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INTEREST RATE PASS-THROUGH IN TÜRKİYE: EVIDENCE OF THE MONETARY POLICY APPROACH

Türkiye'de Faiz Oranı Geçişkenliği: Para Politikası Yaklaşımından Kanıtlar

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Keywords:
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Abstract

Central banks direct banks' rates by increasing or decreasing policy rates through the interest rate channel. The effectiveness of this channel is related to the interest rate pass-through. The pass-through of interest rates indicates the impact of changes in policy rates on the retail rates of banks. Pass-through is not only a prerequisite for the monetary transmission mechanism but also is the first stage of it. A complete and quick pass-through increases the effectiveness of the interest rate channel. This paper focuses on the monetary policy approach and uses the ARDL and NARDL models to analyze the relationship between the policy rate and the lending rate in order to test the interest rate pass-through for Türkiye. To enable a comparison of the degree of pass-through and the speed of adjustment, this paper focuses on two time periods: 2011:01–2016:12 and 2017:01–2023:10. The findings of the paper indicate that there are three shreds of evidence for the interest rate pass-through in Türkiye. It is symmetric for both periods. The level of pass-through in the initial period exceeds that of the subsequent period. The rate of adjustment in the second period is faster than in the first one.

Anahtar Kelimeler:
Faiz Oranı Geçişkenliği,
Türkiye,
ARDL,
NARDL

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Öz

Merkez bankaları, faiz kanalı yoluyla politika faizlerini artırarak veya azaltarak bankaların faiz oranlarını yönlendirmektedir. Faiz kanalının etkinliği, faiz geçişkenliğine bağlı bulunmaktadır. Banka faiz oranlarının politika faiz oranlarındaki değişikliklere verdiği tepkiyi gösteren faiz geçişkenliği, parasal aktarım mekanizmasının sadece önkoşulunu değil, aynı zamanda ilk aşamasını oluşturmaktadır. Geçişkenliğin tam ve hızlı olması ise faiz kanalının etkinliğini artırmaktadır. Türkiye'de faiz geçişkenliğini, para politikası yaklaşımı çerçevesinde test eden bu çalışma, ARDL ve NARDL modellerini kullanarak politika faiz oranı ile kredi faiz oranı arasındaki ilişkiye odaklanmaktadır. Çalışma, faiz geçişkenliğinin derecesini ve ayarlanma hızını karşılaştırabilmek için iki dönemi (2011:01-2016:12 ve 2017:01-2023:10) esas almaktadır. Çalışmanın sonuçları, üç kanıtı ortaya koymaktadır. Türkiye'de faiz geçişkenliği her iki dönem için de simetriktir. Birinci dönemdeki geçişkenlik derecesi ikinci döneme göre daha yüksektir. Geçişkenliğin ayarlama hızı, ikinci dönemde, birinci döneme göre daha hızlıdır.

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1. Introduction

The monetary policy transmission mechanism is the process by which monetary policy decisions affect the economy and the price level through various channels. The interest rate channel, also known as the traditional Keynesian interest rate channel, is one of the channels of the transmission mechanism. As the central bank has the power to issue money, it also has the authority to set short-term nominal interest rates, such as policy rates. The change in the short-run nominal policy rates affects the long-run real money market rate and long-run real banks' rates (lending and deposit rates). The savings and investment decisions of firms and households are impacted by changes in deposit and lending rates. For instance, borrowing money for investment and consumption becomes more attractive when lending rates are lower. The amount of investment and consumption influences the aggregate demand and total output. When everything else is equal, increased investment and consumption lead to an increase in demand and output (CBRT, 2013: 5; ECB, 2024). Two stages exist in the interest rate channel: the pass-through from short-run nominal rates to long-run real rates, followed by the transmission of real rates to aggregate demand and production (Égert and MacDonald, 2008: 8).

Interest rate pass-through is the process by which the policy rate affects the other rates. It shows the speed and degree of the effect of policy rates on market rates and retail bank rates (Tai et al., 2012: 164). Interest rate pass-through is delineated through three distinct approaches within the existing literature: the "Monetary Policy Approach," the "Cost of Funds Approach," and the "Unifying Approach."(see Figure 1.).

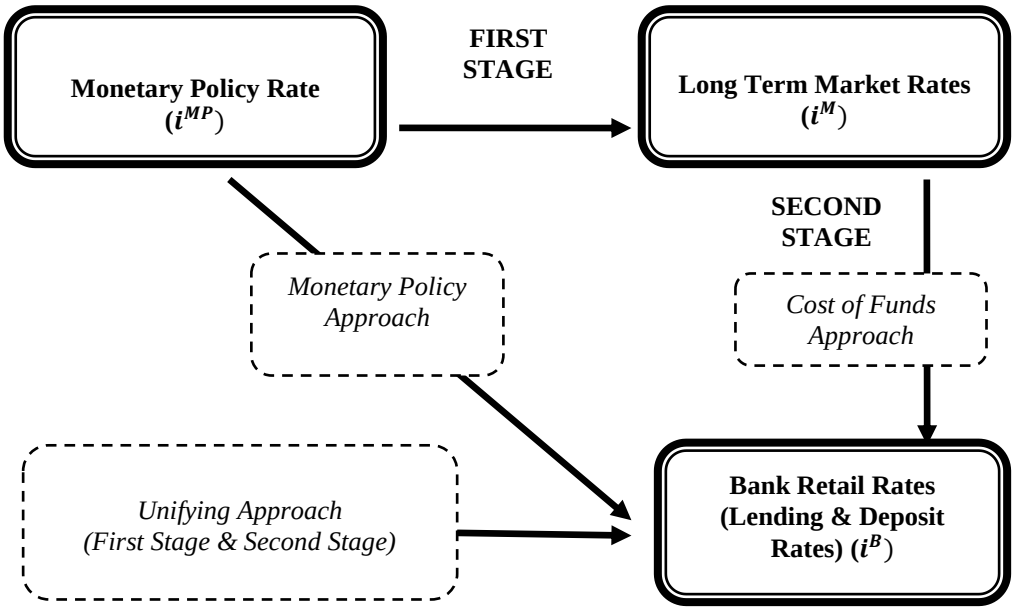

Figure 1. The Approaches Explaining Interest Rate Pass-Through
Source: Égert and MacDonald (2008).

The Monetary Policy Approach ($\boldsymbol{i^{MP} \rightarrow i^{B}}$) deals with the effect of monetary policy on bank's rates and does not include any other explanatory variables. This approach focuses only on the pass-through from the policy rates to the bank's retail rates (Samba and Yan, 2010: 32). It is

possible to look directly at the pass-through between policy rates and the bank's rates under the assumption of a stable yield curve. This assumption allows us to test the pass-through by taking a shortcut (Crespo-Cuaresma et al., 2006: 91).

The Cost of Funds Approach ($\boldsymbol{i^M \rightarrow i^B}$) comprises the second stage of the pass-through (Doojav and Kalirajan, 2016: 277). This approach is supported by the marginal cost pricing model developed by Rousseas (1985) and De Bondt (2005). The Cost of Funds Approach focuses on the decision of setting prices of the banks while revealing the impact of changes in market rates on deposit and lending rates. The cost of funds refers to two meanings for the banks in terms of deposits and loans. While the cost of funds indicates the financing costs for deposits, it indicates the opportunity costs for loans (Samba and Yan, 2010: 32). Short-run money market rates may directly affect long-run market rates according to this approach (Doojav and Kalirajan, 2016: 277).

The Unifying Approach [($\boldsymbol{i^{MP} \rightarrow i^M}$) & ($\boldsymbol{i^M \rightarrow i^B}$)] includes two stages. While the policy rate is transmitted to market rates in the first stage, there is a pass-through from market rates to bank's retail rates in the second stage as may be seen in Figure 1 (Égert and MacDonald, 2008: 10).

The speed and degree of pass-through may be influenced by many factors sorted as follows: macroeconomic conditions, monetary policy operations and the structure of the financial system.

Macroeconomic Conditions: Rapid economic growth has a positive impact on pass-through, however economic contraction has a negative impact. An increase in uncertainty in the economy negatively affects expectations and thus slows down the pass-through. High levels of public debt affect the pass-through negatively (Cavusoglu, 2010: 31-32).

Monetary Policy Operations: Expected and unexpected changes in the policy rates may affect the pass-through variously. Banks are adept at adapting to anticipated changes, but they are less agile when it comes to unforeseen changes. The speed and degree of pass-through also vary depending on whether the change of policy rate is permanent or temporary. Banks just want to adapt to permanent changes due to the adjustment costs (Bredin et al., 2002: 225-226).

Structure of the Financial System: The pass-through may be affected by various factors within the framework of the structure of the financial system, such as competition/concentration, asymmetric information, and adjustment costs. If *competitio*n is low in the banking market, banks may trade with high-profit margins and may adapt slowly and incompletely to changes in policy rates. The competition among banks is measured by the *concentration*. If the concentration of the banking market is high, competition among the banks decreases, and thus interest rate pass-through weakens, slows down, and becomes asymmetric (Égert and MacDonald, 2008: 10). *Asymmetric information* affects the pass-through negatively because the expansion of the cost of asymmetric information increases the funding costs for banks. Banks transmit this increase to their customers by increasing the lending rates. An increase in lending rates may lead to two problems: Adverse Selection and Moral Hazard. If banks increase the lending rates, they may have to choose high-risk and dishonest customers (Adverse Selection) or investors may invest in risky projects (Moral Hazard). Since these problems may increase the credit risk of banks, the expected return of banks may decrease. In this situation, banks adjust lending rates below market rates and ration loan supply.However, credit rationing causes upward rigidity for lending rates. On the other hand, if banks do not ration the supply of credit, upward rigidity may not be valid

for lending rates. It can be assumed that banks lend to two classes of borrowers: riskless borrowers and risky borrowers. Adverse selection and moral hazard cause an increase in lending rates for risky borrowers. In such a situation, transmission from policy rate to lending rates is complete for the riskless borrowers. However, for risky loans, banks need to increase the lending rates by a rate higher than the increase of policy rate to compensate for the probability of default (De Bondt, 2002: 8-10). If policy interest rates change too often, banks do not want to change interest rates often due to *adjustment costs*. In such economic conditions, banks prefer to change other elements of lending or deposit agreements instead of changing interest rates (Cavusoglu, 2010: 31-46).

In short, such conditions as follows support fast and symmetric pass-through: complete and symmetric information, high competition, suitable macroeconomic conditions, expected and permanent changes in the policy rates. If these conditions do not exist in the banking market and the economy as a whole, the policy rate may not adjust to the banks' rates in the same direction and at the same level. In such a situation defined as asymmetric pass-through, the bank's rates may be sticky for upward or downward changes in the policy rate (Uslu and Karahan, 2016: 672). The level of pass-through is so important for the success of monetary policies. An incomplete, asymmetric and slow pass-through may cause a failure of monetary policy and may affect negatively the decisions of economic units about investment, savings, and consumption. On the other hand, if the long-run pass-through is high, fast, and complete, the interest rate channel is effective. A fast, symmetrical and complete pass-through creates an efficient, and well-functioning financial system (Tai et al., 2012: 163-164).

The Central Bank of the Republic of Türkiye (CBRT) had implemented a monetary policy that included a single target (price stability) and a single instrument (short-run rates) until 2010. As the 2008 Global Crisis made it clear that financial stability should not be ignored, the CBRT turned to unconventional monetary policies. The CBRT adopted multiple targets, such as keeping credit volume at reasonable levels and preventing exchange rate volatility (financial stability), in addition to price stability (CBRT, 2024). Since short-run interest rates were not sufficient to achieve these targets, the CBRT started to use additional instruments such as the interest rate corridor, reserve requirements, liquidity management, reserve option mechanism, and the 1-week repo rate to diversify its instruments. For managing liquidity, the CBRT used the 1-week repo rate and the overnight lending rate, which is the upper band of the interest rate corridor, to fund the market. The using of these rates led to the emergence of a new concept known as the weighted average funding cost. The weighted average funding cost represents monetary policy and is expected to play an effective role in the monetary transmission mechanism (Buberkoku and Kizilder, 2019: 219-220).

Based on this, interest rate pass-through is an important research topic in terms of demonstrating the success or failure of monetary policy. The present study tests the pass-through in Türkiye within the framework of the Monetary Policy Approach by using Autoregressive Distributed Lag (ARDL) and Nonlinear ARDL (NARDL) models for two periods (2011:01-2016:12 and 2017:01-2023:10). Testing two periods and comparing the results of these periods with ARDL and NARDL models make this study different from other studies that analyze Türkiye. The weighted average funding cost is preferred as an independent variable. It is also preferable to use the commercial loan interest rate as a dependent variable since bank loans are crucial for both price stability and financial stability. This study tries to find answers to two questions: 1. Is there a one-to-one pass-through for Türkiye? If there is not, what can be said about the degree and speed of it? Is it complete or incomplete? Is it fast or slow? Is the pass-through

symmetric or asymmetric? 2. What are the differences/similarities between the empirical results of the first period and the second period? The study consists of three parts following the introduction section each aimed at answering specific questions. The second section provides the literature review while the third section introduces the model, dataset and methodology. Empirical findings are presented in the fourth section. The conclusion includes policy recommendations for complete and efficient pass-through.

2. Literature Review

The studies test interest rate pass-through are divided into three groups. The studies in the first group perform the analysis with a monetary policy approach, while those in the second group are based on the cost of fund approach. The studies in the last group are tested with the unifying approach. Although the pass-through between the policy rate and money market rate is mostly complete or close to complete according to the results of the studies, the pass-through from the policy rate/the money market rate to the bank's retail rates is usually incomplete. Empirical studies often test a single country, but it is also common to analyze multiple countries. The interest rate pass-through is an important topic for Türkiye as well as for all other countries. Just two of the studies evaluating Türkiye apply the ARDL model. Both studies are based on a single period. No study applying the NARDL model has tested Türkiye. The ARDL and NARDL models are applied in this study to examine the interest rate pass-through over two periods to see if there are any differences. This study differs from other research on Türkiye due to this circumstance. Table 1 provides a review of the empirical literature.

Table 1. Related Studies

Author	Country	Period	Variables	Method	Result
Bredin et al. (2002)	Ireland	1980:01-2001:03	Money Market Rate (MMR), Lending Rate (LR)(Mortgage, Consumer, Firm), Prime Rate	Johansen Cointegration Test, Error Correction Model (ECM)	Pass-through from MMR to LR is not complete. The highest speed of adjustment is valid for prime rates.
De Bondt (2002)	Euro Area	1996:01-2001:05	MMR, Government Bond Yield (GBY), Deposit Rate (DR), LR	Vector Autoregressive (VAR), Impulse Response, ECM	Pass-through within one month from MMR to LR/DR is incomplete. Pass-through of LR is almost complete for the long run.
Sander and Kleimeier (2003)	Euro Area	1993:01-2002:10	O/N MMR, Interbank Rate, GBY, LR, DR	VAR, Threshold Autoregressive (TAR)	Pass-through is high for the monetary policy rate.
Crespo-Cuaresma et al. (2004)	Czech Republic, Hungary, Poland	1994:01-2002:12	Interbank MMR, GBY, LR, DR	ARDL	Although the pass-through is complete for Poland, it is incomplete for the Czech Republic and Hungary.

Table 1. Continued

Horváth et al. (2004)	Hungary	1997:01-2004:04 2001:05-2004:04	MMR, LR (Hausehold and Corporate) DR	ECM, TAR, Panel Regression	Pass-through from MMR to corporate rate is complete and quick. The adjustment of DR and household rates is incomplete and sluggish.
Amarasekara (2005)	Sri Lanka	1996:06-2004:12	Repo & Reverse Repo Rates, Open Market Operation (OMO) Rates, Call MMR, LR, DR	Granger Causality Test, Simple Linear Regressions, Engle Granger (EG) and Johansen Cointegration Tests, ECM	Pass-through from PR to call MMR is almost complete. Pass-through from call MMR to LR and DR is sluggish and incomplete except for the prime rates. Commercial bank's rates adapt symmetrically.
Humala (2005)	Argentina	1993:06-2000:12	MMR, LR (Overdrafts, Bills, Personal Loans)	EG and Johansen Cointegration Test, VAR/VECM, Markov Switching (MS) VAR/VECM	There is a high stickiness for high-risk loans.
Kwapil and Scharler (2006)	Euro Area and United States	1995:01-2003:09	MMR, LR (Household, Mortgage, Business), DR	ARDL	Pass-through is less complete in the Euro Area than in the U.S. for DR and LR.
Sørensen and Werner (2006)	Euro Area	1999:01-2004:06	PR, LR (Corparate, Consumer, Mortgage), DR (Current Account, Time)	Pedroni Cointegration Test, ECM	Pass-through is the highest for mortgages and lowest for current account deposits.
Aydin (2007)	Türkiye	2001:06-2005:09	MMR, LR (Vehicle, Corporate, Consumer, Mortgages)	Westerlund Cointegration Test, Hausman Test	Pass-through of household loans is higher compared to corporate loans.
Von Borstel (2008)	Germany, Euro Area	2003:01-2007:09	MMR, LR (Household, Overdraft, Consumer, Hausing, Corparate), DR (Time, Savings)	VAR, Johansen Cointegration Test, VECM	Although pass-through from MMR to time DR, corporate rates and housing rates is fast, it is sluggish for the consumer rate and saving DR.
Maskay and Pandit (2010)	Nepal	1990:Q1-2009:Q4	PR, DR, LR, Saving Rate	EG and Johansen Cointegration Tests, ECM	PR is ineffective for the retail rates.
Cavusoglu (2010)	Türkiye	2002:01-2009:12	PR, LR (Vehicle, Commercial, Consumer, SME, Mortgages), DR	VAR, ECM	Although the degree of pass-through is high for LR, the speed of adjustment is high for DR. Pass-through of consumer loans is higher and faster compared to commercial loans.

Table 1. Continued

Belke et al. (2012)	European Monetary Union 12 Countries	2003:01-2011:09	MMR, LR	ARDL, Johansen Cointegration Test	Pass-through is incomplete.
Hanif and Khan (2012)	Pakistan	2001:07-2011:08	PR, MMR, DR, LR	ARDL	Pass-through from PR to MMR is swift. Pass-through from MMR to DR is sluggish and incomplete. LRs are more sensitive to changes in MMR compared to the DR.
Tai et al. (2012)	6 Asian Countries	1988:01-1997:06	MMR, DR, LR	Generalized Least Square (GLS), Ordinary Least Squares (OLS)	Pass-through from MMR to DR/LR is slow and sluggish.
Sahin et al. (2013)	Türkiye	2002:01-2012:08	PR, LR (Vehicle, Commercial, Consumer, Mortgages)	VAR, Variance Decomposition, Impulse Response, Granger Causality Test	Pass-through from PR to LR is incomplete.
Yuksel and Metin Ozcan (2013)	Türkiye	2001:12-2011:04	PR, LR (Cash, Vehicle, Housing, Commercial)	TAR, Momentum TAR (MTAR)	Pass-through is symmetric, complete and significant.
Doojav and Kalirajan (2016)	Mongolia	2002:12-2015:09	MMR, LR, DR	ARDL, NARDL	Pass-through of the DR is higher than LR. Adjustment of DR is slower compared to LR. Although the pass-through is negatively asymmetric for LR, it is positively asymmetric for DR.
Uslu and Karahan (2016)	Türkiye	2002:01-2014:12	BIST Interbank O/N Rate, LR (Vehicle, Commercial, Consumer, Mortgages)	ARDL, Kalman Filter	The highest pass-through is valid for consumer loans.
Grigoli and Mota (2017)	Dominican Republic	2006:06-2015:06	PR, DR, LR (Commercial, Mortgage, Consumer)	ARDL, TAR, MTAR	Pass-through of LR is faster compared to DR. Adjustments of short-run rates are asymmetric.
Ugur and Bingol (2018)	Türkiye	2002:01-2016:12	PR, LR (Vehicle, Commercial, Consumer, Mortgages)	Toda Yamamota and Frequency Domain Causality Tests	There is a causality from PR to LRs except for vehicle rate.
Buberkoku and Kizilder (2019)	Türkiye	2011:01-2017:09	The CBRT Average Funding Cost (AFC), BIST Interbank O/N Rate, DR, LR (Vehicle, Commercial, Consumer, Mortgages),	Gregory-Hansen Cointegration Tests	CBRT AFC is more influential than BIST Interbank O/N Rate on LR and DR.

Table 1. Continued

Sahin (2019)	Türkiye	2002:01-2018:04	The CBRT AFC, O/N Simple Rate, LR (Personal, Vehicle, Commercial, Consumer, Housing), DR	EG and Johansen Cointegration Test, VECM, Nonlinear VECM	Pass-through of DR is higher compared to LR. There is a symmetric relationship and correct transmission for all variables.
Bulut (2020)	Türkiye	2011:01-2019:06	BIST Interbank O/N Rate, LR (Consumer, Commercial)	Gregory-Hansen and Tsong Cointegration Tests	Pass-through is almost complete.
Guler (2021)	Türkiye	2013:01-2018:11	CBRT O/N Lending, One Week Repo Rates, CBRT AFC and BIST Interbank O/N Rate, LR, DR	GMM	LR and DR are more sensitive to CBRT AFC and BIST Interbank O/N Rate
Salihoglu and Hepsag (2021)	Türkiye	2011:01 01-2021:22 01	CBRT AFC, BIST Interbank O/N Rate, LR, DR	Residual Augmented Least Squares (RALS)	The Pass-through from BIST Interbank O/N rate to LR and DR is higher than the pass-through of CBRT AFC.
Ozsoy Calis et al. (2022)	Türkiye	2020-2021 weekly data	BIST O/N Repo Rate, LR (Vehicle, Commercial, Consumer, Mortgages)	Granger Causality Test	There is a causality relationship only between the BIST O/N Repo rate and vehicle loans.
Gunes (2022)	Türkiye	2012:06 01-2022:28 01	The CBRT AFC, LR (Vehicle, Commercial, Consumer, Mortgages), DR	VAR, Variance Decomposition, Impulse Response	Pass-through of DR is higher compared to LR.
Jorayev and Yildiz (2022)	Türkiye	2010:05-2021:03	PR, LR (Commercial), DR	ARDL	LR and DR adapt to changes in the PR slowly.
Ojaghlou and Kaya Soztanaci (2022)	Türkiye	2002:01-2021:03	CBRT Discount Rate, LR, DR, MMR, Treasury Bill Rate, GBY	Bayesian VAR	Pass-through between the CBRT discount rate and LR is complete.
Oyadeyi (2022)	Nigeria	2006:12-2020:12	PR, MMR, DR, LR	Mean Adjustment Lag, ECT	Although short run pass-through from PR to MMR is incomplete, the long run process over-shoots. Pass-through from MMR to LR and DR is weak and incomplete.
Herlambang et al. (2023)	Indonesia	1990:03-2017:02	MMR, LR	NARDL	There is an upward rigidity in the overall period.

3. Dataset, Model and Methodology

This study analyzes the interest rate pass-through for Türkiye with a monthly dataset and two periods (2011:01-2016:12 and 2017:01-2023:10). The analysis started with 2011:01 because the dataset of the independent variable was accessible by this year and month. The analysis was based on two periods to understand the pass-through better because the policy rate was relatively stable in the first period of the analysis, while fluctuation increased in the second period (see Figure 2). This situation may differentiate the degree and speed of pass-through. Therefore, it is useful to test these periods separately to prove the difference. Additionally, comparing two periods allows for an analysis of their symmetry/asymmetry, degree, and speed.

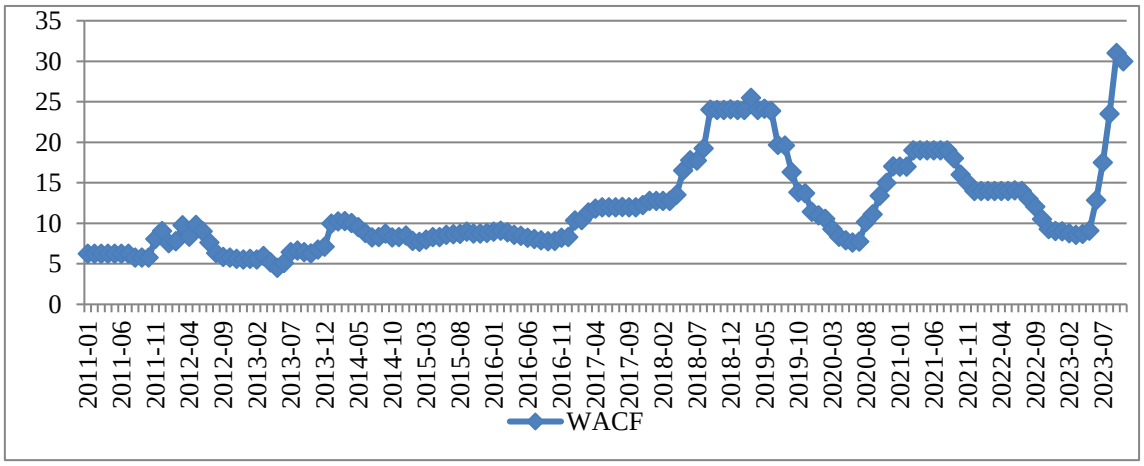

Figure 2. The Weighted Average Funding Cost of the CBRT

Since the policy rate may affect both the money market rate and bank's retail rate, this study prefers to look at the pass-through using a shortcut. Thus, the study focuses on the Monetary Policy Approach. This study represents the policy rate using the weighted average funding cost (WACF) of the CBRT as an independent variable similar to Buberkoku and Kizilder (2019), Sahin (2019), Guler (2021), Salihoglu and Hepsag (2021), and Gunes (2022). This study also adds the weighted average interest rate of banks' commercial loans (IRCL) as a dependent variable to represent the lending rate, or bank retail rate, similar to other studies such as Cavusoglu (2010), Sahin et al. (2013), Yuksel and Metin Ozcan (2013), Uslu and Karahan (2016), Grigoli and Mota (2017), Ugur and Bingol (2018), Buberkoku and Kizilder (2019), Sahin (2019), Bulut (2020), Ozsoy Calis et al. (2022), Gunes (2022), Jorayev and Yildiz (2022). The CBRT Electronic Data Delivery System is the source of the dataset (CBRT, 2023).

Equation (1) shows the model that tests the interest rate pass-through of Türkiye. The degree of the pass-through is indicated by β_1. The Monetary Policy Approach states that β_1 should theoretically have a positive sign.

$$IRCL_t = \beta_0 + \beta_1 WACF_t + \varepsilon_t \quad (1)$$

$(\beta_1 = 1) \rightarrow$ There is a complete, strong and symmetrical pass-through. The condition of commercial loan market is competitive.

$(\beta_1 < 1)$ → There is an incomplete and weak pass-through. The condition of commercial loan market is non-competitive. Weak competition may indicate that banks have some degree of market power. The other factor that can explain the incomplete pass-through is asymmetric information. If banks ration the amount of credit supply due to the asymmetric information, β_1 may take on a value less than 1. There are many factors that may cause incomplete pass-through except market power and asymmetric information. These factors are given as follows: economic contraction, an increase in uncertainty, a high level of public debt, temporary and unexpected changes in policy interest rates, and adjustment costs.

$(\beta_1 > 1)$ → If banks do not ration the supply of credit against asymmetric information problems and they prefer to increase lending rates, β_1 may take on the value higher than 1 (De Bondt, 2002: 8-10; Bulut, 2020: 20; Salihoglu and Hepsag, 2021: 46).

This study analyses the interest rate pass-through by applying ARDL and NARDL models. The ARDL model developed by Pesaran et al. (2001) has a better performance in testing for cointegration in small samples. Time series do not need to be cointegrated in the same order, unlike other traditional cointegration tests. In other words, the ARDL model makes it possible to test for cointegration with I(0) and I(1) variables. However, any variable should not definitely be I(2) (Doojav and Kalirajan, 2016: 277).

Firstly, cointegration between the variables is tested with the ARDL Bound Test and Equation 2 is estimated.

$$\Delta IRCL_t=\alpha_0+\theta_1 IRCL_{t-1} + \theta_2 WACF_{t-1} + \sum_{i=1}^{p} \beta_1 \Delta IRCL_{t-i}+ \sum_{i=0}^{p} \gamma_1 \Delta WACF_{t-i}+\varepsilon_t \quad (2)$$

It is necessary to determine the suitable lag length using Information Criterion such as Akaike (AIC), Schwarz (SC) or Hannan-Quinn (HQ) based on the VAR model for the estimation. ARDL model in Equation 3 is used for the estimation of long-run coefficients.

$$IRCL_t = \beta_0 + \sum_{i=1}^{p} \varphi_1 IRCL_{t-i} + \sum_{i=0}^{q} \gamma_1 WACF_{t-i}+ v_t \quad (3)$$

Error Correct Model (ECM) based on the ARDL is presented in Equation 4, and it is used to test short-run effects. EC_{t-1} refers to adaptation for long-run. The coefficient of EC_{t-1} is expected to be statistically significant and negative.

$$\Delta IRCL_t= \beta_0 + \sum_{i=1}^{p} \varphi_1 \Delta IRCL_{t-i}+ \sum_{i=0}^{q} \gamma_1 \Delta WACF_{t-i}+\rho(EC_{t-1})+\varepsilon_t \quad (4)$$

The NARDL model developed by Shin et al. (2013) has the same advantage as the ARDL model in capturing any cointegrating relation (Herlambang et al., 2023: 5). The NARDL model also allows to determine the nonlinear cointegration, linear cointegration or absence of cointegration (Doojav and Kalirajan, 2016: 277). Asymmetric cointegrating regression in Equation 5 is used for testing pass-through.

$$IRCL_t = \beta^+ WACF_t^+ + \beta^- WACF_t^- + u_t \quad (5)$$

β^+ and β^- represent long-run parameters. The partial sum processes of positive and negative changes in the WACF are separated as shown in Equation 6 and Equations 7.

$$IRCL_t^+ = \sum_{j=1}^{t} IRCL_j^+ = \sum_{j=1}^{t} \max(IRCL_j, 0) \quad (6)$$

$$IRCL_t^- = \sum_{j=1}^{t} IRCL_j^- = \sum_{j=1}^{t} \max(IRCL_j, 0) \quad (7)$$

Equation 5 is indicated in the asymmetric EC form in Equation 8.

$$IRCL_t = \alpha + \rho IRCL_{t-1} + \theta^+ WACF_{t-1}^+ + \theta^- WACF_{t-1}^- + \sum_{j=1}^{p-1} \gamma_j IRCL_{t-j} + \sum_{j=1}^{q-1} (\varphi_j^+ WACF_{t-j}^+ + \varphi_j^- WACF_{t-j}^-) + \varepsilon_t \quad (8)$$

The asymmetric long-run relationship is tested with $\rho = \theta^+ = \theta^- = 0$ based on Equation 8. If there is a long-run relationship, it is tested whether the asymmetric long-run parameters (β^+, β^-) $-\theta^+/\rho$, $-\theta^-/\rho$ are equal to each other. The asymmetric short-run relationship is tested in two ways: strong and weak form. The equality between the positive and negative short- run parameters that in the same lag length ($\varphi_j^+ = \varphi_j^-$) is tested with the Wald Test in order to determine the strong asymmetry. The equality between the sum of positive short-run parameters and the sum of negative short-run parameters ($\sum_{j=1}^{q-1} \varphi_j^+ = \sum_{j=1}^{q-1} \varphi_j^-$) is tested with the Wald Test for determining the weak asymmetry (Malik et al., 2020: 8; Icen, 2021: 9-11).

4. Empirical Results

4.1. Results of First Period: (2011:01-2016:12)

This study applied the Dickey-Fuller Unit Root Test (DF), Augmented Dickey-Fuller Unit Root Test (ADF), and Philips-Perron Unit Root Test (PP) to check the stationarity of the series (Dickey and Fuller, 1979; Dickey and Fuller, 1981; Phillips and Perron, 1988). The empirical results in Table 2 show that dependent and independent variables were I(1). Since none of the series were I(2), the study applied the ARDL and NARDL models.

Table 2. Unit Root Tests: (2011:01-2016:12)

Variable	DF		ADF		PP		Status
	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	
IRCL	(-1.26)	(-2.62)	(-2.88) [0.05]**	(-3.09) [0.12]	(-2.41) [0.14]	(-2.34) [0.41]	I(1)
ΔIRCL	(-5.41)*	(-5.47)*	(-5.39) [0.00]*	(-5.40) [0.00]*	(-5.15) [0.00]*	(-5.15) [0.00]*	
WACF	(-1.84)***	(-2.50)	(-2.23) [0.20]	(-2.47) [0.34]	(-2.34) [0.16]	(2.63) [0.27]	I(1)
ΔWACF	(-7.88)*	(-7.88)*	(-7.82) [0.00]*	(-7.77) [0.00]*	(-7.82) [0.00]*	(7.77) [0.00]*	

Note: Values in () and [] show t-statistics and probability respectively. *, **, *** show significance at 1%, 5% and 10% level respectively. Null Hypothesis of DF, ADF and PP: Variable has a unit root.

The Sequential Modified LR Test Statistic (LR), the Final Prediction Error (FPE), AIC, SC and HQ Information Criterion presented a lag length of 2 for the conducting cointegration. Lag-length selection according to the VAR model showed that all dots were within the circle at the polynomial graph. Table 3 presents the ARDL (2,2) and NARDL (2,0,0) models.

The ARDL (2,2) model included DUMMY1 (it is defined as 1 for 2014M08; as 0 for the other months) because of the instability of the CUSUM^2. Inclusion of DUMMY 1 ensures the stability for the overall model. In addition, other diagnostic test results [Jarque-Bera test for normality (X^2_{JB}), Breusch-Godfrey Serial Correlation LM test (X^2_{BG}), ARCH test for heteroscedasticity (X^2_{ARCH}), Ramsey's reset test for misspecification of model (X^2_R)] and statistics [$\mathrm{R}^2, \overline{\mathrm{R}}^2, \mathrm{F}$] of the model indicated that there was no problem statistically within the ARDL (2,2) model.

The finding of the Bound Test indicated that the estimated F-statistic value was statistically significant, and it was higher than the critical value of the upper bound of Narayan's (2005) table. WACF affected IRCL positively and significantly in the long and short run. The long-run findings indicated that a 1 % increase (decrease) in the WACF was able to lead to an increase (decrease) of 1.094 % in IRCL. Thus, commercial lending rates exhibited an overshooting reaction to the changes in the policy rates.

The short-run estimates were 0.242 and 0.257 respectively. This meant that the commercial lending rate pass-through was incomplete. The estimation of the EC was -0.167. When the CBRT changed the policy rate, the adjustment took around 6 months for the commercial lending rate to reach its long-run equilibrium value.

Table 3. ARDL and NARDL Models: (2011:01-2016:12)

	ARDL (2,2)			**NARDL (2,0,0)**		
Bound Test	**F statistic** 4.460**			**F statistic** 5.278*		
	Variable	**Coef**	**Prob**	**Variable**	**Coef**	**Prob**
Long Run	WACF	1.094	0.000*	WACF_POS	1.234	0.000*
	DUMMY1	-6.568	0.055**	WACF_NEG	1.249	0.000*
	C	5.123	0.018**	DUMMY1	-6.017	0.028**
				C	11.847	0.000*
Error Correction Model	D(IRCL(-1))	0.252	0.008*	D(IRCL(-1))	0.288	0.003*
	D(WACF)	0.242	0.007*	D(WACF_POS)	0.337	0.003*
	D(WACF(-1))	0.257	0.011**	D(WACF_NEG)	0.134	0.397
	D(DUMMY1)	-1.305	0.002*	D(DUMMY1)	-1.431	0.001*
	EC(-1)	-0.167	0.001*	EC(-1)	-0.211	0.000*
Wald Test				$\mathrm{W_L}$	0.037 (0.848)	*Symmetric*
				$\mathrm{W_S}$	(-)	
Model Statistics	R^2		0.501	R^2		0.386
	$\overline{\mathrm{R}}^2$		0.453	$\overline{\mathrm{R}}^2$		0.338
	F		10.541 (0.000)	F		8.038 (0.000)
Diagnostic Tests	$\mathrm{X}^2_{\mathrm{JB}}$		0.362(0.835)	$\mathrm{X}^2_{\mathrm{JB}}$		0.772(0.680)
	$\mathrm{X}^2_{\mathrm{BG}}$		0.097(0.907)	$\mathrm{X}^2_{\mathrm{BG}}$		0.221(0.802)
	$\mathrm{X}^2_{\mathrm{ARCH}}$		0.043(0.958)	$\mathrm{X}^2_{\mathrm{ARCH}}$		0.591(0.557)
	$\mathrm{X}^2_{\mathrm{R}}$		0.599(0.442)	$\mathrm{X}^2_{\mathrm{R}}$		1.065(0.306)
	CUSUM		Stable	CUSUM		Stable
	CUSUM^2		Stable	CUSUM^2		Stable

Note: *, **, *** show significance at 1%, 5% and 10% level respectively.

If there is an asymmetric relationship in the model, the ARDL model may not present correct results. For this reason, the NARDL model is also estimated to test asymmetry with the Wald test. The findings of NARDL showed that there was a positive and statistically significant relationship between WACF and IRCL in the long run. The short-run results indicated that while the increment of WACF increased IRCL, the decrease in WACF did not have a statistically significant effect on IRCL. However, the Wald test results did not support asymmetry in the long run. As a result, the pass-through from the policy rate to the commercial lending rate was symmetric between 2011:01 and 2016:12 for Türkiye. The findings of the NARDL Wald Test confirmed the robustness of the ARDL model.

4.2. Results of Second Period: (2017:01-2023:10)

Table 4 shows the results of the DF, ADF, and PP tests. The findings indicate that IRCL is I(1), while WACF is I(0). Since time series do not need to be cointegrated in the same order, this study applied the ARDL and NARDL models for the period of 2017:01-2023:10.

Table 4. Unit Root Tests: (2017:01-2023:10)

Variable	DF		ADF		PP		Status
	Intercept	Intercept and Trend	Intercept	Intercept and Trend	Intercept	Intercept and Trend	
IRCL	(-1.70)***	(-2.52)	(-1.97) [0.30]	(-2.07) [0.56]	(-1.26) [0.64]	(-1.30) [0.88]	I(1)
ΔIRCL	(-3.68)*	(-3.84)*	(-3.68) [0.01]*	(-3.83) [0.02]**	(-3.68) [0.01]*	(-3.83) [0.02]*	
WACF	(-2.84)*	(-3.45)**	(-3.37) [0.02]**	(-3.20) [0.09]***	(-1.75) [0.40]	(-1.69) [0.75]	I(0)
ΔWACF	(-4.36)*	(-4.45)*	(-4.33) [0.00]*	(-4.40) [0.00]*	(-4.46) [0.00]*	(-4.53) [0.00]*	

LR, FPE, and AIC presented a lag length of 4 for the conducting cointegration. Lag-length selection according to the VAR model indicates that all dots are within the circle at the polynomial graph. Table 5 presents the ARDL (2,2) and NARDL (2,4,0) models.

The ARDL (2,2) includes DUMMY2 (it is defined as 1 for 2021M12-2022M08; as 0 for the other months) to resolve the instability of CUSUM^2. The inclusion of DUMMY2 ensures the stability for the overall model. Thus, all diagnostic test results and statistics of the model show that there is no problem statistically within the model. The Bound test result of the ARDL (2,2) model showed that the calculated F-statistic value was statistically significant and there was a cointegration between WACF and IRCL.

WACF affected IRCL positively and significantly in the long and short run. The long-run results indicated that a 1 % increase (decrease) in the WACF was able to lead to an increase (decrease) of 0.898 % in IRCL. This means that the long-run pass-through is incomplete for the period of 2017:01-2023:10. The short-run estimates were 0.733 and 0.472 respectively. Thus, commercial lending rates exhibited a lower reaction. The estimate of the EC was -0.248 and statistically significant. The adjustment took around 4 months for the commercial lending rate to reach its long-run equilibrium value when CBRT changed the policy rate.

Although the NARDL model provided significant coefficients, the findings of the Wald test did not support asymmetry in the long run. Thus, the pass-through of the commercial lending rates was symmetric for the period of 2017:01-2023:10 in Türkiye. The findings of the NARDL Wald Test confirmed the robustness of the ARDL model.

Table 5. ARDL and NARDL Models: (2017:01-2023:10)

	ARDL (2,2)			**NARDL (2,4,0)**		
Bound Test	**F statistic**			**F statistic**		
	7.065*			8.706*		
	Variable	**Coef**	**Prob**	**Variable**	**Coef**	**Prob**
Long Run	WACF	0.898	0.000*	WACF_POS	0.739	0.000*
	DUMMY2	7.364	0.000*	WACF_NEG	0.751	0.000*
	C	5.222	0.008*	DUMMY2	8.256	0.000*
				C	13.409	0.000*
Error Correction Model	D(IRCL(-1))	0.253	0.009*	D(IRCL(-1))	0.304	0.002*
	D(WACF)	0.733	0.000*	D(WACF_POS)	0.850	0.000*
	D(WACF(-1))	0.472	0.001*	D(WACF_POS(-1))	0.518	0.009*
	D(DUMMY2)	3.129	0.002*	D(WACF_POS(-2))	-0.178	0.388
	EC(-1)	-0.248	0.000*	D(WACF_POS(-3))	0.506	0.010**
				D(WACF_NEG)	0.333	0.090***
				D(DUMMY2)	3.242	0.001*
				EC(-1)	-0.287	0.000*
Wald Test				W_L	0.046 (0.831)	*Symmetric*
				W_S		-
Model Statistics	R^2		0.736	R^2		0.761
	$\overline{R}^2$		0.714	$\overline{R}^2$		0.729
	F		33.846 (0.000)	F		23.754 (0.000)
Diagnostic Tests	X^2_{JB}		3.724(0.155)	X^2_{JB}		0.284(0.868)
	X^2_{BG}		0.667(0.617)	X^2_{BG}		0.721(0.581)
	X^2_{ARCH}		1.008(0.409)	X^2_{ARCH}		0.164(0.956)
	X^2_R		2.075(0.154)	X^2_R		0.325(0.571)
	CUSUM		Stable	CUSUM		Stable
	$CUSUM^2$		Stable	$CUSUM^2$		Stable

5. Conclusion and Policy Recommendations

Monetary policy has a crucial function for the CBRT's two important targets of price stability and financial stability. For central banks to achieve their purpose through the interest rate channel, banks' rates need to be directed in line with targets. Hence, interest rate pass-through is an important topic for the central banks. While an incomplete pass-through may cause a failure of monetary policies, a complete one ensures its success because the bank's deposit and lending rates determine the decisions of the economic units about investment, savings, and consumption. When the policy rate is lowered by applying an expansionary monetary policy aimed at stimulating economic activity and this decrease is reflected in the bank's lending rate completely, economic units increase consumption and investment expenditures. Thus, the aggregate demand and production also increase. On the other hand, when central banks increase the policy rate by applying the contractionary monetary policy in order to curb inflation, and this increase reflects bank's lending rate completely, total output decreases due to the decrement of the expenditures.

Hence, inflationary pressure decreases. As a result, interest rate pass-through should be symmetric and complete in a well-functioning macro-financial market.

This is exactly why the interest rate pass-through is an important research topic in terms of demonstrating the success or failure of monetary policy. This study aimed at testing the pass-through within the framework of the Monetary Policy Approach by using linear ARDL and NARDL models for two periods (2011:01-2016:12 and 2017:01-2023:10). Testing two periods and comparing the results of these periods with ARDL and NARDL makes this study different from other studies that have analyzed Türkiye.

NARDL Wald test results indicated that pass-through was symmetric for both periods. Symmetric pass-through made it possible to discuss and compare the findings of linear ARDL models. According to the long-run results, the coefficient of the pass-through was higher than 1 in the first period while it was lower than 1 in the second period. Short-run findings presented that the coefficient was lower in the first period compared to the second period. The speed of adjustment was faster in the second period.

The finding of the symmetry is in line with Yuksel and Metin Ozcan (2013) and Sahin (2019). The long-run results of the second period are similar to the studies conducted by Buberkoku and Kizilder (2019), Bulut (2020), Salihoglu and Hepsag (2021). Lastly, the speed of adjustment for the second period is similar to the study of Cavusoglu (2010). Symmetric pass-through for both periods is a very important advantage for the CBRT. CBRT may control overall the macroeconomy and reach its aims more easily due to the symmetry. Although the long-run findings are statistically significant for both periods, coefficients differ from each other. This difference indicates that different factors may have been effective for interest rate pass-through. The overshoot of commercial lending rates in the first period may be related to the reaction of banks against asymmetric information. Banks may not have rationed the amount of loan supply and may have chosen to increase lending rates to counter moral hazard and adverse selection problems in the first period. The incomplete pass-through in the second period could be caused by many different factors as weak competition or power market, rationing of credit supply, economic contraction, rising uncertainty, large amounts of public debt, temporary and unexpected changes in policy rates, and adjustment costs. Frequent changes in the policy rate in the second period may have caused weak pass-through due to adjustment costs. Thus, the stability of the policy rate is so important for a complete pass-through.

As a result, the interest rate pass-through of Türkiye is overshoots in the first period while it is incomplete in the second one. These findings require policy recommendations for strengthening interest rate pass-through. The stability of macroeconomic variables is important for the pass-through because the stability of policy rates depends on the stability of macroeconomic variables. The instability of the general level of prices may lead to frequent changes in policy interest rates. It is recommended to be patient and decisive for the contractionary monetary policies applied to reduce inflation for Türkiye. If inflation is permanently reduced, the policy rate can be stable and the stability of the interest rate will strengthen the interest rate pass-through. Since a high level of public debt negatively affects pass-through, it is recommended to pay special attention to fiscal discipline. If the CBRT avoids unexpected and temporary changes to the policy rate, pass-through will be complete or almost complete. Asymmetric information may cause both upward and downward rigidity for lending rates. For this reason, it will be useful to focus on the solution of asymmetric information

problems in commercial loan markets. A good way to solve these problems is for the supplier of the loans to have reliable and detailed information from a neutral institution. Finally, the speed of adjustment is so important for the decisions of central banks. CBRT should take into account the speed of adjustment determined in this study to timely adjust the policy rate and monetary policy decisions.

If these recommendations are put into practice, the interest rate pass-through may be complete. Achieving price stability will be easier and faster when the interest pass-through is complete or almost complete. Additionally, a complete pass-through will increase the resilience of the financial system against macro-financial risks and shocks from both internal and external sources.

Declaration of Research and Publication Ethics
This study which does not require ethics committee approval and/or legal/specific permission complies with the research and publication ethics.

Researcher’s Contribution Rate Statement
I am a single author of this paper. My contribution is 100%.

Declaration of Researcher’s Conflict of Interest
There is no potential conflicts of interest in this study.

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