy instruments in the post-global financial crisis period. In times of recession or crisis, central banks follow activist monetary policy strategies. In this context, in the post-global financial crisis period, central banks of many developed and developing countries have reduced the policy rate to zero or significantly reduced it. However, before the wounds of the global financial crisis were healed, the Covid-19 health crisis broke out. Recently, interest in monetary policy strategies continues in the same way. The low level of policy rates raises doubts about the efficiency.

The monetary transmission mechanism provides an important theoretical opportunity to examine the effectiveness of monetary policies. Keynesian economics argues that money affects the rate of inflation through the interest channel. In this way, the expansionary monetary policy with bond purchases will increase the demand for bonds, which will increase bond prices and cause the interest rate to fall. A lower interest rate will increase investment and consumption. Thus, a higher aggregate demand level will be achieved. On the other hand, the general level of prices will also increase (Lau and Yip, 2020). The monetary transmission mechanism is basically used in economic management through 5 different channels. This channel is especially important for developing countries because they have problems especially with savings deficit and the current account deficit. While interest rates are a cost factor for increasing the productive capacity of the economy and preserving the existing capacity, it also appears as an incentive or deterrent for consumption expenditures. While interest rates are a cost factor for increasing the productive capacity of the economy and preserving the existing capacity, it also appears as an incentive or deterrent for consumption expenditures. The importance of the interest channel in the method of the economy becomes even more important for fragile or high current account deficit countries. However, increasing fragility raises doubts about the efficiency of the interest rate channel. Researchers could not agree on the functionality and effectiveness of the monetary transmission mechanism (Nain and Kamaiah, 2020). Therefore, considering macroeconomic instabilities for the analysis of the monetary transmission mechanism may enable stronger and more accurate results to be obtained.

When the literature is examined, it is seen that the efficiency of the monetary transmission mechanism interest channel is mostly investigated with linear methods. However, the relationships between macroeconomic variables can be non-linear in nature. In the study of Mishkin (2017), it has been mentioned that macroeconomics is not in a linear structure to a large extent. Economic contraction can cause financial deterioration by affecting asset values. This situa-

tion increases the uncertainty for asset values in the form of a cycle by causing a contraction in consumption and investment expenditures. As a result, financial deterioration worsens and negatively affects economic activity.

Inflation and output deficit inherently involve nonlinear processes. These processes have asymmetric adjustment mechanisms. For instance, in output, while improvements during the business cycle are long and straight, recessions can be seen as short and sharp. A similar situation exists for inflation. During the cycle, inflation falls slowly but rises faster. As in these examples, expansion and contraction movements of macroeconomic variables generally have different characteristics. Nonlinear models are needed to explain these nonlinear movements arising from the nature of macroeconomics (Petersen, 2007).

Saldías (2017) indicated that in terms of the monetary transmission mechanism, revenue in different regimes reacts differently to monetary policy shocks. Although Phillips mentioned that the relations between nominal wages and unemployment may be nonlinear, it is seen that linear models are used in the analysis of the Phillips curve in most studies in the literature. Another example of asymmetry research is related to the fact that increases or decreases in inflation rates affect interest rates at different levels, in other words, asymmetrically, as in Gocer and Ongan (2020). This also applies to the monetary transmission mechanism. A similar situation exists for the monetary transfer process. Depending on the conditions of the economy (growth or contraction period), the response of the output to the monetary policy shock may be variable. In particular, activist policy strategies such as the transmission mechanism are important for developing countries in economic management.

Keynes also stated that the recession periods of the economy are sudden and severe, but the recovery periods are slower and last longer. The macroeconomic theory also supports this claim of Keynes. In the functioning of macroeconomics, liquidity trap theory, menu cost models, wage and price stickiness theories can be cited as examples of the sources of nonlinearity (Hasanov, Araç and Telatar, 2010). Therefore, taking into account the non-linearity in the policy design with non-linear methods, performing estimations and calculations will provide more realistic results.

Tena and Tremayne (2009) stated that the threshold method can be preferred in order to reveal the asymmetric effects of policy shocks (regime dependent) among nonlinear estimation methods. Tsay (1998) also stated that asymmetric effects can be captured with threshold methods. Recent studies in the literature may also prefer regime-dependent econometric models to investigate nonlineari-

ty caused by the instability of macroeconomic variables. Specifically, a significant portion of these econometric studies has focused on threshold models that endogenously separate shocks into "tight" and "loose" policy regimes and examine asymmetric responses to impacts from shocks. McCallum (1991), Balke (2000) and Galbraith (1996) for the USA and Atanasova (2003) for the UK pointed out the existence of threshold effects between monetary policy and economic activity.

Uncertainties in the economy may also lead to macroeconomic instability (Montiel and Servén, 2006). The sources of macroeconomic stability are stable or low inflation, predictable exchange rate, a sustainable balance of payments position, and the existence of prudent macroeconomic policies (Fischer, 1992). In this context, many developing countries such as Turkey and Latin American countries have experienced macroeconomic instability due to unstable economic policies for a long time. Increasing macroeconomic instabilities resulted in high inflation, increasing budget deficits and decreasing investments (İsmihan, Metin-Izcan and Tansel, 2005).

Despite the global pandemic, Turkey grew by 5.9% in the fourth quarter of 2020 (real GDP) and by 1.8% on an annual basis with increased domestic demand and loans (World Bank, 2021). Turkey has started to show itself as one of the newly industrialized economies with its emerging market (Statista, 2021). Due to the instability in the past, Turkey's monetary policy strategies and reforms have often been interrupted. With the increasing macroeconomic stability in the post-2001 crisis period, the effectiveness of monetary policy and the credibility of the central bank rose to high levels. However, negative developments, especially the Global financial crisis and the COVID-19 health crisis, have increased doubts about the effectiveness of monetary policy strategies. Turkey sets an example for many countries, especially with its high growth potential, young population and relatively fragile economy. The reason for considering Turkey in this study is that it is a good example especially for countries that have high growth potential and are financially fragile. On the other hand, Turkey has implemented quite different macroeconomic policies from the 1980s to the 2000s. The crises experienced are also a good and natural example of non-linearity in investigating the relationship between monetary policy, inflation and output as a result of unstable economic policies.

The main contribution of the study is the examination of the regime-related effects of the monetary transmission mechanism and the preference of macroeconomic stability as a regime variable. As such, it fills an important gap in the literature. As far as we know, it is the first nonlinear study on the interest channel for

Turkey. Iddrisu and Alagidede (2020) mainly emphasized that in investigating the efficiency of the interest channel, attention should be paid to the consumption and investments components, however, this situation is also ignored in the literature. Another contribution of the study is that it specifically takes into account the final effect of monetary policy on output and inflation through consumption and investments, which are aggregate demand components in the interest channel.

2. Literature Review

In their studies, Çatık and Martin (2012) and Dahlhaus (2017) investigate the efficiency of the monetary transmission mechanism interest channel with nonlinear methods. Çatık and Martin examine how the regime change in Turkey was reflected in the transmission mechanism for the period 1986-2010. However, this study is a comparison of monetary policy before and after inflation. In the study, a comparison of empirical results before and after targeting is presented due to the significant changes in interest and inflation rates before and after the inflation-targeting period. In the study in which the Threshold VAR method is used, it is concluded that the response to macroeconomic shocks in the post-reform (post-targeting) period in Turkey change similarly to market-oriented economies. Dahlhaus investigates the interest rate channel effectiveness of the monetary transmission mechanism in the analyzed period for the American economy, in terms of high and low financial stress. In the analysis using quarterly data from 1970 and 2008, it is found that monetary policy is more effective on macroeconomic variables such as output, production and investment in high financial stress periods than in normal financial stress periods.

Erdoğan and Yıldırım (2009) investigate the efficiency of the interest rate channel with the help of linear VAR methodology in the period of 1995-2007 in Turkey. It is observed that the positive shock to short-term interest rates caused an increase in real interest rates and a decrease in investment and durable consumer goods, consistent with the theory. Findings indicate that the interest rate channel is operating effectively. Çifter and Özün (2007) examine the effectiveness of the monetary transmission mechanism and the validity of the monetary passivity hypothesis in their study for Turkey. According to the causality results with Turkey's money supply, industrial production index, interest rates, credit capacity, real exchange rate variables, it is concluded that production is affected by interest rates and inflation is affected by long-term money supply.

Papadamou and Oikonomou (2007) study the efficiency of the interest rate channel for 8 countries using interest, inflation and output, and concluded that the interest rate channel is effective in some countries. Moreover, in another study, Papadamou, Sidiropoulos and Spyromitros (2015) examine the role of central bank transparency through the monetary transmission interest channel. It is concluded that the communication mechanism of monetary policy is more effective when the central bank is more transparent to the market. Yue and Zhou (2007) study the efficiency of the interest channel for China with the Granger Causality method. As a result, it is found that the interest channel is not efficient. In other words, there is no causality finding between interest and investment and consumption expenditures. Mehrotra (2007) investigates the exchange rate and interest rate channel efficiency in Hong Kong, Japan and China in a deflationary environment using the SVAR method. It is found that interest rate shocks have a strong effect on prices in economies, except China. On the contrary, since prices are shaped by administrative measures in China, they are not affected by interest rate and exchange rate shocks. Karim (2012) investigates the efficiency of the interest channel and the bank loans channel of the monetary transmission mechanism over the investment expenditures of the firms by using the dynamic panel data technique for the Malaysian economy in the period 1990-2008. The findings are that the interest rate and credit channel are effective in the country in question. Mohanty (2012) examined the interest rate channel efficiency of the monetary transmission mechanism for India using the Structural VAR model. It is observed that the policy rate increase has a negative effect on output and had a moderate effect on inflation. Using the SVAR method, Wulandari (2012) examines whether the loan and interest channel are effective in Indonesia. It is concluded that the interest rate channel is more effective in managing inflation, but has a limited effect on economic growth. Atgür and Altay (2017) investigate the efficiency of the interest rate channel using the VAR and FAVAR methodology with quarterly data for Turkey (2002-2013) and Indonesia (2001-2013). It is revealed that the interest channel partially works in Turkey and Indonesia. FAVAR Model impulse-response function results, on the other hand, indicate that the interest rate channel works partially in Indonesia.

Gündüz (2020) investigates the validity of interest, exchange rate and asset price channels in Turkey with the help of SVAR analysis. According to the results of the study, it is found that the channel of interest, exchange rate and asset prices works effectively. Ghosh (2020) investigates the interest and credit channels of the monetary transmission mechanism for India under financial dependency. In the study, it is determined that asset price risk and deposit cost are important factors in explaining the interest channel. The results show that more financial connections create a more palpable impact on the interest rate channel. Lau and Yip

(2020) investigate the monetary transmission channels of the quantitative easing policy in Japan to stimulate the economy (inflation) in the short and long term. In the study, it is found that the inflationary effect of the interest rate channel is more pronounced in the short term in the 2013-2018 period. As a result, the differences in the transmission mechanism on inflation in the short and long term reveal asymmetric effects. Finally, Awdeh, Jomaa and Kassem (2020) investigate the effect of the interest rate channel on the loan supply between 1994-2017. From the empirical results, it is understood that the interest channel of the monetary transmission mechanism in Lebanon operates through banks with high liquidity stock and market power.

3. Data & Methodology

In this study, the efficiency of the interest channel is investigated with monthly data for the Turkish economy in the period 2006:3-2019:6. In order to represent the output, the industrial production index is preferred. For the effect of the interest rate channel on the demand side of the economy, durable good consumption, which is widely used in the literature, is preferred to represent consumption expenditures. Fixed capital formation, which is widely used in the literature, is preferred to represent investment expenditures for the effect of the interest rate channel on the supply side of the economy. Finally, the annual percentage change of the consumer price index is used to represent the inflation series.

Economics theory is used to determine the forecasting model and to rank the series. In this context, the expansionary or contractionary monetary policy strategy of the central bank is represented by the interbank money market overnight interest rates (lnON). The transmission takes place through two separate components. Changes in policy rates affect consumption expenditures (lnDCG) on the one hand, and investments (lnFCG) on the other. Since consumption and investment expenditures are components of total demand and national income, output increases and ultimately affects inflation. Therefore, there are two different equations for the transmission mechanism; in one equation, consumption expenditures mediate the transmission, and in the other, investment mediates the transmission. Estimation equations are shown in Eq.1 and Eq.2.

$$\text{lnON} \rightarrow \text{lnDCG} \rightarrow \text{lnOutput} \rightarrow \text{Inf} \quad (1)$$

$$\text{lnON} \rightarrow \text{lnFCG} \rightarrow \text{lnOutput} \rightarrow \text{Inf} \quad (2)$$

The fact that the effects of external shocks on economic activity in periods of high macroeconomic risk are stronger and more corrosive compared to periods of low macroeconomic risk, reveals the necessity of investigating this change with the help of a model dependent on regimes (Ferraresi, Roventini and Fagiolo, 2015). In this context, it is decided to use the TVAR (Threshold VAR) model in the research in order to detect nonlinear interactions and dynamics such as asymmetrical responses to shocks and regime changes.

An important point for the Threshold VAR method is the determination of the threshold variable. Macroeconomic stability is an important determinant for the effectiveness of the monetary transmission mechanism. Especially in the period after the 2008 crisis, central banks give more importance to macroeconomic stability. Therefore, macroeconomic stability is an important component for the effectiveness of the monetary transmission mechanism. On the other hand, central banks resort to activist policies more in times of increased macroeconomic instability. For this reason, macroeconomic instability is chosen as the threshold variable in our study.

In the literature, the inflation rate is widely used as an important macroeconomic stability indicator (Mallick and Sethi, 2019; Donayre and Panovska, 2016; Ho, 2005; Vinayagathasan, 2013, Guo, 2013; Shen and Chiang, 1999; Mandler, 2012; Çatık and Martin, 2012). If the inflation rate is above a threshold level, market participants change inflationary expectations because the inflation rate is an indicator of policy makers' credibility (Aleem and Lahiani, 2014). Table 1 shows the descriptive statistics.

Table 1: Descriptive Statistics

Variables	Explanation	Mean	S.D	Max.	Min.
lnON	Overnight Interest Rate	2.158	0.626	3.158	0.405
lnDCG	Durable Good Consumption	4.457	0.216	4.856	3.855
lnFCG	Fixed Capital Formation	4.657	0.184	4.931	3.852
lnOutput	GDP	4.430	0.227	4.867	3.921
Inf	Inflation Rate	0.094	0.035	0.252	0.040

The mean value of the lnON series in Table 1 is 2.158. The averages of the lnDCG, lnFCG, lnOutput and Inf series are 4.457, 4.657, 4.430, and 0.094, respectively. The natural logarithms of the series are taken.

Analysis with non-stationary series can lead to a spurious regression problem. For this reason, first of all, ADF and PP unit root tests and Lee-Strazich tests,

which allow two breaks, are used in our study. Lee and Strazinich (2002) examine the accuracy of break point estimation using the endogenous break unit root tests of Zivot and Andrews (1992) and Lumisdaine and Papell (1997). Furthermore, ADF-type tests may incorrectly reject the basic hypothesis, showing that the series is stationary without breaks. Therefore, the rejection of the null hypothesis is taken as basic proof of the stationarity of the series. (Cook, 2005; El-Shazly, 2016; Ahmad ve Aworinde, 2016). On the other hand, Lee and Strazicich's (2003) test indicated in the following paragraph allows for structural change under the null hypothesis. Thus, in the presence of structural breaks, ADF solves the spurious rejection problem of PP and Zivot-Andrews models (Dimitriou and Theodore, 2013; Lee and Strazicich, 2002). In other words, the LM test, unlike test statistics proposed by Perron (1989), allows for double endogenous structural breaks under both null and alternative hypotheses (Ahmad and Aworinde, 2016).

Lee and Strazizich (2003) developed the LM unit root test that allows up to two structural breaks. Model AA allows for two variations in the constant and is expressed as Z_t= [1, t, D_{1t}, D_{2t}], D_{jt}=1, j=1, 2 and its alternative is zero for t ≥ T_{BJ}+1. "T_{BJ}" represents the break date. In addition, in the data generation process, the null and alternative hypotheses are expressed as h_0=β=1 and h_A=β< 1 because they contain breaks. Depending on Model AA, β coefficient, empty and alternative hypotheses are seen in Equation 3 and Equation 4.

$$h_0= y_t= \mu_0 +d_1B_{1t}+ d_2B_{2t}+ y_{t-1}+v_{1t}, \quad (3)$$

$$h_A= y_t= \mu_1 + \gamma_t+ d_1D_{1t}+ d_2D_2t+ v_{2t}, \quad (4)$$

The "vt" error terms found in the regression are equal to B_{jt}=1 j=1, 2 and otherwise zero for t=T_{BJ}+1. Model CC represents double break in intercept and trend. Zt= [1, t, D1t, D2t, DT1t, DT2t], for DTjt= t-TBJ, t ≥ TBJ+1, j=1, 2 and its alternative is zero. The following hypotheses are established for this model.

$$h_0: y_t= \mu_0 +d_1B_{1t}+ d_2B_{2t}+ d_3D_{1t}+ d_4D_{2t} +y_{t-1}+ v_{1t}, \quad (5)$$

$$h_A: y_t= \mu_1 + \gamma_t+ d_1D_{1t}+ d_2D_{2t}+ d_3DT_{1t}+ d_4DT_{2t} + v_{2t}, \quad (6)$$

In equations 3 and 4, with "v_{1t}" and "v_{2t}" as stationary error terms, t=T_{BJ}+1, j= 1, 2 for B_{jt}=1 and 0 otherwise. The test statistic of the LM test includes the regression as Δ_{yt}= δ'Δ Z_t + ϕ $\acute{S}_{t-1}$ + μ_t. $\acute{S}_t$= y_t − ψ_x − Z_t δ't , t= 2, ..., T ; δ' are the coefficients of the Δ_{yt} regression. Δ Z_t is equal to y_t − Z_t δ = ψ_x. In addition, y_1 and Z_1 represent the first observations of yt and Z_t. The LM test statistic is presented by the tau (τ) statistic to test the h_0 hypothesis. For the minimum t-statistic, all possible breakpoints are tested and expressed as "T_B". Its regression is; lnfτ (λ_i)= lnf τ (λ), λ = T_B / T.

Lee and Strazizich propose a unit root test with a minimum Lagrange multiplier in which the H_A hypothesis is stationary (Dimitriou and Theodore, 2013). If the variable contains a unit root, then $\phi_t=0$. The alternative hypothesis is $\phi_t<0$. The unit root hypothesis is tested with the t-value of the ϕ coefficient and this statistic is represented by "τ".

$$H_0 = \phi_t = 0$$

$$H_1 = \phi_t < 0$$

3.1. Threshold Vector Autoregressive Model

The linear VAR method is widely preferred to detect linear relationships between time series. If the existence of asymmetrical relationships between the variables is to be investigated, linear VAR remains ineffective. The threshold VAR method is more effective for examining nonlinear relationships / asymmetric interactions (Balke, 2000). In other words, examining an economy with asymmetric effects and non-linear relations within the scope of linear VAR can lead to misleading results. In this context, regime dependent models such as Markov Regime Change Model and Threshold VAR Model are preferred in the literature in order to examine nonlinear relationships. In the threshold VAR model, the period examined according to the critical threshold is divided into different regimes. However, in these models, it is thought that the variables within each regime are explained by a linear model (Baum and Koester, 2011).

$$Y_t = A^1 Y_t + B^1(L)Y_{t-1} + (A^2 Y_t + B^2(L)Y_{t-1})I(c_{t-d} > \gamma) + U_t \quad (7)$$

In the equation, Y_t represents the vector of endogenous variables. It shows the delayed polynomial matrices $B^1(L)$ and $B^2(L)$ with U_t error terms. The c_{t-d} value represents the threshold variable. The value in the parenthesis $I(c_{t-d} > \gamma)$ is equal to 1 when it is greater than the variable γ (critical threshold) and is equal to 0 when $c_{t-d} < \gamma$. When it is equal to 1, it expresses the high regime, and when it is equal to 0, it expresses the low regime. Finally, the coefficients A^1 and A^2 reflect the structural simultaneous relationships (Balke, 2000).

$$Y_t = A^1 Y_t + B^1(L)Y_{t-1} + U_t \quad \text{if } I = 0 \quad (8)$$

$$Y_t = (A^1 + A^2)Y_t + [B^1(L) + B^2(L)]Y_{t-1} + U_t \quad \text{if } I = 1 \quad (9)$$

4. Empirical Results

In order to investigate the stationarity of the series, first of all, ADF and PP tests are used. ADF and PP unit root test results are seen in Appendix 1 and 2. According to ADF and PP test results, inflation and interest rate series are non-stationary and other series are stationary. ADF-type tests do not allow modeling regime changes or asymmetries in the economy. For this reason, researchers can obtain mixed results (Kum, 2012). Shocks in economies can cause changes in macro data. On top of that, not using structural unit root tests may cause spurious results (Narayan, 2006). On the other hand, tests that allow only one structural break are usually very restrictive (Lee and Strazicich, 2003). For this reason, the LM unit root test, which allows for two breaks, is chosen. Test results for a break at constant and break at constant and trend are shown in Tables 2 and 3.

Table 2: LM Unit Root Test Results (Breaks in Intercept)

Variables	TB_1-TB_2	k	S_{t-1}	B_{1t}	B_{2t}
lnon	2010/11 2011/09	2	-0.046 (-2.219)	-0.806 (-5.890)	-0.210 (-1.232)
lndcg	2010/11 2012/10	7	-0.998* (-5.455)	0.186 (1.709)	0.127 (1.180)
lnfcg	2007/08 2009/12	5	-0.140973* (-3.895)	-0.132 (-2.231)	0.197 (3.187)
lnout	2010/11 2013/08	7	-0.263411 (-2.804)	0.158 (1.952)	0.125 (1.528)
inf	2012/04 2016/11	7	-0.132965* (-3.694)	-0.033 (-3.270)	0.010 (1.029)

Note: S_{t-1} is the test statistic, B_{1t} and B_{2t} are the breakpoints at constant, k is the lag lengths and TB_1 and TB_2 is the break dates. t-values are indicated in parentheses. The critical values for the LM unit root test are -4.091, -3.583 and -3.328 for the significance levels of 1% 5% 10%, respectively.

Table 2 shows the results of the LM unit root test with a constant break. T_{B1} and T_{B2} represent break dates, k lag number, S_{t-1} unit root coefficient, B_{1t} and B_{2t} represent break at constant. According to the results, the null hypothesis cannot be rejected for the interest and industrial production index series, and the null hypothesis is rejected for durable consumer goods, fixed capital formations and inflation series. Therefore, the interest rate and industrial production index are not stationary with breaks, and it is concluded that durable goods, fixed capital formations and inflation series are stationary with breaks.

Table 3: LM Unit Root Test Results (Breaks in Intercept & Trend)

Variables	TB_1-TB	k	S_{t-1}	B_{1t}	B_{2t}	D_{1t}	D_{2t}
lnon	2010/11	3	-0.1776	-0.851	0.001	0.032	-0.091
	2016/09		-4.305	(-6.557)	(0.008)	(1.393)	(-2.620)
lndcg	2008/10	7	-1.34*	0.208	-0.186	-0.149	0.209
	2011/03		-6.93	(1.917)	(-1.733)	(-4.264)	(5.756)
lnfcg	2008/08	5	-0.37*	0.124	-0.056	-0.144	0.122
	2010/03		-6.44	(1.986)	(-0.903)	(-4.518)	(4.796)
lnout	2008/10	7	-0.63*	0.062	-0.258	-0.118	0.193
	2010/12		-5.65	(0.815)	(-3.255)	(-4.020)	(5.203)
inf	2009/02	7	-0.43*	0.018	-0.022	-0.009	0.025
	2018/02		-6.84	(1.883)	(-2.195)	(-3.834)	(6.009)

Note: S_{t-1} is the test statistic, B_{1t} and B_{2t} are the breakpoints at constant, D_{1t} and D_{2t} are the breakpoints at trend, k is the lag lengths and TB_1 and TB_2 is the break dates. t-values are indicated in parentheses. The critical values for the LM unit root test are -6.206, -5.638 and -5.339 for the significance levels of 1% 5% 10%, respectively.

Finally, Table 3 shows the results of the two breaks LM unit root test with a break in constant and trend. The results show that lnon has a unit root process with the break. In other variables, it is concluded that the series are stationary with a break after the null hypothesis is rejected.

In the models used in general, it is determined that there is a mortgage crisis that took place in 2008 and affected all countries. In this context, macroeconomic instabilities caused by the financial crisis can be considered as an important factor for monetary transmission as we foresee. For this reason, it is important to determine the effectiveness of the strategies so that the central bank can manage the economy with activist policy strategies in times of increased instability. On the other hand, the structural changes in the monetary policy of the central bank that emerged after the half of 2010 are effective. It is seen that these breaks, which coincide with August 2008 and April 2010, are significant.

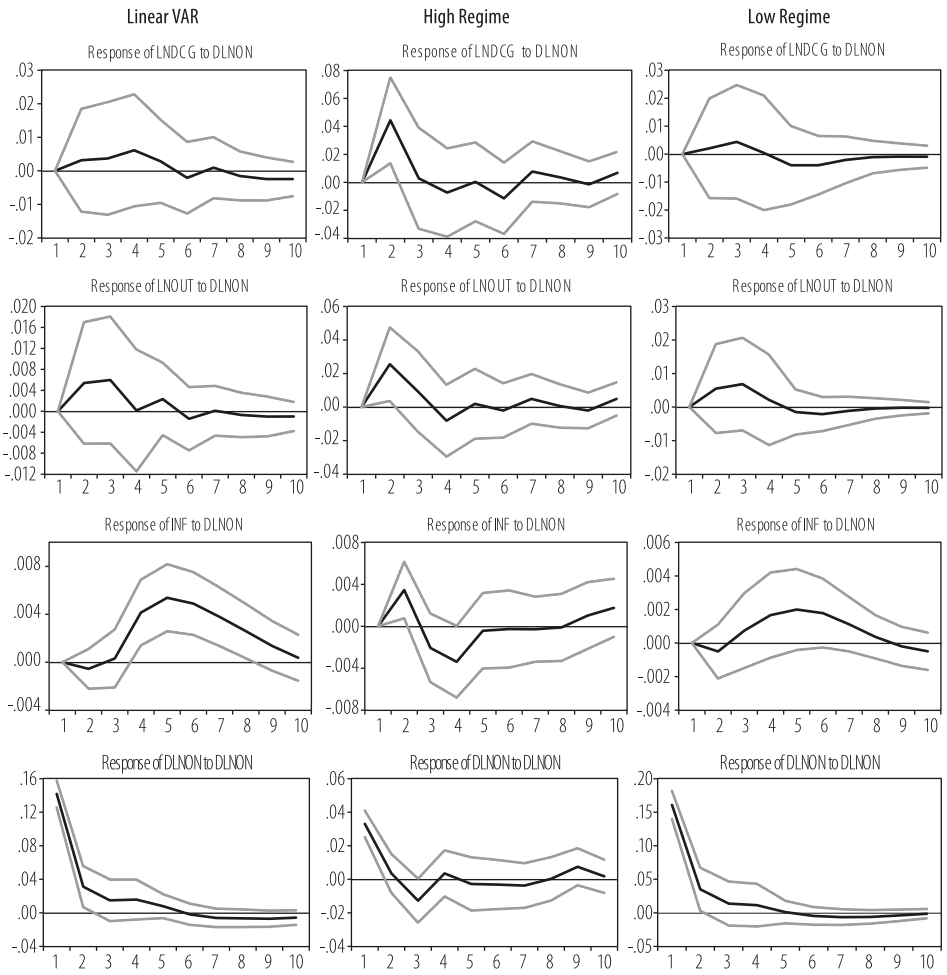
After performing ADF, PP and LM unit root tests with two structural breaks, linear and threshold VAR model were estimated. To test the presence of threshold effect, a linearity test is performed and the test result is shown in Table 7.

Table 4: Nonlinearity Test (for Eq.1)

Stats.	Test stat.	P-Values
Sup-Wald	100.08	0.000
Avg-Wald	75.16	0.040
Exp-Wald	46.25	0.000

In Table 3, the basic hypothesis stating that the model is linear is rejected and it is concluded that there are threshold effects. In Graph 1, the results of the impulse-response analysis for Eq.1 are shown.

Graph 1: Impulse-Response Results for Eq.1



According to the linear VAR results in Graph 1, expenditures and output for durable consumer goods do not respond to a shock to interest rates. However, inflation is increasing. On the other hand, according to the non-linear results, the variables do not respond to the monetary policy shock in the low regime. However, in the face of rising interest rates in the high regime, consumption ex-

penditures increase, output increases and inflation increases. In this context, it is seen that the interest rate channel is partly effective during periods of high macroeconomic stability, but the monetary policy interest rate channel is an effective policy strategy in times of increased instability. Finally, the increasing effect on inflation rates as a result of contractionary policy strategies is called the Price Puzzle (as discussed below) in the literature. The results of the linearity tests for Eq.2 are shown in table 5.

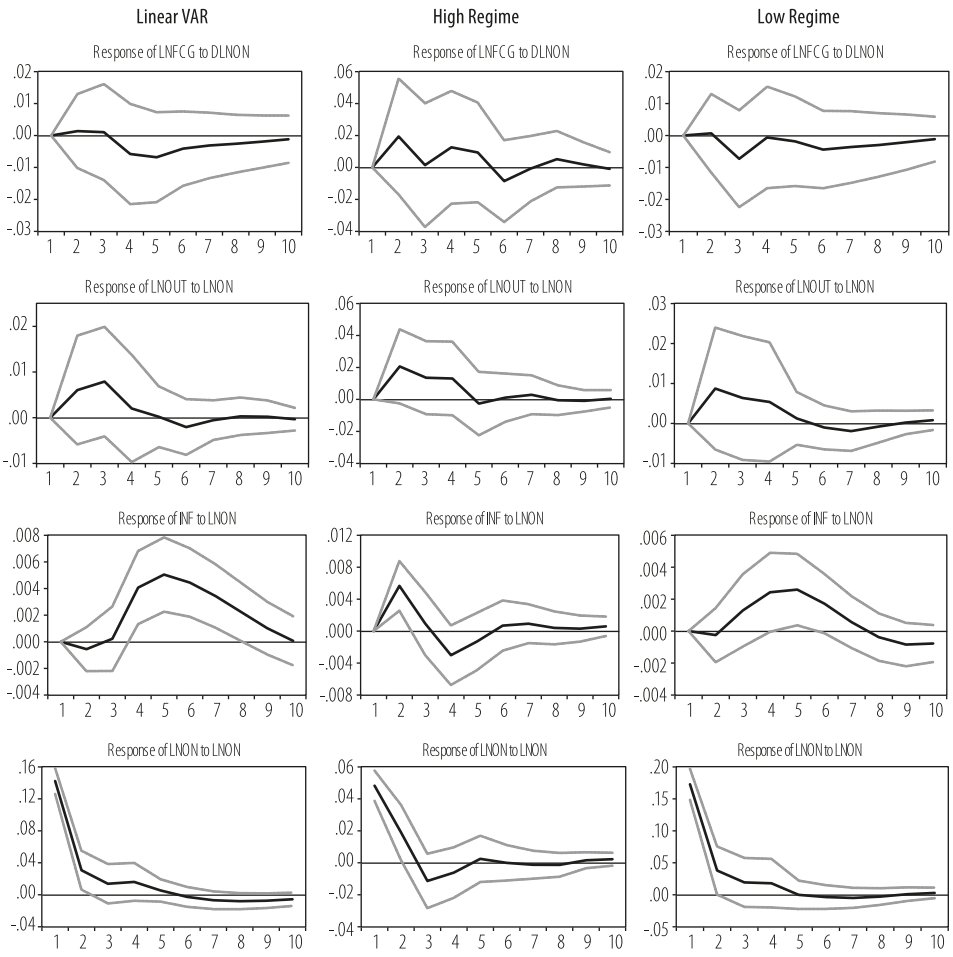
Table 5: Nonlinearity Test (for Eq.2)

Stats.	Test stat.	P-Values
Sup-Wald	146.29	0.000
Avg-Wald	101.82	0.000
Exp-Wald	69.66	0.000

In Table 5, the basic hypothesis stating that the model is linear is rejected and it is concluded that there are threshold effects. Graph 2 shows the results of the impulse-response analysis for Eq.2.

Similar to Graph 1, when the results in Graph 2 are examined, the monetary policy rate channel for the linear VAR model is only effective on inflation rates, supporting the policy ineffectiveness view. On the other hand, when nonlinear results are examined, it is seen that the results differ from Graph 1. In both high and low regimes, only inflation rates respond to the shock to the interest rate. In other words, for the model in which investment expenditures are included in the transmission process, the contractionary monetary policy only leads to an increase in inflation rates. Hence, it is concluded that the interest rate channel is partially effective for both regimes. In this context, the price puzzle phenomenon is frequently seen in the literature in the short term.

Graph 2: Impulse-Response Findings for Eq.2



4.1. Price Puzzle

Eichenbaum (1992) states that central banks tend to increase policy rates to combat high inflation. The monetarist school states that the relationship between interest and inflation may be unstable. An increase in the policy rate to combat inflation will discourage investors. On the other hand, costs will increase in the face of rising interest rates and investors will reflect the cost increases to the prices. As a result, an increase in inflation rates may occur in the face of increasing interest rates.

For this situation, it is necessary to distinguish between demand and supply-side (cost-side) inflation. Consumption costs will increase, especially in the face of an increase in interest rates, and there will be downward pressure on demand-side inflation and the shrinking demand. On the other hand, if the increase in interest rates and the production elements and prices of inputs are increasing due to non-demand reasons, it will increase costs even more and cause upward pressure on prices. Thus, the structure of inflation in the country determines the direction of the inflation response against the policy rate.

This positive correlation between the interest rate and inflation is known as the price puzzle. According to economic theory, an increase in the nominal interest rate decreases aggregate demand, which in turn causes a decrease in inflation. There are two possibilities that interrupt this negative relationship between prices and interest rate. Accordingly, an increase in the nominal interest rate may increase the demand for goods and services by lowering the real interest rate, thereby increasing inflation. The second possibility is that the monetary transmission mechanism cost channel is efficient. In this context, it is the situation that marginal production costs will be affected by interest rates if firms borrow to finance their production costs. Meanwhile, a contractionary monetary policy shock to be implemented by the central banks may increase the production costs of the firms, leading to an increase in the prices of goods and services, thus causing an increase in inflation (Ali and Anwar, 2017).

Sims (1992) revealed that contractionary monetary policy leads to an increase in inflation. Eichenbaum (1992), on the other hand, introduced the positive correlation between interest and inflation to the literature with the price puzzle concept. The important point here is the efficiency of the cost channel (Ali and Anwar, 2018). If cost-side inflation exceeds the effect of demand-side inflation, an increase in the policy rate may lead to an increase in inflation.

5. Conclusion

Central banks aim to reach their macroeconomic targets with their monetary policy strategies. In this context, it is important to determine the effectiveness of monetary policy strategies. Especially in the period after the 2001 crisis, efforts have been made to increase the independence and credibility of the central bank for Turkey and thus to increase the effectiveness of the monetary policy. Especially in the post-2008 financial crisis period, financial stability was included in the targets in addition to price stability, emphasizing the importance of macroeconomic stability. Within the scope of our study, the Turkish economy is an

important example for developing countries with its high growth potential and relatively fragile economic structure.

In this study, the interest channel effectiveness of the monetary transmission mechanism in Turkey was examined using monthly data for the period 2006:03-2019:06. The year 2006, when Turkey switched to the explicit inflation targeting regime that has been started to implement in the post-2001 crisis period, is accepted as the starting year. This is due to the drastic change in monetary policy. Within the scope of investigating the efficiency of the interest channel, interbank overnight interest rates, durable consumer goods, fixed capital formations, industrial production index and inflation series are used with linear and nonlinear VAR models.

According to the results of the linearity analysis, the linearity assumption is rejected for both models (consumption expenditures mediate the transmission in Eq.1 and investment expenditures mediate the transmission in Eq.2). On the other hand, the results of linear and nonlinear impulse response functions obtained for Eq.1 and Eq.2 differ from each other. In the linear VAR model results, we cannot find any evidence to prove the effectiveness of the interest rate channel for the Turkish economy. The linear model results show that policy rate changes only have an effect on inflation.

According to the results obtained from the Threshold VAR method, the results of the equations using Eq.1 and Eq.2 vary. First of all, the interest rate channel is partially effective for Eq.1 in the low regime. In the high regime, consumption expenditures and on the other hand, an increase in output, occur in the face of the contractionary monetary policy shock. Mukhtarov and Aliyev (2014) emphasize that the incentive policies given by policymakers for consumption expenditures may lie behind this increase in consumer goods. Since durable goods consumption is a component of the industrial production index, the correlation between the increase in durable goods consumption and the increase in industrial production is significant.

The interest channel with investment expenditures transmission is partially effective in both low and high regimes. The fact that fixed capital formations do not respond to interest rate shocks indicates that it cannot affect investments with the central bank policy rate. As a factor here, investments may be excluded as a result of policy makers' interest rate hikes during the domestic borrowing process (see Şen and Kaya, 2014; Uysal and Mucuk, 2003; Kesbiç, Dündar and Devrim, 2016). Another important factor is that investors make investment decisions based on their instincts (expectations), as Keynes emphasized, instead of interest. In this

context, instead of interest rate developments, the future expectations of entrepreneurs can be the main determinant of investment decisions. In this case, investment expenditures are not able to react to an increase (decrease) in interest.

As a result, it is seen that monetary policy is an effective tool that can be used in the high regime in economic management through the interest rate channel. An important point here is that the threshold value for inflation is 10%. In this context, it has been seen that the interest rate channel can be used as an effective tool in periods when inflation exceeds 10%, but it is a partially effective tool at low inflation levels.

Another important result obtained from the study is the rise in inflation in the face of contractionary monetary policy. This situation is called the price puzzle phenomenon in the literature. Especially if cost-driven inflation rates are more effective than demand-side inflation rates, inflation rates also increase in the face of an increase in the policy rate. This finding is consistent with previous studies (Doğan, 2012; Berument, 2007; Berument and Dinçer, 2008; Çatık and Karaçuka, 2012).

The limitation of this study is, first of all, that the analysis period is relatively limited. Since there was a significant change in monetary policy (inflation targeting), the starting year of the study is 2006. The study can be renewed by increasing the time dimension of the data set. On the other hand, the same study can be done again for the period after 2010, when the effects of the global financial crisis intensified with an increase in the working time dimension.

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Appendix

Appendix 1: PP Unit Root Test Results

		Variables				
		LNON	LNDCG	LNFCG	LNOUT	INF
With Constant	t-statistic	-1.707	-3.723	-2.581	-2.775	-1.890
	p value	**0.425**	**0.004**	**0.098**	**0.064**	**0.336**
With Constant & Trend	t-statistic	-1.621	-8.342	-2.574	-7.588	-2.326
	p value	**0.780**	**0.000**	**0.292**	**0.000**	**0.416**
Without Constant & Trend	t-statistic	-0.266	0.966	-0.260	0.895	-0.215
	p value	**0.588**	**0.911**	**0.591**	**0.900**	**0.607**
		First Difference				
		d(LNON)	d(LNDCG)	d(LNFCG)	d(LNOUT)	d(INF)
With Constant	t-statistic	-9.691	-41.751	-13.503	-35.311	-9.111
	p value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
With Constant & Trend	t-statistic	-9.682	-41.616	-13.467	-34.719	-9.068
	p value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
Without Constant & Trend	t-statistic	-9.718	-38.507	-13.536	-29.082	-9.145
	p value	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**

Note: *, **, *** show the statistical significance of the variables at the levels of 10%, 5%, and 1%, respectively.

Appendix 2: ADF Unit Root Test Results

		Variables				
		LNON	LNDCG	LNFCG	LNOUT	INF
With Constant	t-statistic	-1.696	-1.013	-2.963	-1.024	1.070
	p value	**0.431**	**0.747**	**0.040**	**0.743**	**0.997**
With Constant & Trend	t-statistic	-1.637	-2.326	-2.971	-3.076	0.464
	p value	**0.773**	**0.416**	**0.143**	**0.116**	**0.999**
Without Constant & Trend	t-statistic	-0.268	1.683	-0.464	0.900	1.237
	p value	**0.587**	**0.977**	**0.512**	**0.901**	**0.944**
		First Difference				
		d(LNON)	d(LNDCG)	d(LNFCG)	d(LNOUT)	d(INF)
With Constant	t-statistic	-9.615	-4.430	-5.778	-2.527	-5.465
	p value	**0.000**	**0.000**	**0.000**	**0.111**	**0.000**
With Constant & Trend	t-statistic	-5.970	-4.430	-5.777	-2.502	-6.218
	p value	**0.000**	**0.002**	**0.000**	**0.326**	**0.000**
Without Constant & Trend	t-statistic	-9.642	-4.049	-5.786	-2.357	-5.337
	p value	0.000	0.000	0.000	0.018	0.000

Note: *, **, *** show the statistical significance of the variables at the levels of 10%, 5%, and 1%, respectively.